



PHD IN MANAGEMENT

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THESIS

INTERNATIONAL KNOWLEDGE TRANSFER:

**AN INTEGRATED ANALYSIS OF ANTECEDENTS, CONSEQUENCES AND TIME
PATTERNS OF THE FDI KNOWLEDGE SPILLOVER EFFECT**

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Abstract

This thesis is concerned with the process of international knowledge transfer mediated by multinational corporations' Foreign Direct Investment. Answering to International Business scholars' recent call for a deeper analysis of the multinational firms' strategic behaviour at the level of the subsidiary, it explores the theoretical drivers behind the active role foreign subsidiaries can play in influencing the process of knowledge dissemination within the host-location.

Using two different datasets on foreign subsidiaries' local innovative activity and business linkages with domestic suppliers and distributors, the empirical analysis lends support for established theorizing about multinational firms' trade-off between the opportunity to learn from the host-environment and the risk to lose control over their proprietary knowledge assets, due to the local spillover effect. Moreover, shifting the focus of the analysis from the head-quarter to the foreign subunits, the results reveal that subsidiaries actively manage these knowledge flows within their host-locations, to the aim of fostering incoming information (in terms of both technology and knowledge of the local business network and market), while at the same time restricting outward spillovers.

It is also shown that, in order to manage these knowledge flows, foreign subsidiaries adapt their investment in local interaction with domestic firms to both internal and external factors. More specifically, the results suggest that increasing competitive pressure fosters the importance of sourcing resources for innovation from the local context. However, when competition becomes too high, subsidiaries tend to lower the extent of close interaction with local counterparts, in order to protect their competitive assets from the increased risk of knowledge spillover in the external environment. Furthermore, this relationship is moderated by the extent to which the subsidiaries possess relevant competitive assets. In other words, especially capable subsidiaries in very competitive environments tend to shy away from strong interaction with local firms, since under such circumstances the risk of spillovers is larger than the potential benefits of learning.

This thesis also makes a theoretical contribution by combining International Business literature with Open Innovation perspectives to develop a framework for the analysis of the time patterns of the knowledge flows between foreign and domestic firms. Specifically, it motivates the importance – for firms' competitiveness - of evaluating the speed at which this phenomenon takes place.

Keywords: knowledge spillover, multinational corporation, foreign subsidiaries, knowledge strategies, local linkages, patents, speed.

Extended Abstract

This thesis is concerned with the process of international knowledge transfer mediated by multinational corporations' Foreign Direct Investment. Multinational firms (hereafter, MNC) are recognized as central actors for the dynamics of this phenomenon, since - through their globally distributed network of foreign subsidiaries - they transfer part of their knowledge to the host-locations, and contribute to the processes of local innovation and knowledge creation.

Foreign Direct Investment (hereafter, FDI) has been recognized as a crucial channel through which recipient countries become more able to overcome the geographic localisation of knowledge distribution, thanks to the effect of localised spillovers. This strategic importance has legitimated a substantial strand of literature to focus on the *macro-level mechanisms* that explain the positive consequences of FDI on countries' growth, but has lead to postpone the analysis of its consequences on individual firms' competitiveness.

However, over time, a relevant line of study has emphasized the role played by firm-level heterogeneity on the FDI knowledge spillover effect (Castellani and Zanfei, 2006). Research has in fact recognized that, in the case of FDI, the knowledge sources (i.e., the MNCs' affiliates) and the knowledge recipients (i.e., the domestic firms) can be the parties of a competitive relation (Meyer, 2004; Chang and Xu, 2008) and, as a consequence, the resources that flow from MNCs to local firms are an important determinant of their relative competitive position (Alcacer and Chung, 2007). The acknowledgment of knowledge spillovers' relevance for the micro-level competitive dynamics among foreign and local firms - which has probably been motivated by the increasing diffusion of knowledge-based theoretical perspectives in the International Business literature - has promoted the start of a research strand on the antecedents and consequences of FDI-mediated spillovers *at the level of the individual firm*.

The very first contributions to this literature aimed to account for the role that MNCs' parent companies can play in determining the extent of spillovers generated within their host-locations. These studies suggest that not only are multinational corporations different in terms of their *potential* to generate knowledge spillovers (due to their different endowments in terms of technological capabilities); rather, they also heterogeneously manage the risk of spillover (due to their different willingness to share knowledge with competitors), thus affecting the *actual* level of knowledge flows they generate to local firms.

Consequences of these sources of heterogeneity *at the subsidiary-level* have long been ignored, due to the established belief that sees subsidiaries as passive actors of the MNC and the host-country networks. Indeed, on a more theoretical level, the knowledge spillover effect has been traditionally conceptualized through the so-called "pipeline-model" (Marin and Bell, 2006), as an *automatic* consequence of the international transfer of the knowledge assets developed at the level of headquarters, with no role for the subsidiaries in the dynamics of this process.

Only very recently, scholars have begun to recognize that also *subsidiaries* may influence the patterns of knowledge flows to local firms (Branstetter, 2006; Marin and Sasidharan, 2010). However, most of the studies on the subsidiary-level antecedents of FDI-spillovers have focused

on the *structural* characteristics of subsidiaries (e.g. the type of facility, the intensity of local technological activity, the relationships with the parent company), thus overlooking the potential impact of subsidiaries' *strategy*.

Answering to International Business scholars' recent call for a deeper analysis of the multinational firms' strategic behaviour at the level of the subsidiary, this dissertation explores the theoretical drivers behind the active role foreign subsidiaries can play in influencing the process of knowledge dissemination within the host-location, and its consequences for the knowledge spillover effect.

Understanding how *subsidiaries* can affect the degree of knowledge spillovers to local firms is important for two main reasons: first, because knowledge spillovers happen *locally*, through the process of interaction between the foreign affiliate of the MNC firm and the domestic organizations (accordingly, being the real *local* agent, it's the subsidiary – rather than the parent company - to be the main character of the interactive dynamics); second, because subsidiaries are becoming increasingly active within both the MNC network and the local context (Cantwell, 1995; Birkinshaw *et al.*, 1998; Birkinshaw and Hood, 2000; Marin and Bell, 2006) especially with regard to their technological activities (Blomkvist *et al.*, 2010).

Inspired by these insights, the overarching research question of this dissertation is: *How does subsidiaries' local strategic behavior affect the knowledge spillover effect to domestic firms?* In answering this overarching research question, the dissertation is composed of four essays, each addressing a specific aspect of the general subject.

In the first essay, the drivers, consequences and attributes of the FDI-mediated knowledge spillover effect are elaborated within a comprehensive theoretical framework, which integrates the several contributions to the topic over the different levels of analysis (both macro and micro) with the new perspectives on subsidiaries' active role, and provides innovative tools to comprehensively evaluate this effect. This essay aims to address the lack of conceptualisation of International Business research on FDI-mediated knowledge spillovers, which is due to both the predominance of macroeconomic analyses on the topic, and the complexity of disentangling the effects of the manifold variables that may influence the phenomenon.

The second essay investigates the relationship between subsidiaries' knowledge strategies within the host-location and the spillover effect. Subsidiaries' local strategic behaviour, with respect to the management of their knowledge assets, is in fact conceptualised through the identification of two main knowledge imperatives: a need for knowledge creation, explained by the importance of sourcing local knowledge to feed the innovative process and create new technology, and a need for knowledge protection, related to the urge to fully appropriate the benefits of proprietary assets and outperform local rivals. In order to understand how a subsidiary's management of these knowledge imperatives influences the spillover effect to local firms, the following research question is addressed: *How does the tension between knowledge creation and knowledge protection influence the extent of a subsidiary's local knowledge outflows?*

In the third essay, the effects of subsidiaries' strategy on FDI-mediated spillovers are analysed by exploring how subsidiaries manage their local vertical linkages (i.e., their business relationships with local suppliers and distributors). Research has indeed demonstrated that "quality linkages", that is linkages characterized by trust, interdependence and mutual adaptation, act as privileged conduits through which tacit knowledge flows bidirectionally, thus generating both outward (from foreign subsidiary to local firms) and inward (from local firms to foreign subsidiaries) spillovers. Traditional empirical research on vertical linkages has focused on less developed and developing countries, and has mainly investigated local firms' gain from MNCs' subsidiaries presence. However, in more developed settings, local partners are endowed with absorptive capacity and possess competitive resources, which make outward spillovers more dangerous and inward spillovers more attractive. An analysis of how subsidiaries behave under these conditions, and of how this behaviour influences the local spillover effect, is still missing. To fill this gap, the third essay addresses the following research question: *To what extent do foreign subsidiaries develop high-quality buyer-supplier relationships in developed countries?*

The fourth essay matches International Business literature on spillovers with recent "Open Innovation" perspectives. This choice is justified by the fact that openness can be defined as the attitude to emphasize the search for external knowledge sources, while downsizing the relevance of knowledge protection. Therefore, multinational corporations' adoption of such an attitude can be crucial in fostering the local knowledge spillover effect, especially if firms in the host-location share the same approach. Moreover, in a departure from previous literature that has merely investigated the *magnitude* of the knowledge spillover effect, in this essay, the impact of "openness" is explored by looking at the time patterns of the phenomenon. This study therefore elaborates on the speed with which subsidiaries' knowledge diffuses to the host economy and become available to local firms, thus allowing them to accelerate their innovation processes, and reads this phenomenon through an "Open Innovation" lens. To investigate this topic, the fourth essay addresses the following research question: *How do multinational firms' and host-regions' openness influence the time patterns of the FDI-mediated knowledge spillover effect?*

Using two different datasets on foreign subsidiaries' local innovative activity and business linkages with domestic suppliers and distributors, the empirical analysis lends support for established theorizing about multinational firms' trade-off between the opportunity to learn from the host-environment and the risk to lose control over their proprietary knowledge assets, due to the local spillover effect. Moreover, shifting the focus of the analysis from the head-quarter to the foreign subunits, the results reveal that subsidiaries actively manage these knowledge flows within their host-locations, to the aim of fostering incoming information (in terms of both technology and knowledge of the local business network and market), while at the same time controlling outward spillovers.

Previous research suggests that, within the MNC's organization, headquarters are the subjects that have the responsibility to manage the spillover risks in host-countries. Adding to this literature, the empirical analysis of this dissertation provides support to the idea that also subsidiaries can influence the local spillover effect, and that this happens not only because of

their structural characteristics (like the subsidiary type or the local activity developed in the foreign location), but also depending on their local strategic behaviour.

It is also shown that, in order to manage these knowledge flows, foreign subsidiaries adapt their investment in local interaction with domestic firms to both internal and external factors. More specifically, the results suggest that increasing competitive pressure fosters the importance of sourcing resources for innovation from the local context. However, when competition becomes too high, subsidiaries tend to lower the extent of close interaction with local counterparts, in order to protect their competitive assets from the increased risk of knowledge spillover in the external environment. Furthermore, this relationship is moderated by the extent to which the subsidiaries possess relevant competitive assets. In other words, especially capable subsidiaries in very competitive environments tend to shy away from strong interaction with local firms, since under such circumstances the risk of spillovers is larger than the potential benefits of learning.

Keywords: knowledge spillover, multinational corporation, foreign subsidiaries, knowledge strategies, local linkages, patents, speed.

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Research idea: Local Spill-over Effects and R&D Co-Practices between Foreign and Domestic Firms: The Role of Technological and Geographical Proximity

SUMMARY OF THE THESIS*

* In 2009, the proposal of this thesis was awarded with the European International Business Academy “*Best Doctoral Thesis Proposal Award*”

	Title of the essay/research idea	Authors	Type of paper (theoretical/conceptual vs. empirical)	Conferences/ seminars	Status of the paper
1.	<i>Assessing FDI knowledge spillover research: a multilevel perspective</i>	Perri A. and Caroli M.G.	Theoretical/conceptual	<ol style="list-style-type: none"> 1. PhD seminar, Center for Strategic Management and Globalization, Copenhagen Business School – February, 2010 2. Department research seminar, Deusto Business School, San Sebastian – January, 2011 	Completed
2.	<i>Knowledge flows from foreign subsidiaries: the tension between knowledge creation and knowledge protection</i>	Perri A.	Empirical	<ol style="list-style-type: none"> 1. Summer School “Economics and Management of IPRs”, University of Bologna – June, 2009 2. European International Business Academy Doctoral Tutorial, Valencia – December, 2009 3. Strategic Management Society Doctoral Workshop – September, 2010 4. Accepted at DIME (Dynamics of Institutions and Markets in Europe) – April, 2011 	Completed
3.	<i>Balancing the trade-off between learning prospects and spillover risks: MNC subsidiaries vertical linkage patterns in developed countries</i>	Perri A., Andersson U., Nell P.C., Santangelo, G.	Empirical	<ol style="list-style-type: none"> 1. Presented as a competitive paper at the European International Business Academy, Porto - December, 2010 	Completed
4.	<i>Does FDI Accelerate the Local Spillover Effect? The Role of MNCs' and Host-Regions' Openness</i>	Perri A. and Oriani R.	Empirical	<ol style="list-style-type: none"> 1. Submitted to the Academy of International Business Annual Conference, to be held in Nagoya – June, 2011 	At the stage of complementary data collection
5.	<i>Local Spill-over Effects and R&D Co-Practices between Foreign and Domestic Firms: The Role of Technological and Geographical Proximity</i>	Perri A. and Leone M.I.	Empirical	<ol style="list-style-type: none"> 1. Submitted to the Strategic Management Society Annual Conference, to be held in Miami – September, 2011 	At the stage of complementary data collection

INTRODUCTION

This dissertation analyses the process of international knowledge transfer mediated by Multinational Corporations' Foreign Direct Investment. Multinational firms (hereafter, MNCs) are recognized as central actors for the dynamics of this phenomenon, since - through their globally distributed network of foreign subsidiaries - they transfer part of their knowledge to the host-locations, and contribute to the processes of local innovation and knowledge creation.

Foreign direct investment (hereafter, FDI) has been recognized as a crucial means through which recipient countries become more able to overcome the geographic localisation of knowledge distribution, thanks to the effect of localised spillovers. This strategic importance has legitimated a substantial strand of literature to focus on the *macro-level mechanisms* that explain the positive consequences of FDI on countries' growth. These studies have identified the pivotal role of the technological gap between the MNCs' home and host countries as an enabler of the spillover effect. In fact, scholars have suggested that the deeper is this gap, the higher is the potential for spillover, since local firms have more to learn from the foreign counterparts. Additionally, empirical evidence has confirmed the importance of local firms' absorptive capacity, as a pre-condition required to assimilate the knowledge flows generated by MNCs' subsidiaries.

The relevance of the FDI-mediated spillover effect for host countries' growth has lead to postpone the analysis of its consequences on individual firms' competitiveness. However, over time, a relevant line of study has emphasized the role played by firm-level heterogeneity on the FDI knowledge spillover effect (Castellani and Zanfei, 2006). Research has in fact recognized that, in the case of FDI, the knowledge sources (i.e., the MNCs' affiliates) and the knowledge recipients (i.e., the domestic firms) can be the parties of a competitive relation (Meyer, 2004; Chang and Xu, 2008) and, as a consequence, the resources that flow from MNCs to local firms are an important determinant of their relative competitive position (Alcacer and Chung, 2007). The acknowledgment of the relevance of knowledge spillovers for the micro-level competitive

dynamics among foreign and local firms - which has probably been motivated by the increasing diffusion of knowledge-based theoretical perspectives in the international business literature - has promoted the start of a research strand on the antecedents and consequences of FDI-mediated spillovers *at the level of the individual firm*.

The very first contributions to this literature aimed to account for the role that MNCs' parent companies can play in determining the extent of spillovers generated within their host-locations. These studies suggest that not only are multinational corporations different in terms of their *potential* to generate knowledge spillovers (due to their different endowments in terms of technological capabilities); rather, they also heterogeneously manage the risk of spillover (due to their different willingness to share knowledge with competitors), thus affecting the *actual* level of knowledge spillover they generate to local firms.

Consequences of these sources of heterogeneity *at the subsidiary-level* have long been ignored, due to the established belief that sees subsidiaries as passive actors of the MNC and the host-country networks. Indeed, on a more theoretical level, the knowledge spillover effect has been traditionally conceptualized through the so-called "pipeline-model" (Marin and Bell, 2006), as an *automatic* consequence of the international transfer of the knowledge assets developed at the level of headquarters, with no role for the subsidiaries in the dynamics of this process.

Only very recently, scholars have begun to recognize that also *subsidiaries* may influence the patterns of knowledge flows to local firms (Branstetter, 2006; Marin and Sasidharan, 2010). Most of the studies on the subsidiary-level antecedents of FDI-spillovers have focused on the *structural* characteristics of subsidiaries (e.g. the type of facility, the intensity of local technological activity, the relationships with the parent company), thus overlooking the potential impact of subsidiaries' *strategy*. However, recent international business literature (Holm and Pedersen, 2000; Frost, Birkinshaw and Ensign, 2002) has highlighted the importance of examining firms' strategic behaviour also "*at the level of the subsidiary, rather than the level of the corporate group as a whole*" (Cantwell and Mudambi, 2005).

Understanding how *subsidiaries* can affect the degree of knowledge spillovers to local firms is important for two main reasons: first, because knowledge spillovers happen *locally*, through the process of interaction between the foreign affiliate of the MNC firm and the domestic organizations (accordingly, being the real *local agent*, it's the subsidiary – rather than the parent company - to be the main character of the interactive dynamics); second, because subsidiaries are becoming increasingly active within both the MNC network and the local context (Cantwell, 1995; Birkinshaw *et al.*, 1998; Birkinshaw and Hood, 2000; Marin and Bell, 2006) especially with regard to their technological activities (Blomkvist *et al.*, 2010).

Inspired by these insights, the overarching research question of this dissertation is: *How does subsidiaries' local strategic behavior affect the knowledge spillover effect to domestic firms?* In answering this overarching research question, the dissertation is composed of four essays, each addressing a specific aspect of the general subject.

In the first essay, the drivers, consequences and attributes of the FDI-mediated knowledge spillover effect are elaborated within a comprehensive theoretical framework, which integrates the several contributions to the topic over the different levels of analysis (both macro and micro) with the new perspectives on subsidiaries' active role, and provides innovative tools to comprehensively evaluate this effect. This essay aims to address the lack of conceptualisation of international business research on FDI-mediated knowledge spillovers, which is due to both the predominance of macroeconomic analyses on the topic, and the complexity of disentangling the effects of the manifold variables that may influence the phenomenon.

The second essay investigates the relationship between subsidiaries' knowledge strategies within the host-location and the spillover effect. Subsidiaries' local strategic behaviour in terms of the management of their knowledge assets is in fact conceptualised through the identification of two main knowledge imperatives: a need for knowledge creation, explained by the importance of sourcing local knowledge to feed the innovative process and create new technology, and a need for knowledge protection, related to the urge to fully appropriate the benefits of proprietary

assets and outperform local rivals. In order to understand how a subsidiary's management of these knowledge imperatives influences the spillover effect to local firms, the following research question is addressed: *How does the tension between knowledge creation and knowledge protection influence the extent of a subsidiary's local knowledge outflows?*

In the third essay, the effects of subsidiaries' strategy on FDI-mediated spillovers is analysed by exploring how subsidiaries manage their local vertical linkages (i.e., their business relationships with local suppliers and distributors). Research has indeed demonstrated that "quality linkages", that is linkages characterized by trust, interdependence and mutual adaptation, act as a privileged conduit through which tacit knowledge flows bidirectionally, thus generating both outward (from foreign subsidiary to local firms) and inward (from local firms to foreign subsidiaries) spillovers. Traditional empirical research on vertical linkages has focused on less developed and developing countries, and has investigated local firms' gain from MNCs' subsidiaries presence. However, in more developed settings, local partners are endowed with absorptive capacity and possess themselves competitive resources, which make outward spillovers more dangerous and inward spillovers more attractive. An analysis of how subsidiaries behave under these conditions, and of how this behaviour influences the local spillover effect, is still missing. To fill this gap, the third essay addresses the following research question: *To what extent do foreign subsidiaries develop high-quality buyer-supplier relationships in developed countries?*

The fourth essay matches International Business literature on spillovers with the "Open Innovation" perspective. This choice is justified by the fact that openness can be defined as the attitude to emphasize the search for external knowledge sources, while downsizing the relevance of knowledge protection. Therefore, multinational corporations' adoption of such an attitude can be crucial in fostering the knowledge spillover effect, especially if firms in the host-location share the same approach. Moreover, in a departure from previous literature that has merely investigated the *magnitude* of the knowledge spillover effect, in this essay, the impact of

“openness” is explored by looking at the time patterns of the phenomenon. This study therefore provides an analysis of the speed with which subsidiaries’ knowledge diffuses to the host economy and become available to local firms, thus allowing them to accelerate their innovation processes, and reads this phenomenon through an “Open Innovation” lens. To investigate this topic, the fourth research question addressed by this dissertation is the following: *How do multinational firms’ and host-regions’ openness influence the time patterns of the FDI-mediated knowledge spillover effect?*

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ESSAY 1

**ASSESSING FDI KNOWLEDGE SPILLOVER RESEARCH:
A MULTILEVEL PERSPECTIVE**

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Abstract

The first essay of this dissertation aims to argue the need for further and renewed research in FDI knowledge spillover related topics. We suggest that international business literature has underestimated the strategic relevance of this phenomenon for the competitiveness of foreign subsidiaries. We review existing research on the antecedents and consequences of FDI knowledge spillovers, and identify a set of gaps in the theoretical and empirical literature that may represent useful starting points for future research attention. We integrate these considerations within a FDI knowledge spillover theoretical framework, whose contribution is manifold. First, it provides a comprehensive illustration of all factors that should be accounted for when trying to understand the spillover effect, as well as a flexible methodological approach to analyse the phenomenon, along different relevant dimensions. Second, it adds a set of useful insights from heterogeneous and more recent strands of research to the traditional literature on FDI-spillovers. Third, in a departure from most of previous research that has focused mainly on local firms' gains from the presence of subsidiaries, it reconciles this perspective with the point of view of the foreign firm. Finally, it develops three spillovers constructs (quantity, speed and scope) that can be used in future empirical research, in order to describe more comprehensively the spillover effect, as well as to better assess the impact of the phenomenon on both local firms' and MNCs' competitiveness.

Keywords: knowledge spillover, multinational corporations, foreign subsidiaries, knowledge strategies, social norms, networks.

1. Introduction

A half-century of foreign direct investment spillover research has led to the build-up of many different perspectives on the topic. The benefits arising from the foreign multinational corporations' investment are a matter of considerable importance for host countries. When multinational firms locate their activities abroad, they pull in large capital inflows, boost the local employment and bring technological and managerial expertise to the host economy.

As recently stated by Eden (2009, p. 1065), the literature on the impact of foreign direct investment (hereafter, FDI) on host countries “*tends to be dominated by economists*”. Indeed, many of the consequences of the private investment from abroad are relevant for the objectives of the research that studies growth- and international economics- related issues, while they go beyond the scope of management scholars. As an example, the analysis of the direct welfare effects arising from the increase of the aggregate level of capital stock or employment generated by FDI does not fall within the aims of managerial research. However, the localization of multinational corporations' subsidiaries abroad is associated with several other indirect effects, which are more “micro-founded”. These effects deal with the extent to which the *strategic interaction between foreign and local firms* alters their relative competitive positions, due to the impact of knowledge spillovers. Therefore, they are of great interest for the management – and, more specifically, for the international business - audience, since they help us to understand the costs and benefits that both domestic and foreign firms get when they come in contact.

Notwithstanding its relevance, there is poor conceptualisation of this phenomenon in the International Business literature, due to both the predominance of macroeconomic analyses on the topic, and the complexity of disentangling the effects of the wide set of variables that - at different levels of analysis - affect the net result of such interaction between local and foreign agents on firms' competitiveness.

Extant research has either provided empirical evidence of spillovers' existence, or analysed the mechanisms through which they take place, or focused on single determinants of their occurrence. While being very important in shedding some light on different aspects of FDI knowledge spillovers, such approaches limit our *general understanding of the topic*, and are still far from elucidating the *attributes of the knowledge spillover effect* that determine the extent to which it actually affects the relative competitive position between foreign and local firms.

The purpose of this paper is to improve the International Business theoretical foundations of FDI knowledge spillovers, by developing a comprehensive framework for the analysis of this phenomenon. To this aim, we take stock of what we know about the topic, and give directions for future research, by evaluating existing contributions to the FDI-spillover literature both at a macro-level and at a micro-level of analysis, and by focusing on the antecedents and consequences of spillovers at each level. We adopt a Knowledge-Based theoretical perspective, in which knowledge is assumed as "*the most strategically important of the firm's resources*" (Grant, 1996; p. 110). In this framework, firms have a strong incentive both to absorb relevant knowledge from external sources, and to protect their own valuable knowledge from third parties' appropriation. Hence, consistent with our objectives, this approach allows us to understand the conditions that affect the bi-directional patterns of "*learning and contribution*" (Almeida, 1996; p. 162) between local and foreign firms, thus providing a more focused analysis of how and to what extent FDI influence firms' relative competitive position. Following this perspective, we also develop a comprehensive set of *knowledge spillovers' attributes*, that can be employed in future empirical research, and may help to better assess the impact of the spillover effect on firms' competitiveness.

The paper is structured as follows. First, we define different types of FDI externalities, and provide a justification for our focus on *knowledge-based* spillovers. Second, we review existing literature on the antecedents and consequences of the phenomenon, either at a country-, industry- and firm-level of analysis, and stress the main contributions and limitations of these studies,

drawing on insights originating from different theoretical perspectives that we consider relevant to the aim of our analysis. Finally, we integrate our points into a framework useful for the comprehensive understanding, and further investigation, of FDI knowledge spillovers.

2. Multinational firms, knowledge and FDI spillovers

Original research on multinational corporations (hereafter, MNCs) grounds their existence into the failure of the international market for technology (Hymer, 1976; Buckley and Casson, 1976). Following this perspective, International Business (hereafter, IB) literature has started to look at multinational corporations as geographically distributed networks of innovation, whose main ability is to assimilate, create and integrate knowledge on a global basis (Bartlett and Ghoshal, 1989; Kogut and Zander, 1993; Hedlund, 1994; Birkinshaw, 1997; Frost et al., 2002). As a consequence, for multinational firms, the set of knowledge resources they own, and their capability to manage such resources, often constitute the major ingredients for value creation and competitiveness. This perspective on multinational corporations, which has gained large support among IB scholars, is consistent with the Knowledge-Based Theory of the Firm, which considers knowledge as the key-resource of contemporary firms (Grant, 1996).

There is a general consensus that the localization of FDI, and – thereby - the presence of multinational corporations, generates externalities for host-country firms. Generally speaking, spillovers arise when third parties, not directly involved into a given activity, reap the costs or benefits of the activity itself (Pigou, 1920). In order to conceptualise the externalities generated by FDI, the first step is to distinguish between pecuniary and non-pecuniary spillovers (Eden, 2009).

FDI *pecuniary spillovers* originate from buyer-supplier relationships, in which the multinational firm is involved, and impact the supply or demand conditions for consumers or other firms (Dunning and Lundan, 2008). They are usually “vertical” and materialize in the so-

called backward and forward linkages, i.e. business relationships with local suppliers or distributors. They take place, for instance, when a foreign firm boosts the local demand for a given input, thus generating an increase in the cost of that input, or when it produces more specialized intermediate factors - that will be used by local firms as inputs of their productive processes - at more competitive costs (Rodriguez-Clare, 1996).

Non-pecuniary spillovers take place when the activities of MNCs affect local firms' technological endowment and productivity, in ways that are independent on relative prices changes and, hence, on the functioning of markets. Much literature has analysed the direction, the scope and the channels through which this specific type of spillover occur within international settings (Teece, 1977; Rodriguez-Clare, 1996; Song et al., 2003; Feinberg and Majumdar, 2001; Nakamura, 2002; Jabbour and Mucchielli, 2004; Zhu and Jeon, 2007). FDI non-pecuniary spillovers may be either vertical or horizontal. In fact, even if vertical linkages mostly instigate pecuniary spillovers (since they entail transactions for goods or services between the foreign subsidiary and the local firms), they often involve partner firms into processes of business and technical adaptation and learning-by-doing (Andersson et al., 2002; Jindra et al., 2009), thus giving rise also to non-pecuniary spillovers.

Vertical spillovers affect mainly firms belonging to industries other than that to which the MNC belongs; however, the MNC's knowledge such linkages canalize to vertical partners can also benefit MNC's direct competitors, in several ways. As an example, since the set of information and resources shared within a vertical relationship might be channelled also to other agents within the local context (Spencer, 2008), leakages of knowledge may also take place horizontally, through contacts between the subsidiary and its domestic competitors, which are mediated by common suppliers or distributors.

Horizontal spillovers, on the other hand, involve only domestic firms operating in the same industry as the foreign corporation. They take place, for instance, through the well known "demonstration effect", arising from local firms' opportunity to be exposed to MNCs' activities,

that may lead them to the emulation of new productive, marketing and organizational techniques (Blomstrom and Kokko, 1998). Horizontal spillovers also arise due to the inter-firm labour mobility. When a domestic firm hires a worker who has previously been employed in a MNC, this agent can act as a channel through which the competitive information about the MNCs' practices may flow toward the local firms (Fosfuri et al., 2001; Glass and Saggi, 2002; Spencer, 2008); most importantly, this dynamic has a major impact if a foreign firm's manager decides to start his own entrepreneurial initiative in the host-country (Pack and Saggi, 2001). Other more informal types of horizontal spillovers' channels deal with trade show, supplier/distributor discussions, technical support from affiliates, reverse engineering (Haskel et al., 2007). Finally, horizontal spillovers may arise when the entry of foreign firms within an industry increases the competitive pressure on local firms, thus inducing them to improve their products and processes, to the aim of maintaining a certain degree of competitiveness (Wang and Blomstrom, 1992; Markusen and Venables, 1999).

With the exception of the latter mechanism of technological upgrading, which drives local firms to use *their own existing knowledge* more efficiently in order to react to foreign competition, FDI non-pecuniary externalities, often referred to also as *technology-* or *knowledge-spillovers*, have the capacity to *move* a relevant amount of resources, that can be highly valuable and have a large competitive content, *from one party to another*.

Embracing the mainstream IB approach, which sees multinational firms' advantages as embedded into their set of competitive knowledge assets and technological capabilities, it becomes clear that it is exactly this type of spillovers to be the most interesting of the FDI effects on host-countries, for International Business scholars: in fact, it represents the channel through which the key-factors of the MNCs' advantage may lose their competitive value, by diffusing to other agents in the subsidiary's local context. Even if we know that the "knowledge spillover" label is used to identify all types of externalities that stem from the localization of MNCs'

foreign subsidiaries abroad, in this paper we will focus only on knowledge-based spillovers, that transfer MNCs' technology to local firms.

The Resource-Based Theory of the firm suggests that, in order to serve as a means to pursue the firm's competitive advantage, resources must be rare and difficult to imitate (Barney, 1991; Dyer and Singh, 1998). Knowledge resources are particularly sensitive to the issues of rareness and imitation, since they are "*subject to uniquely complex problems of appropriability*" (Grant, 1996; p. 111), due to their non-rival nature. By enabling the transfer of technology from the multinational corporations to local firms, FDI knowledge spillovers undermine MNCs' resources' rareness and stimulate imitation from competitors, thus representing a threat for MNCs' competitive position. It is actually this threat that we are going to deeply investigate and conceptualise in the following section, in order to understand the conditions that impact its occurrence and its consequences on firms' competitiveness.

3. Antecedents of FDI knowledge spillovers

Traditional International Business literature suggests that MNCs are provided with a knowledge endowment made up of patents, proprietary technology, trademarks and know-how, which can be transferred abroad through the establishment of foreign subsidiaries (Dunning, 1981; Carr et al., 2001). When this transfer takes place, the interaction between MNCs' subsidiaries and the local firms may produce knowledge spillovers, allowing host-country competitors to gain access to MNCs' technology (Haskel et al., 2007), and improve their products and processes.

On the light of the insights on the role of MNCs for the knowledge spillover effect, along the last years, governments have been strongly committed to adopt measures to attract and facilitate foreign direct investment, in prospect of acquiring modern technology as well as managerial, marketing and distribution skills (Singh, 2007).

Both international economics theorists and international business scholars have dedicated their research attention to these knowledge flows, the former being interested in FDI as “*a mechanism that helps a country to overcome the geographic localisation of knowledge diffusion*” (Singh, 2007; p.765), the latter trying to understand the consequences of this phenomenon for the international management of knowledge assets within MNCs. However, while there is a long tradition of analyses regarding the macro-level determinants of FDI spillovers, the influence that the firm itself (and, in particular, its subsidiaries) may exert on the patterns of local knowledge outflows has started to be investigated only in latest years. The reason for this emergent attention lies probably in the recent acknowledgement, by international business scholars, of the importance of our disciplines for a comprehensive understanding of the topic. In the following section, we review the most important contributions on both types of antecedents, at macro- and micro-levels of analysis, and highlight their main strengths and limitations.

3.1 The macro-level perspective: on the role of the technological gap between home and host countries

Theory predicts that MNCs belonging to countries, or to industries within a country, that are technologically more advanced with respect to host country organizations, are more likely to generate local knowledge flows. The logic underlying this prediction is that the higher the technological gap between local and foreign firms, the higher the potential for learning and spillover (Findlay, 1978; Wang and Blomstrom, 1992; Kokko, 1994).

However, in order for this potential to materialize, host country firms are required to have sufficient absorptive capacity, which allows them to integrate and adopt such technology within their productive processes (Lapan and Bardhan, 1973; Wang and Blomstrom, 1992; Perez, 1997; Kinoshita, 2001). Combining these insights, traditional models suggest that an inverted U-shaped relationship links the depth of the technological gap between foreign and domestic firms and the extent of FDI knowledge spillovers. In fact, for increasing degrees of technological gap between

the MNC and its local environment, an increasing level of spillover can be predicted, due to the large set of technical and business practices that domestic firms can learn from the foreign entity. However, after a given threshold, when the gap becomes too deep, local firms may lack the basic resources and capabilities needed to understand and utilize the MNC's technology, thus hindering the spillover effect's occurrence.

Recently, Meyer and Sinani (2009) propose an application of competitive dynamics theory to FDI spillovers that contradicts this view. The authors use the "awareness-motivation-capability" framework to analyse the contextual moderators of spillovers, and find that there is *curvilinear* link between the host-country level of development and the extent of knowledge spillover. According with the authors: i) when host countries are *low-income economies*, due to a large technology gap, local firms can benefit from foreign subsidiaries' presence, by absorbing only their "standardized" knowledge, even if their awareness, motivation and capability for strategic reaction to foreign entry is low (hence, with high levels of technological gap between host-country and foreign firms, spillovers are very high); ii) when host countries are *medium-income economies*, local firms are unable to benefit from the presence of foreign subsidiaries, since they don't have enough capabilities to extract and use foreign firms' proprietary and distinctive knowledge to their advantage (hence, spillovers' increase slows down, for medium levels of technological gap between host-country and foreign firms); finally, iii) when host countries are *high-income economies*, local firms have both the awareness, the motivation and the capability to strongly benefit from the presence of foreign firms (hence, at low levels of technological gap between host-country and foreign firms, the spillover effect increases again).

Beyond the role of the technological gap in home and host countries, also cultural factors have been found to play a role in the FDI-mediated spillover effect. Indeed, accounting for the differences in terms of "*language, levels of protection and the sectoral structures of FDP*" (Crespo and Fontoura, 2007) between home and host countries can help to predict the level of spillover originating from FDI (Banga, 2003).

Wang and Blomstrom (1992) highlight the importance of the level of competition in the local markets, as a determinant of the knowledge spillover effect. In presence of fierce competitive pressure, MNCs will find it convenient to use innovative and superior technology in order to outperform local rivals. Simultaneously, such set of advanced resources they bring to the host-country will increase the potential benefits that local firms may derive from their presence¹.

Along with this reasoning, Kokko et al. (2001) suggest that host-countries' trade policy also affects FDI spillovers. In fact, an inward-oriented trade policy can be expected to drive MNCs' subsidiaries to concentrate their efforts on local markets in order to successfully compete with the domestic rivals, thus adopting more advanced technologies that are not commonly diffused in the host-countries. This situation creates a great potential for the occurrence of demonstration and imitation effects, since local firms will be exposed to a large set of new and valuable business and technical practices, from which to learn and improve their own product and processes.

Another important contextual factor that strongly influences the knowledge spillover effect is the host-country intellectual property rights regime. Systems characterized by weak protection increase the risk of knowledge expropriation for foreign firms aiming to enter the local markets. As a consequence, it has been shown that MNCs tend to locate in these contexts mainly through low-technology investment projects (Javorcik, 2004), thus reducing local firms' potential learning opportunities.

Although these studies provide useful, yet sometimes controversial, starting points for the analysis of knowledge spillovers from FDI, the relationships they predict seem too deterministic. They suggest that (1) the level of externalities arising from foreign subsidiaries' presence in the host economy can be foreseen by comparing the degree of technological development in foreign

¹ Note that, on the other hand, high levels of competition may also lead MNCs to increase the protection over their knowledge assets, as conceptualised by Fosfuri et al. (2001).

and domestic countries, and that (2) several other contextual factors determine the type of investment MNCs will carry out within a given host-country, thus allowing to predict the potential benefits arising for local firms. Notwithstanding the relevance of the arguments on which these studies build, it is important to keep in mind that knowledge spillovers are phenomena that occur through the interaction among single firms, and among individuals within these firms. As a consequence, we expect that other, more micro-founded, conditions influence their occurrence.

In addition, the review of these studies suggests that previous literature has focused on “absorptive capacity” as the local firm’s main attribute needed to allow spillovers to take place. However, the existing knowledge base is not the only local firms’ characteristic that can foster subsidiaries’ knowledge diffusion within the host-region. Recent literature has highlighted that firms can adopt a wide set of strategies that help them to increase the chances to profit from knowledge sources located outside their organizational boundaries. As an example, the “open innovation” literature shows that firms invest in networking and interaction with several agents in order to augment the number of external knowledge inputs that can feed their innovation processes. If absorptive capacity increases recipient firms’ familiarity, awareness and ability to internalize existing technological opportunities (Levinthal and March, 1981), an “open” attitude may act on their *effort* to absorb external knowledge. We believe that the lack of analyses on how local firms can improve their ability to absorb foreign subsidiaries’ knowledge is another consequence of the scant attention that has been paid to the profile of the individual firms involved in the spillover effect. This issue needs to be further investigated to comprehensively understand current dynamics of the spillover effect, in the light of new literature that has highlighted the increasing diffusion of strategies aimed at fostering incoming spillovers that can ignite the innovation funnel. In other words, local firms are not passive in receiving potential knowledge flows from foreign subsidiaries, and the analysis of their absorptive capacity might not be sufficient when trying to understand how they can influence the process of local spillover.

3.2 The role of firm-level characteristics: the headquarter

Compared to the great amount of literature that has analysed the macro-level determinants of FDI spillovers, the stream of research focusing on the role of the firm-level characteristics of foreign investors is much younger. However, over time, a relevant line of study has emphasized the role of firm-level heterogeneity on the FDI knowledge spillover effect (Castellani and Zanfei, 2006). In this regard, some of the very first contribution stems from the studies that take into account the role of the MNC headquarters. The focus on these agents is justified by the fact that they have the power to take decisions about the FDI.

Among the authors who have approached this “headquarter perspective” on FDI spillovers, Chung (2001) and Driffield and Love (2007) take into account the firms’ investing motive. They find that, when FDI are carried out in order to exploit MNCs’ competences, local firms have more chances to benefit from the superior assets that subsidiaries bring into the foreign location. On the contrary, when the foreign investment is aimed at sourcing of local technology, domestic firms have little to gain from the presence of the MNCs’ subsidiaries. While being very innovative in their theoretical contributions, these researches show a weakness in that they infer the motivation for FDI (a firm-level construct), based on the analysis of industry-level measures. A direct consequence of this technique is that the investing motive becomes a variable automatically determined by external conditions, that does not account for the set of potentially heterogeneous firm-level reasons that may drive multinational firms in their location strategies, and affect their conduct within the host-country.

A second important line of research based on headquarters’ role builds on the assumption that the main source of FDI-related spillovers derives from the technological assets created, and centrally accumulated, by parent companies. In terms of plant characteristics, beyond being usually larger than domestic plants, MNCs are often thought to be more capital intensive and to use more advanced technology (Doms and Jensen, 1998). Knowledge spillovers are believed to originate in the generation and ownership of such superior knowledge assets at the corporate

centres of multinational corporations (Vernon, 1966; Hymer, 1976; Caves, 1971, 1982). According with this view of the MNC, foreign investors' centrally accumulated technology represents a pre-condition for the spillovers to occur. As this knowledge stock is believed to have a "public-good" nature within the MNCs' organization, traditional theory suggests that it can be transferred to affiliates located abroad. This transfer provides the basis for the so-called "pipeline" mechanism (Marin et al., 2006), which delivers spillovers of superior technology from the MNC parent companies to local firms. Hence, the MNCs' internationalized network of subsidiaries serves as a more conduit for the transfer of knowledge from parents to local firms.

Along with this reasoning, Braconier et al. (2001) find that when FDI are realized through a greenfield investment, the knowledge spillover effect is more likely to occur, since the headquarter can automatically transfer its technology to newly created foreign affiliates. Conversely, in case of mergers or acquisitions - when the integration of the MNC's knowledge within the acquired local organization is a more difficult task - the leakage of such knowledge to domestic firms is less likely to occur. Similar results are obtained by Branstetter (2006), who finds that Japanese investors generate a higher extent of knowledge spillovers to (American) host country firms when their foreign investment takes the form of greenfield production facilities and distribution centres, since these types of establishments are more likely to incorporate the head-quarter superior technology.

Still in this context, another influencing factor of knowledge spillovers from FDI is the degree of foreign ownership of the investment project (Blomstrom and Sjöholm, 1999; Javorcik and Spatareanu, 2003). In fact, in presence of minority ownership stakes, head-quarters can be expected to have a lower incentive to transfer their superior technology to the foreign subsidiaries, due to their limited control over the local management, thus ultimately reducing the potential for spillovers (Ramachandran, 1993).

Although very interesting, these lines of research neglect some ascertained arguments for why their results need not always to hold in real data. Indeed, they all build on the assumption

that knowledge can circulate effectively and at no cost within the MNC's network, thus allowing foreign subsidiaries to receive and use the head-quarter's resources locally, and in turn to generate spillover to the host-economy. However, recent studies have highlighted that knowledge flows within MNCs do not occur as automatically as theory predicts, because relevant barriers to the internal technology transfer prevent the effective knowledge sharing among international source- and recipient- units (Szulanski, 1996; Zander and Kogut, 1995). Several studies have investigated the factors that influence MNCs' internal knowledge transfer like, for instance, the motivation and absorptive capacity of the transaction's parties (Gupta and Govindarajan, 2000), the effectiveness of internal transmission channels (Gupta and Govindarajan, 2000) and the degree of centrality within the network (Tsai, 2001). The lack of any of these factors hinders the ease of knowledge's circulation among the MNCs' units, and casts doubts on the traditional "pipeline" model's representativeness. Indeed, should the internal knowledge sharing mechanisms fail, foreign affiliates of even highly advanced MNCs will have difficulties in accessing the parents' knowledge endowment, thus being unable to originate spillovers in favour of domestic firms. A recent study by Driffield et al. (2010) acknowledges this limitation and suggests that FDI-spillovers' analyses should not take parent-affiliate knowledge flows for granted.

Recognizing the importance of evaluating the actual existence and effectiveness of the parent-affiliate patterns of knowledge sharing for the phenomenon of FDI spillovers raises the need to adopt the view of the MNC as an inter-organizational network (Bartlett and Ghoshal, 1990). Indeed, this approach allows to account for the fact that: i) not all MNCs' networks are the same, in terms of internal knowledge transfer capacity (i.e., there is heterogeneity at the aggregate level); ii) not all agents within the network have the same access to internal knowledge resources (i.e., there is heterogeneity at the inter-subsidiary level). Furthermore, this perspective also allows considering that subsidiaries do not draw only on head quarter's resources, but they can potentially access and use the knowledge developed by any other geographically distributed

tie of the MNC network. Since the knowledge inputs sourced from the MNC's internal network have been found to increase either the quality and the quantity of the subsidiary's knowledge (Almeida and Phene, 2004), accounting also for the affiliate-affiliate lateral relationships can contribute to provide a more comprehensive evaluation of subsidiaries' potential for knowledge spillover to local firms.

3.3 The role of firm-level characteristics: the subsidiaries

Traditional studies treat FDI as a "homogeneous exogenous factor", thus assuming that its firm-level characteristics (i.e., the characteristics of the foreign subsidiary) have no influence on the likelihood and the intensity of the knowledge spillover effect. Nevertheless, as claimed by Blomstrom and Kokko (2003), the set up of a MNC's foreign affiliate "*leads to a geographical diffusion of technology, but not necessarily to any formal transfer of technology beyond the boundaries of the MNC*". Along with this reasoning, recent literature has suggested that FDI-spillovers do not happen automatically, and has tried to account for the *quality*, rather than the quantity, of FDI.

Within this stream of research, scholars have focused on the role played by the type of technological activity carried out by subsidiaries within host-countries. As an example, Marin and Bell (2006) propose the "active subsidiary model", and suggest that only subsidiaries that engage in local R&D and invest in capital-embodied technology within the host countries are actually able to contribute to local firms' productivity upgrading. Similarly, Marin and Sasidharan (2010) distinguish between "competence creating" and "competence exploiting" subsidiaries, and find that - in less advanced settings - only creative affiliates do spill over local firms, while - in more developed contexts - subsidiaries that are exploitation-oriented harm host-countries' competitiveness. Pushing forward this line of research, Driffield et al. (2010) suggest that spillovers to the host economies stem from subsidiaries' productivity, rather than from their internal R&D, since - while the former materializes in non-proprietary knowledge, more easily

appropriable by domestic firms - the latter generates private technology, to which local agents can hardly gain access.

Other studies have explained how subsidiaries' autonomy, mandate (Scott-Kennel, 2007; Jindra et al., 2009) and local competitive relationships with other foreign investors (Santangelo, 2010) affect their patterns of linkage creation with local firms, trying to indirectly relate these factors to the extent of spillovers generated within the host-countries.

Despite these contributions, research has failed to look at how the subsidiary's strategy, in terms of *the management of its knowledge assets*, affects the extent of the technology that flows to domestic firms. The neglect of this issue is probably due to the established belief that considered subsidiaries as passive actors of the MNC and the host-country networks, whose role, objectives, autonomy and local behaviour reflect the general headquarter's plans. However, recent international business literature (Holm and Pedersen, 2000; Frost, Birkinshaw and Ensign, 2002) has underlined the increasing importance that subsidiaries are acquiring in terms of strategy-making and initiative-taking within MNCs, and has hence highlighted the importance of examining firms' strategic behaviour also "*at the level of the subsidiary, rather than the level of the corporate group as a whole*" (Cantwell and Mudambi, 2005), notably with respect to technological activities (Almeida and Phene, 2004; Cantwell and Mudambi, 2005). To the aim of this paper, this claim raises the need to recognize that subsidiaries can actively manage their knowledge resources within their foreign location (Cantwell, 1989; Birkinshaw and Hood, 1998; Cantwell and Mudambi, 2005), thus generating heterogeneous patterns of interaction with domestic firms and, hence, different levels of knowledge spillovers.

Previous works have shown that, when assessing their location choices, MNCs account for the possibility that their knowledge can flow across their organizational boundaries, and that this leads to differences in firms' propensity to agglomerate (Shaver and Flyer, 2000; Alcacer and Chung, 2007) and in the level of equity ownership they choose for their foreign subsidiaries (Blomstrom and Sjöholm, 1999; Javorcik and Spatareanu, 2003). Analysing the consequences of

the subsidiary's strategy within the host-location allows to account for the possibility that the risk of knowledge leakage may play a role also in the stages following the MNCs' location decision, and that this risk can be actively managed by the subsidiary itself, through its local behavior.

Recent empirical evidence has actually started to pay special attention to subsidiaries' knowledge protection strategies, and has suggested that these agents see the host-country as a danger for their competitive assets' integrity, and therefore protect their knowledge more extensively than local firms do (De Faria and Sofka, 2010).

However, local firms are not only a threat for subsidiaries. In fact, starting from the "*learning-oriented FDI*" approach (Cantwell, 1989; Dunning, 1994), subsequent studies have highlighted the importance, for subsidiaries, of the knowledge opportunities offered by host regions. Many studies demonstrate that subsidiaries extensively source knowledge from host country regions (Almeida, 1996; Frost, 2001; Singh; 2007), and that this allows them to gain competence-creating mandates and power (Cantwell, 1989, 1995; Papanastassiou and Pearce, 1997; Cantwell and Janne, 1999), and to increase the quantity and the quality of their innovation (Almeida and Phene, 2004; Phene and Almeida, 2008).

However, acquiring knowledge from the local environment is not an immediate consequence of a subsidiary's establishment in a foreign country.

Localized knowledge flows through "*the establishment of interfirm (and interpersonal) linkages between firms in a region*" (Almeida and Phene, 2004, p. 849). Resource sharing mechanisms are embedded in the web of close and repeated interactions among firms, which stimulate the creation of social networks and trust (Rogers and Larsen, 1984). It is mainly under these conditions of interaction and trust that firms learn to benefit from each other, since they develop common cognitive models and collaborative attitudes, and engage in processes of joint problem solving and information sharing (Gulati, 1995; Gulati and Gargiulo, 1999; Powell et al., 1996).

However, foreign firms entering a new country are extraneous to the existing network of local relationships. Therefore, the access to localized sources of expertise may require them to build a reputation for cooperation, which allows subsidiaries that share their technology with indigenous firms to become embedded in the local business network and, hence, to be able to intercept local knowledge flows. This reasoning suggests that, when trying to predict the functioning of the knowledge spillover effect, which is in fact based on micro-level processes between firms and individuals across firms, not only economically-rational drivers should be accounted for, since other driving forces, arising – as an example - from major social rules, can play a determinant role, too.

When considering the potential effects of social norms on knowledge spillovers from foreign subsidiaries, a further element to account for is the local business network in which the subsidiary is embedded, as well as the set of its characteristics. The subsidiary's local business network represents "*the different actors that are connected with one another through business activities rather than administrative or legal links*" (Holm et al., 2005; p. 94). For the objective of this paper, the stream of research that focuses on subsidiaries' business network may help to understand the social relationships that link the subsidiary and its local business partners, as well as the attributes of such relationships. These information are crucial to understand the patterns of spillover from subsidiaries to local firms, since network ties act as major knowledge conduits and affect their participating agents' behaviour, thus allowing for imitation, learning, and adoption of practices (Ahuja, 2000; Davis and Greve, 1997). The extent to which such consequences of inter-organizational relationships do take place depends on networks' attributes (its structural characteristics, its trust, its system of norms and monitoring), as well as on both relationships' and participating agents' attributes (strength, direction, similarity of social, strategic or organizational characteristics of ties). Accounting for all these factors allows to reconstruct the social infrastructure through which knowledge flows, thus providing a more thorough understanding of the FDI spillover phenomenon.

4. Consequences of FDI knowledge spillovers: the reduction of the competitive value of MNCs' knowledge

Traditional IB theory suggests that MNCs choose to enter a foreign country through the establishment of subsidiaries to the aim of internalizing their international activities. In fact, especially when such activities are knowledge intensive, their foreign organization is more likely to be arranged through an hierarchic governance mode, since it allows to minimize the transaction costs related to the entry into an external market (Buckley and Casson, 1976; Hennart, 1982; Kogut and Zander, 1993). This reasoning suggests that the appropriation of the rents arising from the activities transferred abroad is a relevant issue for MNCs.

The Ownership-Location-Internalization paradigm (Dunning, 1988) states that multinational corporations are often provided with firm-specific resources that give rise to an “ownership advantage”. Therefore, compared to local firms, they are considered as more advanced agents, both in terms of their operations, and in terms of their marketing and organizational skills. The geographical distributed network of agents that characterizes MNCs' organization plays an important role in determining this advantage. Indeed, as highlighted by Criscuolo et al. (2005), MNCs develop more ideas than their purely domestic competitors, not only because of the greater human resources they can employ, but also due to the larger stock of creative knowledge from which they can benefit thanks to their “*intra-firm worldwide pool of information*”. Several studies on international firms' structure have highlighted that “*technical, market, and functional knowledge is sourced from various locations and generated continuously in all parts of a company, and shared across the organization*” (Almeida and Phene, 2004; p. 848). The set of advanced knowledge resources and capabilities that MNCs initiate at their headquarter level and fertilize through their world-wide distributed network of subsidiaries is a unique asset that allows them to successfully compete with domestic counterparts, despite their “liability of foreignness”.

When MNCs' subsidiaries come in contact with local firms, their interaction can activate the leakage of part of their knowledge through several formal and informal channels. Since this knowledge is the basis on which MNCs build their superiority compared to local firms, its leakage and subsequent loss of uniqueness and competitive content is extremely dangerous. In fact, in the case of FDI, the knowledge sources (i.e., the MNCs' affiliates) and the knowledge recipients (i.e., the domestic firms) are parts of a competitive relation (Meyer, 2004; Chang and Xu, 2008). As a consequence, the knowledge that may flow from MNCs to local firms is an important determinant of their relative competitive position (Alcacer and Chung, 2007).

Building on this reasoning, recent literature on firms' heterogeneity and agglomeration dynamics and on the knowledge protection strategies of multinational firms (Alcacer and Chung, 2007; De Faria and Sofka, 2010; Shaver and Flyer, 2000; Zhao, 2006) has pointed to the threats, in terms of knowledge spillover, arising from the contact with the local context. These threats are stronger when domestic actors are highly competitive and possess absorptive capacity, which allows them to learn, use and disseminate the knowledge eventually spilling out through the local interaction. Alcacer and Chung (2007) and Shaver and Flyer (2000) show indeed that technologically advanced multinational firms avoid to agglomerate with highly concentrated clusters of related industrial activities, in order to protect their knowledge from external appropriation.

In sum, knowledge spillovers represent a dangerous phenomenon for foreign subsidiaries established in a given local context, since they act as a means through which the subsidiary itself and, in turn, the whole MNC may lose their competitive superiority compared to host-country firms. Symmetrically, from the perspective of local firms, they may serve as a catalyst for their technical and business upgrading.

4.1 Consequences of FDI knowledge spillovers: indirect benefits for foreign subsidiaries

Notwithstanding the insights on the competitive threats foreign subsidiaries face when coming in contact with domestic firms, as already mentioned, recent international business research provides a different perspective on the role played by the host country for multinational firms, and focuses on the opportunities offered to subsidiaries. However, existing literature on FDI spillovers has seldom considered that knowledge spillovers from MNCs to local firms can have indirect positive effects on foreign firms, by influencing their ability to capture such opportunities.

The local business network, with which subsidiaries interact, as well as the general external environment in which they are established, can be a source of valuable knowledge and ideas (Almeida and Phene, 2004). Empirical evidence suggests that sourcing knowledge from the local context can help subsidiaries to develop their roles within the MNC (Andersson et al, 2007), to extend and upgrade their competences (Cantwell and Mudambi, 2005), and to increase the quantity and the quality of their innovation (Phene and Almeida, 2008). In addition, all the resources acquired and developed within the subsidiaries can feed the whole MNC network, thanks to the process of internal sharing. As already highlighted in the section on the social drivers of spillovers, it is important to recognize that, by allowing the leakage of their proprietary knowledge, subsidiaries build a reputation for cooperation that generates reciprocity mechanisms and facilitates their processes of local knowledge sourcing, relevant for both the individual subsidiary and the MNC.

By improving subsidiaries' integration within the local environment, such collaborative attitude can also help subsidiaries to overcome the liability of foreignness (Zaheer, 1995), eventually arising from their poor knowledge of the domestic market and of the local business network.

In addition, the processes of knowledge sharing with the local business network may allow for subsidiaries' embeddedness, which has been found to generate adaptation with domestic

partners and acquisition of local practices, as well as to facilitate the upgrading of the subsidiary's role and the achievement of importance and power within the MNC's hierarchy (Andersson et al., 2002; 2007).

Knowledge sourcing, overcoming of the liability of foreignness and embeddedness are all potential indirect advantages of FDI spillovers that extant literature has always neglected, and that should instead be accounted for in order to comprehensively assess their consequences for MNCs' competitiveness. It goes without saying that, when outward knowledge spillovers represent a privileged channel through which subsidiaries gain an easy access to the local knowledge resources, the consequence for domestic firms may be the erosion of the advantages stemming from their specialized and competitive technology (Branstetter, 2006).

5. The conceptual framework

5.1 Conceptualisation of spillover attributes

Spillover attributes refer to the characteristics of the knowledge flows that spill out from subsidiaries' boundaries and reach domestic firms. To the purpose of this paper, we consider as relevant those attributes that have the potential to affect the relative competitive position between foreign and local firms.

Previous studies have focused on the attribute of "magnitude". The magnitude of spillovers relates to the *amount* of subsidiaries' knowledge that spread within the host-economy. Traditional empirical studies have tried to capture the quantity of knowledge spillovers through raw measures, like the change in total factor productivity of local firms (Aitken and Harrison, 1999; Feinberg and Majumdar, 2001; Chung et al., 2003; Haskel et. al, 2007), assuming that the technology absorbed by local agents due to the presence of foreign firms reflects into productivity improvements. However, local firms' productivity may increase for several reasons, not all of which are related to the knowledge-side of the spillover effect. As an example, literature has demonstrated that the reason why contexts with a higher presence of foreign

subsidiaries are characterized by structurally higher productivity rates may lie in the fact that MNCs may tend to establish in those that are already the more productive industries or countries, therefore highlighting an endogeneity problem (Aitken and Harrison, 1999).

In more recent years, some scholars have begun to experience an alternative empirical framework, which uses citations from local patents to subsidiaries' patents as a measure for the quantity of knowledge spillovers (Almeida, 1996; Branstetter, 2006; Singh, 2007). Notwithstanding the several limitations associated with the use of patent citations-based measures, this indicator captures only phenomena linked to actual knowledge flows, thus allowing to separate knowledge spillovers from other types of FDI-related effects.

Whereas the analysis of the quantity of knowledge spillovers provides a useful assessment of the extent of resources that subsidiaries transfer to local firms, in order to fully understand the impact of the strategic interaction between domestic and foreign firms on their relative competitive position, other factors must be accounted for. Our framework focuses on two additional attributes of knowledge spillovers: "speed" and "scope".

The *speed* at which subsidiaries' technology spreads out to domestic firms is a neglected - yet crucial - topic, when discussing the strategic consequences of spillovers. In fact, since the ability to accelerate innovation processes can provide a competitive advantage (Eisenhardt and Martin, 2000), the rate at which new knowledge diffuses to local firms, allowing them to build on its innovative content, is a relevant dimension along which to evaluate either local firms' benefits, in terms of increase of the pace of their innovative processes (Markman et al., 2005), and subsidiaries' costs, in terms of erosion of the duration of their technological advantages. The speed of knowledge spillovers refers to the time needed for subsidiaries' technology to be acquired by local firms; considering this attribute when evaluating the knowledge spillover effect means to account for the importance of *time-based advantages*, that are especially relevant in developed countries and in high-tech industries, and that allow to achieve a better evaluation of

the consequences of knowledge spillovers, than that provided by focusing only on the quantity of these flows.

Finally, we refer to the “*scope*” of knowledge spillovers as to the range of applications in which the technology brought in by subsidiaries can be used by local firms in order to upgrade their products and processes. A piece of knowledge that diffuses from subsidiaries to local firms can have different levels of utility. In order to fully evaluate domestic firms’ gain (or, similarly, foreign firms’ loss) arising from MNCs’ knowledge spillovers to the host-economy, it is important to analyse the extent to which the knowledge spread locally can be used in a broad set of fields and innovative processes, that can ultimately be useful to enter new and unexplored markets.

5.2 Knowledge spillover framework

Our knowledge spillover framework integrates the macro-level and micro-level antecedents of spillovers with their consequences, and proposes to analyse spillovers along all three main attributes that characterize their occurrence.

Its contribution is threefold. First, it provides a comprehensive illustration of all factors that should be accounted for when trying to understand the spillover effect, as well as a flexible methodological approach to analyse the phenomenon, along different relevant dimensions: 1) the *macro-level of analysis*, focusing on differences between the home- and the host- countries and on the contextual factors that can influence the process of local knowledge diffusion, 2) the *micro-level of analysis*, focusing on both the foreign and the domestic firms’ characteristics, and 3) the *network-level of analysis*, highlighting the importance of being part of heterogeneous internal and external networks. Specifically, regarding the micro-level dimension, beyond accounting for both the head-quarter and the subsidiary role, it focuses on the strategic profile of the foreign subsidiary as a determinant of the spillover effect, thus answering to recent research’s

call for a more comprehensive understanding of the consequences of subsidiaries' strategic behaviour within the host country (Cantwell and Mudambi, 2005).

Second, it adds a set of useful insights from heterogeneous and more recent strands of research to the traditional literature on FDI-spillovers. Specifically, by highlighting the role of social mechanisms that influences the interactions between the subsidiary and the local firms, and the by suggesting the importance of considering how the relationships that take place within the internal network of geographically distributed MNC's actors, it offers a more realistic picture of the mechanisms that activate or influence the knowledge flow from foreign subsidiaries to local firms.

Third, in a departure from most of previous research that has focused mainly on local firms' gains from the presence of subsidiaries, it reconciles this perspective with the point of view of the foreign firm. In particular, not only it accounts for subsidiaries direct consequences originating from spillovers (i.e., the reduction of the competitive value of their knowledge), but it also highlights potential indirect effects that could foster the subsidiaries' competitiveness (i.e., knowledge sourcing, overcoming of liability of foreignness, embeddedness). Hence, it can be used to evaluate the consequences of knowledge spillovers not only in the perspective of domestic firms, but also from the point of view of the MNC.

Finally, it develops three spillovers constructs (quantity, speed and scope) that can be used in future empirical research, in order to describe more comprehensively the spillover effect, as well as to better assess the impact of the phenomenon on both local firms and MNCs' competitiveness.

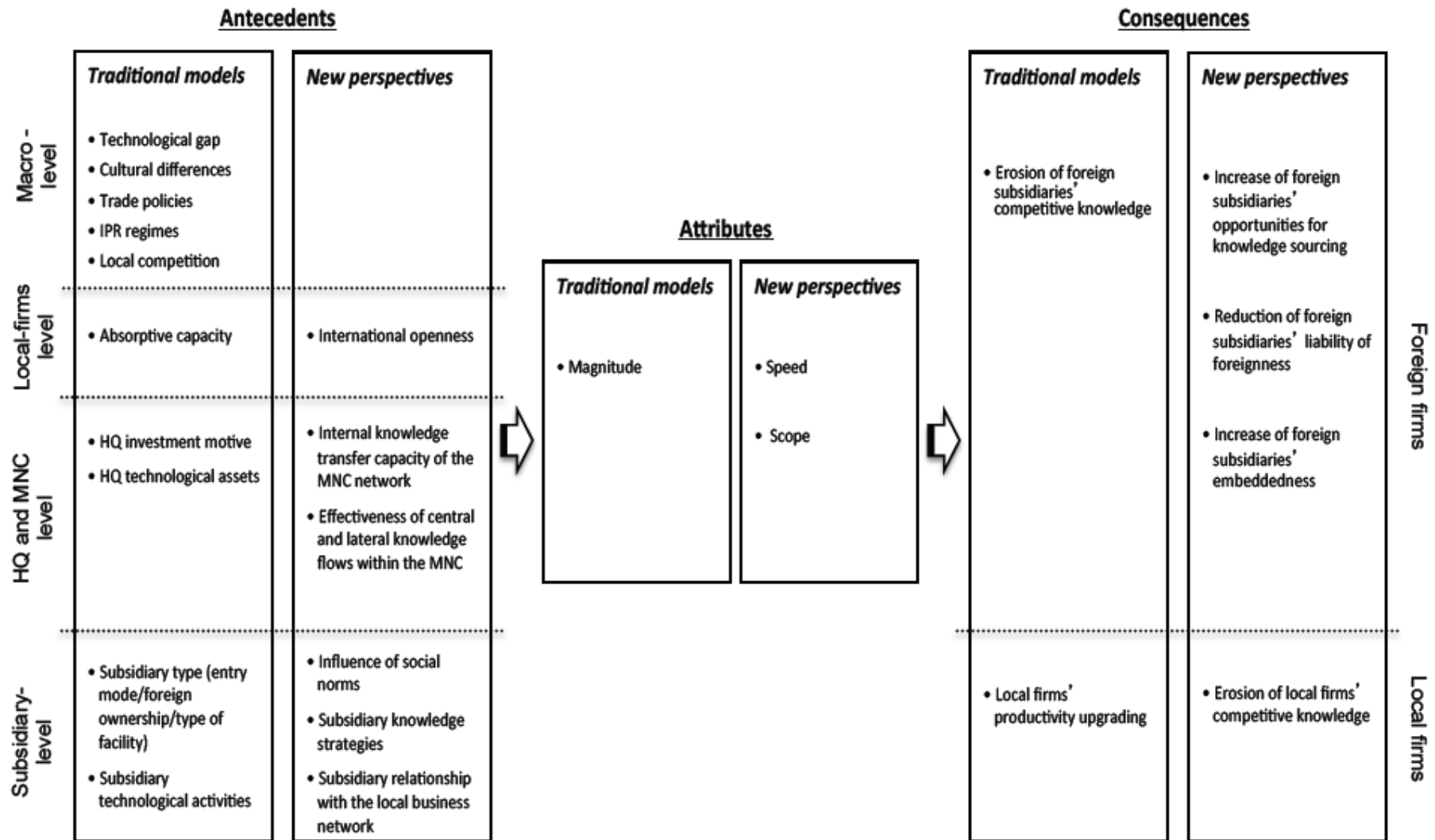
6. Conclusions

In this first essay, we have tried to argue the need for further and renewed research in FDI knowledge spillover related topics. We have suggested that international business literature has underestimated the strategic relevance of this phenomenon for the competitiveness of foreign

subsidiaries. Indeed, since the pioneering works in international and growth economics which have highlighted the importance of FDI inflows for the productivity of host-country firms, the scope of international business spillover research on this topic has been limited. We have tried to underline the reasons why the flows of knowledge from foreign subsidiaries and local firms constitute a natural field of investigation for managerial research. Furthermore, we have reviewed existing research on the antecedents and consequences of FDI knowledge spillovers, and identified a set of gaps in the theoretical and empirical literature that we invite future investigation to fill. To this aim, we have also highlighted several recent strands of research, which we believe could be very useful in providing directions for the comprehensive understanding of the knowledge spillover effect. In particular, there are four aspects that should be accounted for and that we consider crucial to improve this research: 1) the subsidiary is not a passive actor of the spillover process, and its knowledge strategies within the host-country influence the extent of knowledge that spreads to the local firms; 2) the knowledge spillover effect is a micro-founded process, which takes place through the interaction between firms, and between people among firms, and therefore is influenced by social norms; 3) beyond the diffusion of the subsidiary's knowledge, it may encompass indirect effects, that are beneficial for the subsidiary itself, since they increase its chance to tap into the local knowledge network, to become embedded and to overcome the liability of foreignness; 4) it should be characterized not only through the analysis of the extent of knowledge that leaks to the local environment, since other attributes (like the speed and the scope of spillovers) are crucial to fully evaluate its real effect on the competitiveness of both the MNC and the local firms. In the following essays, we will try to provide empirical support for these claims, by analysing: 1) the influence that foreign subsidiaries' knowledge strategies within the host-region and social norms exert on the knowledge spillover effect; 2) the trade-off that the host-environment generates for subsidiaries' competitiveness, in terms of both knowledge spillover threats and of local learning opportunities;

3) the time-patterns of the process of foreign subsidiaries' knowledge diffusion in the host-location, and the factors that influence this process.

Figure 1. Foreign subsidiaries' knowledge spillover framework.



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ESSAY 2

KNOWLEDGE FLOWS FROM FOREIGN SUBSIDIARIES: THE TENSION BETWEEN KNOWLEDGE CREATION AND KNOWLEDGE PROTECTION

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Abstract

This paper analyzes the MNC subsidiaries' trade-off between the need for knowledge creation and the need for knowledge protection, and relates it to the extent of knowledge outflows generated within the host location. Combining research in International Business and Strategy with Social Theory, we argue that subsidiaries that source more from the local knowledge network in order to create new knowledge are also more likely to generate spillovers to local firms, due to the willingness to build the trust that facilitates the establishment of reciprocal knowledge linkages. However, when subsidiaries enjoy high knowledge quality, the need for knowledge protection overweighs the need for knowledge creation, thus reversing the effects of reciprocity in knowledge exchanges, and reducing the extent of knowledge outflows to the host location. This study contributes to the literature on the firm-level antecedents of FDI-mediated knowledge spillover, as well as to the broad IB literature on the relationship between subsidiaries and their host regions. The implications for managers and policy-makers are also discussed.

Keywords: knowledge management, foreign subsidiaries, spillovers, reciprocity.

1. Introduction

A widely investigated topic in the field of international business (hereafter, IB) is the globalization of the innovative activities of multinational corporations (hereafter, MNCs), particularly in high-technology sectors (Almeida and Phene, 2004; Frost and Zhou, 2005; Phene and Almeida, 2008). Since the pioneering works that attributed the very existence of MNCs to the failure of the international market for technology (Hymer, 1976; Buckley and Casson, 1976), a growing body of literature has started to look at multinational corporations as geographically distributed networks of innovation, whose main ability is to assimilate, create and integrate knowledge on a global basis (Bartlett and Ghoshal, 1989; Kogut and Zander, 1993; Hedlund, 1994; Birkinshaw, 1997; Frost et al., 2002).

An important consequence of MNCs' international distribution of innovation resides in the phenomenon of the *knowledge flows to the host-location*. Indeed, beyond absorbing knowledge from local sources of expertise, MNCs' foreign subsidiaries also generate knowledge spillovers to domestic firms (Almeida, 1996), through the process of local interaction (Haskel *et al.*, 2007). Much research has analysed the direction, the scope, the channels and the antecedents of such knowledge flows (Teece, 1977; Rodriguez-Clare, 1996; Song *et al.*, 2001; Feinberg and Majumdar, 2001; Nakamura, 2002; Jabbour and Mucchielli, 2005; Zhu and Jeon, 2007). However, an accurate analysis of the extant literature still reveals some gaps.

In the first place, while there is plenty of analysis regarding the *country-level* and *industry-level* determinants of this phenomenon, the influence that *the firm* itself (and, in particular, its subsidiaries) may exert on the patterns of local knowledge outflows remains an under investigated topic. Notable exceptions have tried to account for the role of firms' heterogeneity in terms of innovation, productivity and internationalisation (Castellani and Zanfei, 2006), of the MNCs' investing motive (Chung, 2001; Driffield and Love, 2007), of

the relationships with the MNC internal network (Zhao, 2006; Driffield et al., 2010), and of the type of activity realized abroad by foreign facilities (Branstetter, 2006; Marin and Bell, 2006; Marin and Sashidaran, 2010). Despite these contributions, research has failed to look at how *the subsidiary's strategy*, in terms of the management of its knowledge assets, affects the extent of the technology that flows to domestic firms. However, this issue is relevant since it is by now recognized that subsidiaries can *actively* manage their knowledge resources within their local context (Cantwell, 1989; Birkinshaw and Hood, 1998; Cantwell and Mudambi, 2005), thus generating heterogeneous patterns of interaction with the local knowledge network and, hence, different levels of knowledge spillovers.

In addition, IB and strategy literature has looked at the knowledge exchange relationships between subsidiaries and domestic firms from two different perspectives. Traditional research on subsidiary innovation (Almeida and Phene, 2004; Phene and Almeida, 2008), mandate (Birkinshaw and Hood, 1998; Cantwell and Mudambi, 2005) and embeddedness (Andersson et al, 2002; 2007) has highlighted the role that local firms may play as a source of valuable resources and knowledge. On the other hand, recent literature on the knowledge protection strategies of multinational firms (Alcacer and Chung, 2007; De Faria and Sofka, 2010; Shaver and Flyer, 2000; Zhao, 2006) has pointed to the threats, in terms of knowledge spillover, arising from the contact with the local context. With few notable exceptions (Sanna-Randaccio and Veugelers, 2007; Santangelo, 2010), an integrated analysis of the double role the interaction with domestic firms plays for a subsidiary's competitiveness is still missing.

In this paper, we try to fill these gaps by explicitly analyzing how the opportunities and challenges subsidiaries face in the local knowledge network influence the patterns of knowledge outflows they generate within the host location. We conceptualize the mechanism that drives a subsidiary's management of its knowledge assets as the *tension between knowledge creation and knowledge protection*. A subsidiary's knowledge creation is highly

dependent on its ability to leverage on external resources embedded in its local knowledge network (Almeida and Phene, 2004). We suggest that the access to such resources is eased by the involvement into *reciprocal exchange relationships* (Kachra and White, 2008), which consequently boost the knowledge outflows to local firms. However, such relationships – through which knowledge flows bidirectionally - can also be detrimental for subsidiaries' competitive standing inside the foreign location, especially when their knowledge is highly valuable. In this latter case, they might be driven to enforce their knowledge protection strategies when interacting with the local environment, thus reducing the level of knowledge spillovers.

This paper aims to demonstrate that the differences in the patterns of knowledge flows generated by MNCs' foreign subsidiaries can be explained by accounting for the trade-off between knowledge creation and knowledge protection they face within their host location. The need for knowledge creation is captured through the analysis of subsidiaries' *local sourcing capability*, which allows to establish what are the consequences, in terms of knowledge outflows, of subsidiaries' ability to tap into the local knowledge network. Additionally, we focus on subsidiaries' *knowledge quality* as the condition that activates the need for a higher knowledge protection.

We use patent citation data to test our models, performing negative binomial regression analysis on a panel dataset of US subsidiaries of foreign MNCs, and try to address the question: *How does the tension between knowledge creation and knowledge protection influence the extent of a subsidiary's local knowledge outflows?* Empirical results suggest that local sourcing behaviors generate higher levels of knowledge outflows, unless they are associated with increasing subsidiaries' knowledge quality: in this case, subsidiaries tend to protect more their knowledge assets, thus reversing the effects of reciprocity in knowledge exchanges.

Our study contributes to the literature on FDI knowledge flows and spillovers, by accounting for the double role host locations play for subsidiaries' competitiveness. Previous research has analyzed either subsidiaries' knowledge exchange dynamics within the host environment and headquarters' strategies to prevent local knowledge spillovers. No study has considered how subsidiaries manage both the need for knowledge creation and the need for knowledge protection, and how this affects the phenomenon of local knowledge outflows. We believe that this focus will provide a more comprehensive understanding of how subsidiaries find a balance between such conflicting forces, and shed more light on the subsidiary-level antecedents of FDI knowledge spillovers.

This analysis can also be an important source of strategic considerations for practitioners involved into the management of cross-border knowledge investment in MNCs. Subsidiaries' managers must be aware that, in order to explore and acquire local knowledge resources, it's important to reciprocally contribute to the host-location knowledge assets. However, when subsidiaries have too much to loose in such knowledge exchange relationships, managers can have recourse to high knowledge protection barriers, to avoid the diffusion of their competitive assets.

The rest of the paper is organized as follows. In the next section, we review the existing research on subsidiaries' knowledge flows and knowledge management. We then elaborate on the "trade-off" between knowledge creation and knowledge protection, and develop hypotheses. Finally, we present our model and discuss the empirical results.

2. Literature review

2.1 Knowledge flows and knowledge spillovers: an overview of country, industry and firm level determinants

IB theory has highlighted that the localization of FDI generates positive externalities for host-country firms. Beyond the ability to boost local employment and to pull in large capital inflows, the embedding of multinational operations may also result in knowledge outflows, which span MNCs affiliates' boundaries through several channels.

Traditional literature suggests that knowledge flows from MNCs to host-country firms derive from the technological assets created by parent companies (Blomstrom and Kokko, 2003; Caves, 1974; Haskel et al. 2007; Hymer, 1976). According with this view of the MNC, the centrally accumulated knowledge endowment of foreign firms represents the pre-condition for spillovers to occur. In fact, as this knowledge stock is believed to have a “public good” nature within the MNC's organization, it can be easily transferred to affiliates located abroad, thus providing the basis for the so-called “pipeline” mechanism (Marin and Bell; 2006), which delivers spillovers of superior technology from the MNC parents to local firms. Based on this model, the MNCs' internationalized network of foreign subsidiaries acts as a mere conduit for the transfer of knowledge between parent companies and local firms.

Knowledge flows may be both unintentional and intentional (Mudambi and Navarra, 2002). In the first case, when local firms internalize the spillovers, their products and processes may improve almost costless, thus stimulating their performance (Shaver and Flyer, 2000; Feinberg and Majumdar, 2001). In the second case, the access to MNCs' knowledge takes place through real market transactions (i.e., license agreements), for which foreign firms get compensated: though it's not possible to talk about “externalities”, the contact with the MNCs' highly competitive knowledge is still supposed to generate strong benefits for local firms.

Both international economics theorists and international business scholars have long studied the extent and direction of these knowledge flows, the former being interested in FDI as a mechanism that helps a country to overcome the geographic localisation of knowledge diffusion, the latter trying to understand the consequences of this phenomenon for the international knowledge-management within MNCs. In a departure from the traditional “*macro-level*” analyses of the determinants of FDI-spillovers, in recent years, scholars have recognized that also the *firm heterogeneity* may play a role in this phenomenon. As an example, Chung (2001) and Driffield and Love (2007) find that the firms’ investing motive influences the knowledge spillover effect. In his research on Japanese investors in the United States, also Branstetter (2006) focuses on firm-level characteristics, and shows that FDI are more likely to generate knowledge spillover to American firms when they take the form of greenfield production facilities and distribution centers, since they are supposed to embody the parent firms’ technological superiority. Conversely, Driffield et al. (2010) suggest that subsidiaries that receive more of the parent firm’s technology do not share knowledge with local firms to the aim of appropriating the benefits of these valuable assets. Finally, Marin and Bell (2006) propose the “*active subsidiary model*”, and show that subsidiaries’ own technological activity is an important determinant of the spillover effect within host countries.

While being very important in shedding some lights on the firm-specific determinants of the FDI-mediated knowledge spillovers, these studies seem to focus on the *structural* characteristics of subsidiaries (e.g. type of facility, type of local activity), thus overlooking the potential impact of subsidiaries’ *strategy*. One reason for this gap may be that traditional literature has considered subsidiaries as *passive actors* of both the MNC and the host-country networks (Alcacer and Chung, 2007; De Faria and Sofka, 2010), whose aim was just to implement the tasks assigned by the head-quarter, with scarce - if any – autonomy in terms of strategy-making. However, recent international business literature (Holm and Pedersen, 2000;

Frost, Birkinshaw and Ensign, 2002) has highlighted the importance of examining firms' strategic behaviour also "*at the level of the subsidiary, rather than the level of the corporate group as a whole*" (Cantwell and Mudambi, 2005), especially with respect to technological activities. Indeed, MNCs' subsidiaries have been found to be increasingly active in terms of the management of their knowledge assets (Mudambi and Navarra, 2004; Cantwell and Mudambi, 2005; Marin and Bell, 2006). Based on this reasoning, we believe that – in order to gain a more comprehensive understanding of the firm-level determinants of the knowledge spillover effect – a closer look at how subsidiaries manage their knowledge needs in the host location is required.

2.2 Local firms in IB literature: opportunities and challenges for subsidiaries' knowledge management

Traditional IB and strategy research has looked at the local context in which subsidiaries are established as the source of valuable resources (Mariotti and Piscitello, 1995), to which they should gain access in order to be successful within the internal (the MNC) and external (the host-country) networks to which they belong. As an example, Almeida and Phene (2004) show that the host country technological diversity increases subsidiaries' knowledge creation capability. Similarly, Phene and Almeida (2008) demonstrate that the knowledge assimilated from host-country firms is positively associated with both the scale and the quality of a subsidiary's innovation. Also Birkinshaw and Hood (1998) and Cantwell and Mudambi (2005) elaborate on the importance of the local context for subsidiaries' acquisition of competence-creating mandates. Finally, Andersson et al. (2002; 2007) suggest that the embeddedness with the local business network increases the subsidiary expected performance, as well as its importance and power within the MNC internal hierarchy. Based

on this logic, the host location represents an opportunity, and the interaction with local firms is desirable and beneficial.

A different perspective on the role of host countries for multinational firms arises from the research on firms' heterogeneity and agglomeration dynamics. Alcacer and Chung (2007) and Shaver and Flyer (2000) have suggested that the host country can be a threat for multinational firms' competitive position, and have analyzed the strategies that leading MNCs use to manage and protect their knowledge from the risk of local knowledge outflows. Their works show that MNCs assess their location choices based on an accurate evaluation of the net (inward vs. outward) knowledge spillover. As a consequence, technological advanced multinational firms avoid to agglomerate with highly concentrated clusters of related industrial activities, in order to protect their knowledge from external appropriation. Also Zhao (2006) considers the risks of conducting R&D in countries with weak intellectual property rights protection, and finds that MNCs try to internalize their technology by using it more extensively within the MNCs' network. Finally, recent empirical evidence confirms that subsidiaries see the host-country as a danger for their competitive assets' integrity, showing that they protect their knowledge more extensively than local firms do (De Faria and Sofka, 2010).

Although apparently contrasting, the above-mentioned perspectives are complementary, and can provide a clear understanding of a subsidiary's needs, in terms of the management of its knowledge assets, only if considered jointly. Support for this statement is provided by the recent work by De Faria and Sofka (2010), who find that subsidiaries adapt their knowledge protection strategies to both their own characteristics and the host-country's challenges and opportunities. We extend this stream of research by analyzing how the way subsidiaries manage such challenges and opportunities affects the extent of knowledge spillovers they generate within the local context.

We posit that subsidiaries are subject to two different *stimuli* emerging from the host location: a *need for knowledge creation*, which arises from the willingness to benefit from the learning opportunities embedded in the local knowledge network, and a *need for knowledge protection*, which derives from the urge to safeguard their competitive knowledge from the risk of local dissemination. The tension between these two strategic needs will affect subsidiaries' choices in terms of knowledge management, thus influencing the extent of knowledge outflows generated in the host location. This framework is consistent with recent knowledge-based research (Arikan, 2009), which highlights that firms have two knowledge imperatives: 1) “*exploit all the bodies of knowledge it possesses to the fullest*”, thus appropriating of all the rents its own knowledge generates; and 2) “*secure access to all the knowledge it needs to prolong its value creation activities*”, thus sourcing knowledge inputs from external networks to which it belongs.

Our analysis finds its rationale in the study by Almeida (1996), who shows that US subsidiaries of foreign MNCs generate both knowledge sourcing and *knowledge contributing* relationships with local firms. Providing additional support for the existence of this bi-directional knowledge flows' mechanism, Singh (2007) demonstrates that MNCs usually absorb more knowledge than they provide, thus suggesting that they have strong abilities to restrict their assets' leakage. We add to this literature by specifically analyzing how subsidiaries' knowledge imperatives affect the patterns of their outward knowledge flows within host-regions.

In the following section, we elaborate on the concept of the *tension between knowledge creation and knowledge protection*, and demonstrate that subsidiaries' choices in terms of knowledge exchange relationships and assets' protection affect the extent of knowledge outflows to the host location.

3. Hypotheses

3.1 Local knowledge outflows and the need for knowledge creation: the local sourcing capability

Local firms are an important source of knowledge for foreign subsidiaries. In a departure from the traditional view of the host-country as a mere channel to develop new markets or obtain cheap resources, the “*learning-oriented FDI*” perspective has increasingly provided evidence about the knowledge opportunities offered by host-regions (Cantwell, 1989; Dunning, 1994). Much literature has demonstrated that sector-specific knowledge develops in geographically concentrated areas (Marshall, 1920; Porter, 1990), and that countries follow different patterns of industrial specialization (Cantwell, 1989; Patel and Pavitt, 1991). Therefore, subsidiaries that access local sources of expertise absorb knowledge that is highly valuable, since it’s often complementary, or at least different (hence, non redundant), to that of the MNC (Singh, 2010). An abundance of studies demonstrates that subsidiaries extensively source knowledge from host countries (Almeida, 1996; Frost, 2001; Singh; 2007), and that this allows them to gain competence-creating mandates and power (Cantwell, 1989, 1995; Cantwell and Janne, 1999), and to increase the quantity and the quality of their innovation (Almeida and Phene, 2004; Phene and Almeida, 2008).

However, acquiring knowledge from the external environment is not an immediate consequence of a subsidiary’s localization in a foreign country.

Localized knowledge flows through “*the establishment of interfirm (and interpersonal) linkages between firms in a region*” (Almeida and Phene, 2004, p. 849). In order to exchange resources and share unique knowledge, firms must involve in close and repeated interactions that stimulate the creation of social networks and trust (Rogers and Larsen, 1984). When this happens, firms learn to benefit from each other, since they develop common cognitive models and collaborative attitudes; in addition, they may engage in processes of joint problem solving

and information sharing, useful for their innovative activities (Gulati, 1995; Powell et al., 1996).

In the specific case of subsidiaries, that is foreign agents which are *external* to the local network of inter-firm relationships, the access to localized sources of expertise does not happen automatically, but rather may require them to build a *reputation for cooperation*, that could allow subsidiaries that share their technology with local firms to become embedded in the domestic knowledge network. As a consequence, subsidiary managers might wish to involve into reciprocal relationships with host-country firms and accept to disclose some of their knowledge, if they expect to gain a greater local integration that facilitates the acquisition of relevant knowledge.

Social theory has already demonstrated that this reciprocity mechanism is fundamental to the exchange of resources (Gouldner, 1960; Williamson, 1993). In addition, empirical evidence supports this view: as a case in point, Saxenian (1994) reports the importance of knowledge sharing between firms for the dynamism and the success of the Silicon Valley region; similarly, Kachra and White (2008) elaborate on the role of the self-interested “*process of giving and getting*” in the transfer of know-how between scientists.

We posit that subsidiaries that are interested in gaining access to the local sources of expertise, and – as a consequence – have a *need for knowledge creation*, might find useful to manifest their “willingness to reciprocate”, thus accepting the leakage of some of their knowledge within the host location. We define the *local sourcing capability* as a subsidiary’s ability to tap into the local knowledge network, and to use the knowledge absorbed locally for further innovation. We expect that a high level of local sourcing capability is associated with reciprocity mechanisms, since subsidiaries that absorb local knowledge are also expected to contribute to it, thus generating a high extent of knowledge outflows:

Hypothesis 1: *Subsidiary local sourcing capability has a positive influence on the extent of knowledge outflows to local firms.*

3.2 Local knowledge outflows and the need for knowledge protection: the quality of subsidiaries' knowledge

A well established stream of literature suggests that innovation in multinational subsidiaries is a peculiar process, since they are simultaneously embedded in two different knowledge contexts: (1) the *internal* multinational corporation network, composed of the headquarters and other subsidiaries; (2) the *external* environment of host country firms (Almeida and Phene, 2004). The opportunity to absorb knowledge from both these networks is nontrivial for their innovative output and creative processes. Subsidiaries are indeed provided with *sourcing* and *combinative capabilities* (Phene and Almeida, 2008), which allow them to effectively recognize the relevant external sources of expertise, and to recombine the subsidiary's knowledge with knowledge absorbed from the other networks it belongs to. Increasing levels of sourcing and combinative capabilities boost the quality of a subsidiary's innovation (Phene and Almeida, 2008), since the creative use of distant and, hence, diverse sets of knowledge leads to distinctiveness and uniqueness.

When subsidiaries are able to exploit the geographical distributed learning opportunities they are exposed to, thus increasing the quality of their knowledge, their local competitiveness is highly reliant on such "superior" knowledge. Moreover, they become extremely attractive for local actors (Hakansson and Nobel, 2001), especially if the latter are strictly domestic, and hence do not have the chance to overcome the local search as multi-location firms do.

Resource-based theory suggests that, in order to serve as a means to pursue the firm's competitive advantage, resources must have some particular characteristics: among others,

they must be rare and difficult to imitate (Barney, 1991; Dyer and Singh, 1998), since when they diffuse to competitors and become replicable, they lose their strategic value.

According to the Knowledge-based Theory of the Firm (Grant, 1996; Liebeskind, 1996), knowledge assets are a firm's most important resources and the primary sources of their rents. As a consequence, "*firms have every reason to prevent others from accessing a valuable body of knowledge they possess so that the knowledge remains rare and a source of competitive advantage*" (Arikan, 2009). Based on this line of reasoning, we expect that when subsidiaries possess a highly valuable stock of knowledge, they might not be willing to share it with local firms. Specifically, we posit that the incentive to protect their knowledge from external appropriation increases with its quality, since the higher the quality of a subsidiary's knowledge, the higher the potential loss associated with its leakage to local firms. We conclude that the increasing levels of quality of a subsidiary's knowledge activate a subsidiary's *need for knowledge protection*, thus reducing the extent of the knowledge that flows to local firms:

Hypothesis 2: *The quality of a subsidiary's knowledge has a negative influence on the extent of knowledge outflows to local firms.*

3.3 Local knowledge outflows and the tension between knowledge creation and knowledge protection

Although subsidiaries may accept some knowledge leakage if they expect to gain access to local sources of expertise, such "tolerant" attitude might not necessarily apply to every situation. We have already explained that the combination of the MNC knowledge with the technology absorbed locally may lead subsidiaries to become strongly innovative, and to produce high-quality knowledge. When subsidiaries are the repository of valuable knowledge,

they might be expected to look at the reciprocity mechanisms stemming from a local sourcing behaviour with reluctance, since the disclosure of their knowledge could be highly detrimental for their competitive advantage. In fact, literature suggests that knowledge-based interactions can hinder a firm's appropriation of her knowledge bodies, thus endangering its competitive standing (Teece, 1998; Arikian, 2009). We suggest that the quality of a subsidiary's knowledge acts as a mediator of the mechanism of reciprocity in knowledge exchanges.

Previous literature has highlighted that the degree of technological development of multinational firms affects their location choices, and has demonstrated that - while lagging firms tend to agglomerate in clusters of related industrial activities, where the inward spillover is higher than the knowledge outflows - leading MNCs avoid highly concentrated locations, where they have much to lose and very few to learn (Shaver and Flyer, 2000, Alcacer and Chung, 2007). We argue that a similar mechanism applies to subsidiaries, and to their knowledge exchange strategies. Specifically, we propose that subsidiaries that possess high quality knowledge are not willing to engage in reciprocal relationships (that might act as a channel for spillovers) with local firms, since their need for knowledge protection is higher than their need for knowledge creation. In fact, given the high quality of their knowledge, they expect to lose more than they can gain from the interaction with local firms. Moreover, subsidiaries with high-quality knowledge are usually provided with the ability and the tools to effectively protect their assets from external appropriation (De Faria and Sofka, 2010): therefore, in contrast with reciprocity predictions, they might be able to access the local sources of knowledge without equally contributing to the local knowledge network. In such cases, a local sourcing behaviour – which generally exposes subsidiaries to a higher likelihood of knowledge outflows – will drive them to increase their protective barriers, thus reducing the extent of knowledge that diffuses in the host location.

Summarizing this reasoning, we hypothesize that the quality of a subsidiary's knowledge emphasizes the need for knowledge protection, thus reversing the effects of reciprocity in knowledge exchanges stemming from local sourcing behaviors:

Hypothesis 3: *Subsidiaries' knowledge quality negatively mediates the relationship between the local sourcing capability and the extent of knowledge outflows to local firms.*

4. Data

We test our hypotheses on a sample of US subsidiaries of European and Asiatic firms from the semiconductor industry. The semiconductor industry seems to be the most appropriate empirical setting of this research for several reasons. First of all, during the last decades, the U.S. semiconductor industry has been the target of an increasing number of inward FDI (Almeida, 1996). Moreover, it is one of the most high-technology industries: therefore, how to profit from knowledge inflows and how to prevent the diffusion of proprietary technology are fundamental issues for agents affiliated to this industry.

In this paper, we use patent citation data to measure the knowledge outflows generated by multinational subsidiaries in their host locations, and to develop measures of *local sourcing capability* and *knowledge quality*. The advantages of using patent citation data to analyze the knowledge spillover phenomenon stem from the rich information content provided by patent documents, which includes the geographic location of both the inventor and the "owner" of the innovation, as well as its time and technology (Almeida, 1996). Thanks to this information, patents allow to identify the locus of the innovative activity, the organization to which the patent is assigned, and the temporal and technological characteristics of the invention (Almeida and Phene, 2004; Branstetter, 2006). In addition, what is pivotal for knowledge spillover studies is that patent documents report a list of citations to other patents

which serves the function to identify the technological antecedents to the particular innovation (Almeida, 1996), and whose inclusion is mandatory in the U.S. patent system.

As literature has widely documented, there are certainly several potential limitations to using patent citation data to investigate knowledge flows. However, empirical spillover analysis has long recognized the effectiveness of the citation measure (Jaffe *et al.*, 1998; Alcacer and Gittelman, 2003; Branstetter, 2006), and lets us be confident about its general significance.

To create our sample, we followed the procedure used by Almeida and Phene (2004) and Phene and Almeida (2008). We considered the largest semiconductor companies by sales leaders, in year 2005, and select the first 10 European and Asiatic MNCs. This list of firms was compiled using information from Gartner Dataquest and Osiris. For this set of MNCs, we identified every U.S. subsidiary engaged in innovation between 1983 and 2005². Our final sample is composed of 29 subsidiaries, observed over a 23-years period: hence, the unit of analysis is a subsidiary-year. The total number of observation in our sample should be 29 (the number of subsidiaries) multiplied by 23 (the number of years of observation). However, not all subsidiaries were observed over the all period, since some of them were established or began patenting later than 1983; moreover, because of the lags built into our model, we had to drop the first observation for each subsidiary. As a result, the actual size of our sample was 459. Patent data were obtained from the United States Patents and Trademarks Office, as well

² This means that, in order to be part of our sample, a U.S. subsidiary had to have registered for at least one semiconductor patent during the whole period. Moreover, we did not infer the presence of a subsidiary in a given location just from the existence of patents developed in that location, but we checked for the existence of the subsidiary since its establishment until the end of our period of observation through different data sources like Uniworld Online, the reports “Foreign Direct Investment in the United States” compiled by the US Dept. of Commerce, as well as the company websites.

as from an on-line database supplied by Derwent Inc.. Firm level data were obtained from Orbis/Osiris.

4.1 Measures

Dependent variable: Knowledge outflows to local firms. As suggested by most of the studies about knowledge spillovers and knowledge flows, the dependent variable used in this paper is built based on the geographic information contained on the citations listed by a U.S. subsidiary's patent. Specifically, to capture the knowledge outflows from MNCs' subsidiaries to local firms, our dependent variable is defined as the number of (forward) citations made to a subsidiary's patent portfolio³ in year t by the universe of local-invented patents applied for in year t.

In order to select the *local* citations relevant to the purpose of this analysis, it is important to correctly define the sub-national geographic unit of analysis. Following recent trends in management and IB literature (Phene and Tallman, 2007; Zhao and Islam, 2007), in this study, we chose to use a more fine-grained option than that of the "State", opting for the "Metropolitan Statistical Area" (MSA), as identified by the United States Office of Management and Budget (OMB). This choice is justified by the observation that many of the relevant U.S. semiconductor technology clusters span more than one state (e.g., New York -

³ In order to identify a subsidiary's patent portfolio, we analyzed the assignee name (typically, the name of the MNC, like Siemens-Infineon or Renesas), and the geographic location of the inventor (which had to be located in the Metropolitan Statistical Area where the subsidiary itself was sited). The patent application date of successful patents was used as the year of innovation. Only semiconductor patents were selected as part of the subsidiary's patent portfolio, based on Derwent's technological classification. Hence, we retained only patents belonging to the first four Derwent patent classes included in the section "Semiconductors and Electronic Circuitry" (Alcacer and Zhao, 2007): U11 (semiconductor materials and processes), U12 (discrete devices), U13 (integrated circuits) and U14 (memories, film and hybrid circuits).

New Jersey – Connecticut tri-state area), and that similarly some states host more than one cluster (e.g., California).

Independent variables: Local sourcing Capability. It is difficult to examine and objectively measure capabilities (Phene and Almeida, 2008). Therefore, in order to proxy a subsidiary's local sourcing capability, we quantify the results of such capability (Ambos et al., 2006; Phene and Almeida, 2008), as represented by citations data. Following Frost (2001), we assume that the attitude of subsidiaries to innovate by building directly upon different sources of knowledge may be inferred through the analysis of the pattern of citations referenced by a particular subsidiary patent. Similarly, Phene and Almeida (2008) in their study about the role of knowledge assimilation and subsidiaries capabilities for subsidiaries' innovative processes suggest that "*cited patents identify the technological antecedents of the innovation, and reflect the knowledge assimilated to create innovation*" (Phene and Almeida, 2008): therefore, analysing cited patents, we can infer the knowledge bases on which subsidiaries have built their creative processes, assuming that they represent the outcome driven by the subsidiary's capability to access and source knowledge. Along with this reasoning, we assume that the greater the number of citations (referenced by a subsidiary patent) to patents generated by local organizations, the greater the local sourcing capability of that subsidiary. We calculate the local sourcing capability as the total number of (backward) citations a subsidiary's patent portfolio has referenced to patents that (a) were assigned to a firm other than the MNC, and (b) whose inventor was located in the same MSA as the subsidiary, in the three years prior to year t^4 .

Independent variables: Quality of subsidiary knowledge. Most of the studies that use patent data proxy the quality of innovation with the number of forward citations a patent

⁴ This is because we expect a lag between the the subsidiary local sourcing capability and our dependent variable.

receives (Trajtenberg, 1990; Gittelman and Kogut, 2003; Singh, 2008). When patents are extensively cited, it means that the knowledge they embody has been used to realize several further innovations. Therefore, it is supposed to be relevant and productive. Hall et al. (2005) find that firms' patent citations are significantly correlated with their market value. As a consequence, highly cited patents should correspond to relevant technological innovations (Gittelman and Kogut, 2003).

To build our measure of innovation, we embrace this perspective and consider the average number of citations that a subsidiary's patent portfolio has received up to year $t-1$ ⁵. We excluded from this count the self-citations from the MNC (either from the subsidiary itself, and from any other tie of the MNC's internal network), in order to have an objective evaluation of the quality that external agents recognize to the subsidiary's innovation.

Controls. Forward and backward citations tend to be correlated between each other. Since we use citation-based measure both as dependent and independent variables, we need to control for the possibility that spurious correlation between these variables can bias our results. As a result, a set of firm, patent portfolio and location characteristics has been applied as control variables in our model.

First of all, since we expect that the number of citations a subsidiary receives will depend on the number of patents it owns, we controlled for the size of a subsidiary's patent portfolio in year t (Sub_Size), a count-based measure of the patents a subsidiary has successfully applied for up to year t . This measure also allows to control for the general size of the subsidiary, since subsidiaries that are able to develop a large number of patents are usually the ones that receive the greater amount of resources from the head-quarter, and hence tend to be the larger in terms of size (Almeida and Phene, 2004).

⁵ Also in this case, we expect a lag between the quality of innovation and our dependent variable.

The age of the patent portfolio is a variable needed to control for heterogeneity in the “citedness” of different foreign subsidiaries, that is driven by differences in the age distribution of their patent stocks, rather than by the subsidiaries’ knowledge strategies (Branstetter, 2006). Jaffe et al. (2000) have found that the knowledge contained in patents needs time to diffuse. Therefore, patent citations are believed to show an initial tendency to increase over time, and to decrease over longer periods, as the innovations they represent become obsolete⁶ (Branstetter, 2006). To account for this effect, for each year and each subsidiary, we included an index (Ptf_Age) calculated as the number of patents, in a subsidiary’s patent portfolio, that are at this peak “citing age”, divided by the total number of a subsidiary’s patents.

Moreover, to assure that differences in the extent of knowledge spillover are not driven by the degree of embeddedness of the foreign subsidiaries, we added a measure (Sub_Age) that accounts for the number of years in which the subsidiary has been located in the U.S.

The MNC’s technological assets have been traditionally considered as a major determinant of the local knowledge spillovers (Blomstrom and Kokko, 2003; Caves, 1974; Haskel et al. 2007; Hymer, 1976). Subsidiaries that are part of highly innovative multinational firms are believed to deliver a greater extent of knowledge outflows to the host location. In particular, the knowledge stock accumulated at the head-quarter level has always been identified as main source of the local spillover effect, thanks to the so-called “pipeline effect” (Hymer, 1976). To control for such MNC-level characteristics, we introduce a measure of the head-quarter’s patent portfolio size (HQ_Know_Stock), given by the total number of

⁶ Empirical evidence shows that a patent usually receives its highest number of citations 4-6 years after its granting (Branstetter, 2006). However, since the semiconductor industry is a fast-changing technological environment, and semiconductor products have a duration of a product life cycle of 5 year on average (Almeida and Phene, 2008), we considered the peak age of semiconductor patents as being comprised between 3-5 years.

semiconductor patents applied for by the head-quarter (whose inventor location is the MNC's home country), in year t-1.

Since the received citations will tend to increase with the number of potentially citing local patents applied for in year t, we controlled for that, by introducing a variable (Region_Size) that accounts for the density of the host location, in terms of semiconductor patents.

The patterns of knowledge spillovers in a specific region can be influenced by the underlying distribution of the technological activities within that area (Jaffe et. al, 1993). Therefore, to control for the technological “closeness” between the subsidiary and its local context, we introduced in our model the variable “Region_Tech_Prox”, as a measure of “technological proximity”⁷ between the firm and the local knowledge network (Jaffe et al., 1986).

Since our research analyses subsidiaries over a number of years, we added year dummies in our model to account for possible effects of serial correlation. We also included two sets of dummies to control for either host-regions and home-country⁸ heterogeneity.

Finally, in a patent-based dynamic study, it is important to control for the general increase in the industry's propensity to patent over time. To do that, we adjusted the patents used to create our measures, by dividing them by a factor that accounted for the increase in patenting in the semiconductor industry. For the year t, this factor was calculated by dividing the total number of semiconductor patents filed in year t by the total number of semiconductor patents

⁷ We build this measure following Jaffe (1986): $PROX_{it} = (\text{FitFmsat}) / [(\text{FitFit})(\text{FmsatFmsat})]^{1/2}$, as the angular separation between the two vectors (Fit and Fmsa) representing the distribution of semiconductors patents in sub-classes for the subsidiary and its host-location.

⁸ We distinguished between subsidiaries belonging to MNCs' whose head-quarter was located in Europe and MNCs' whose head-quarter was located in Asia.

filed in year 1983 (our earliest year, assumed as the base year) (Almeida and Phene, 2004; Phene and Almeida, 2008). We also controlled for trend in the propensity to cite and to be cited in the semiconductor industry between 1983 and 2005: specifically, as suggested by Almeida and Phene (2004) and Phene and Almeida (2008) we assumed that the propensity to cite and to be cited was correlated with the propensity to patent in the semiconductor industry (Almeida and Phene, 2004; Phene and Almeida, 2008), and adjusted the citations used to build our measures by a factor equal to the levels of patenting. Finally, we added host-region as well as home-country dummies⁹.

5. Methods

The first econometrical issue about studies involving patents and patents' citations refers to the count nature of the dependent variable (Hausman et al., 1984). Literature suggests to deal with this type of data by using a Poisson model. However, such model is based on the assumption that there is no heterogeneity in the sample, since it may lead to a case termed "overdispersion", thus generating underestimation of standard errors and an inflation of significativity levels.

When performing a Poisson estimation on our full model, the results showed a high and significant value of chi-square (chi-square = 2918.03, with a p-value of 0.0000), which indicates the presence of overdispersion, and advises against the use of the Poisson specification. This problem was addressed by using an econometric model whose design corrects for the presence of overdispersion: the negative binomial regression model, developed by Hausman et al. (1984).

⁹ Home-country dummies were built distinguishing between Europe and Asia.

Since we have panel data involving repeated observations of our sample of subsidiaries, there might be unaccounted subsidiary effects that are fixed in time or vary randomly. In order to establish whether to use fixed-effects or random-effects specifications, we performed the Hausman test (1978), and we found insignificant differences between the coefficients. Therefore, we could not reject the random effects specification.

6. Findings

Table 1 presents the descriptive statistics for our sample and bivariate correlations among all variables included in our model. The high value of the correlation coefficients between the Local Sourcing Capability and the Subsidiary Size (0.639) and between the Quality of a subsidiary innovation and the Subsidiary Age (0.583) requires attention, and will be object of further investigation in our “Sensitivity Analyses and Robustness Checks” section. Potential problems of multicollinearity could also emerge from the inclusion of our interaction variable. To account for this issue, we followed the standard procedure (Aiken and West, 1991) and centered the interacting terms to reduce collinearity. Moreover, we calculated the variance inflation factor (VIF), which allows to diagnose the eventual presence of multicollinearity. The value of the VIF was below the critical limit of 10 indicated by Neter, Wasserman and Kutner (1983) for all our models, suggesting no apparent risk of multicollinearity.

The results of our negative binomial models with random effects are presented in Table 2.

We first test a baseline model (Model 1) including all our controls variables. The results confirm traditional beliefs on the importance of the Head-Quarter Knowledge Stock for the FDI-mediated spillover effect (Blomstrom and Kokko, 2003; Caves, 1974; Haskel et al. 2007; Hymer, 1976), and point to the importance of Subsidiary Age, a proxy for the subsidiary’s integration in the host-region, as a predictor of the extent of knowledge flows to the host environment: both the coefficients of these two control variables were indeed positive and

significant ($p < 0.01$). Predictably, also the variable “Portfolio Age” was positive and significant at $p < 0.01$. However, none of the other controls turned out to be significant.

Model 2 presents our findings on the effect of subsidiaries’ Local Sourcing Capability on the extent of knowledge spillover to local firms. We find strong support for Hypothesis 1 regarding the reciprocity in knowledge exchange mechanism. The coefficient of our Sourcing Capability variable is positive (+0.022) and highly significant ($p < 0.01$), and the Wald statistic increases from 354.03 to 402.28. Our result shows that the stronger is a subsidiary’s *need for knowledge creation* (and, therefore, the higher is the extent of knowledge it absorbs from the host location), the higher will be its contribution to the local knowledge network, in terms of knowledge outflows. Indeed, in order to gain and maintain the access to the host knowledge base, the subsidiary will need to reciprocate the knowledge acquired locally, accepting the leakage of some of its proprietary technology.

Model 3 accounts for the effects of the subsidiaries’ *need for knowledge protection*. Hypothesis 2 is supported, as we can see from the negative (-0.150) and significant ($p < 0.01$) coefficient of the “Quality” term. Subsidiaries that are able to produce highly valuable knowledge are less likely to share it with their host location, since they find crucial to maintain the control on these resources. As a consequence, they generate lower levels of knowledge outflows to local firms.

Model 4 presents the results of the full model. The inclusion of the interaction term between a subsidiary’s Local Sourcing Capability and the Quality of its knowledge leads to an increase in the overall fit of the model, with the Wald statistic at 408.32. While the signs of the interacting terms remain unchanged, the mediating coefficient turns out to be negative (-0.012) and significant ($p < 0.01$), supporting our Hypothesis 3. In presence of high knowledge Quality, the Local Sourcing Capability reduces the extent of knowledge outflows to local firms. This finding seems to suggest that, when subsidiaries’ knowledge is strongly valuable,

not only the Local Sourcing Capability does not push toward a greater knowledge diffusion; rather, subsidiaries' attempt to enforce their knowledge protection strategies in order to neutralize eventual reciprocity mechanisms leads to a lower extent of outward knowledge spillover.

6.1 Sensitivity analyses and Robustness Checks

Due to the high correlation between some of our variables, we performed several sensitivity analyses to ensure the robustness of our results.

We first dealt with the high value of the correlation coefficient between the Local Sourcing Capability and the Subsidiary Size (0.639). We ran our full model regressions without the Local Sourcing Capability variable: our results did not change, and the Portfolio Size maintained its sign and significance. Subsequently, we ran the alternative model, this time dropping the Portfolio Size, and also in this case our results did not change.

Also the correlation between the Quality of a subsidiary innovation and the Subsidiary Age was very high (0.583). We dropped the Quality variable, but our findings were the same. When we tried the alternative of dropping the Subsidiary Age, the variable of Region Size (which is correlated with the Subsidiary Age size at 0.230) became negative, but other results did not change.

We conducted further robustness checks on our models. First, we test the appropriateness of the definition of our Local Sourcing Capability variable. In our first model (Table 2), we measured Local Sourcing Capability based on the citations a Subsidiary makes to local patents in the three years prior to year t . This focus on the past is meant to capture how the subsidiary's local knowledge sourcing behavior affects its subsequent knowledge outflows to the host location. Specifically, we built the variable over a three-years period in order to make sure that the subsidiary's knowledge sourcing was a structured behavior, rather than just a

mere occurrence. In order to test the robustness of our measure, we ran our models with alternative specifications of the Local Sourcing Capability. In particular, in the first and second columns of Table 3, we measured it over a single-year period (t-1) and over a five-years period. Our findings maintain their signs, as well as their overall significance. Light drops of significance are just detectable for our interaction term in the second column, when using the measure of Local Sourcing Capability as built on a five-years period.

Finally, we wanted to account for the use of the MSA as the locations' boundary where to knowledge flows take place. Since administrative boundaries do not necessarily mimic the shape of the locations where firms exchange knowledge, in the last column of Table 3, we use the State boundaries as an alternative definition of "region". The regression results maintain the expected signs and significance, thus confirming the robustness of our models.

7. Conclusions and Implications

Our study investigates how the trade-off between the need for knowledge creation and the need for knowledge protection affects the extent of knowledge outflows subsidiaries generate within host regions. Empirical findings confirm that subsidiaries that source more from the local knowledge network are also more likely to contribute to it, due to the mechanism of reciprocity in knowledge exchanges. Indeed, the willingness to gain access to foreign pockets of expertise and complementary knowledge drives subsidiaries to tolerate the leakage of part of their proprietary assets abroad, in order to build the trust needed to facilitate knowledge inflows. However, as the quality of their knowledge increases, the level of knowledge outflows diminishes, suggesting that subsidiaries tend to protect their assets from external appropriation more, when the competitive value of these assets is very high. Interestingly, our results also show that the presence of high knowledge quality reverses the effects of reciprocity in knowledge exchanges, since its interaction with the subsidiaries' sourcing

capability is negatively associated with the level of local knowledge outflows. Based on our theoretical reasoning, we believe that such finding can be explained by the tension between the need for knowledge creation and the need for knowledge protection: when the quality of a subsidiary's knowledge is very high, the pressure to protect its assets is much more urgent than the need to build reciprocal knowledge linkages that could foster the creation of new knowledge. Specifically, subsidiaries with high knowledge quality that source local knowledge not only do not activate mechanisms of knowledge reciprocity, but rather protect their knowledge even more, due to the greater potential danger associated with the dissemination of their knowledge in the host location. These results are consistent with a recent theoretical study on the interfirm knowledge exchanges within a cluster, claiming that *“knowledge interactions are plagued by opportunism and appropriability problems. Solutions to these problems lie in the development of trust and norms of cooperation within the cluster. Yet competitive challenges make the development of cooperative norms highly difficult while at the same time creating numerous reasons to break them once they are established”*.

The study offers two main contributions. In the first place, it adds to the literature on the firm-level antecedents of FDI-mediated knowledge spillovers, which so far has focused on the structural profile of the MNCs and the subsidiaries, while leaving aside the issue of the subsidiary's knowledge strategies. Building on recent insights on the active role of subsidiaries in the generation (Cantwell and Mudambi, 2005; Phene and Almeida, 2008) and protection (De Faria and Sofka, 2010) of knowledge in MNCs, we investigate how a subsidiary's management of its knowledge assets influences the extent of knowledge outflows generated abroad. More broadly, this paper contributes to general IB literature on the relationship between subsidiaries and their host regions. Overcoming the traditional, and partial, perspectives that see the foreign location *either* as an opportunity *or* as a threat for

MNC subsidiaries' competitiveness, we show that both the roles are possible, if we explicitly account for the subsidiaries' needs in term of knowledge creation and knowledge protection.

This paper has important implications also for managers of both the subsidiaries and the local firms. Regarding the latter, most of prior research has looked at the phenomenon of knowledge spillovers as a danger for firms, whose assets could be appropriated by competitors, thus losing their competitive value (Shaver and Flyer, 2000; Alcacer and Chung, 2007; Sanna-Randaccio and Veugelers, 2007). In this study, we demonstrate how subsidiaries' managers may use their knowledge as "bargaining chips" in the relationships with the local partners, thus working "*on the social side of the exchange calculus*" (Kachra and White, 2008). In this case, allowing for the occurrence of knowledge spillovers within the host location is just another competitive tool to gain access to the local knowledge network, thus acquiring the complementary resources they need to evolve. Of course, such strategy – which is effective when subsidiaries' innovative performance is strongly dependent on their ability to access to the local knowledge assets – might become too dangerous in situations when their knowledge quality is already very high. In these cases, subsidiaries' managers should invest more in the protection of their proprietary resources, since they often constitute the real competitive asset that distinguishes them from local competitors.

Local firms' managers, on the other hand, should be aware that subsidiaries' cooperative behavior not necessarily signals a constant and stable approach to the local knowledge network: indeed, subsidiaries reciprocate to knowledge exchanges when this choice is consistent with the pursuit of their knowledge imperatives and with their need for knowledge creation, but they may turn to opportunistic attitudes when sharing their resources with the local knowledge network implies a too high strategic loss.

The analysis also provides a major policy implication. Indeed, when designing FDI-attraction strategies, policy makers should be aware that: (1) MNCs will likely share their

knowledge with local firms only if they expect to gain something in return; (2) the most advanced subsidiaries, which own highly valuable knowledge and superior technology, are the ones that contribute less to the local knowledge network, since they are likely to implement the strictest protection strategies to avoid the external appropriation of their competitive assets. In conclusion, governments that aim to incentivize the localization of FDI in their countries should account for the possibility that the most technologically advanced subsidiaries might not be the best target to attract, when aiming to foster local firms' acquisition of MNCs' knowledge.

Though this paper provides interesting insights on the firm-level antecedents of FDI local spillover, the study has several limitations. First, our sample is limited to US-based semiconductor subsidiaries. As a consequence, its external validity is constrained. Moreover, we acknowledge that the choice of the firms analyzed in the study was driven by data availability. Therefore our sample is a convenience sample, and our findings might not hold for the population of semiconductor firms. In future research, we plan to provide further support to our findings by extending the focus of our analysis to subsidiaries located in other host countries, as well as belonging to other high-tech sectors.

Second, we measure most of our variables through the use of patents and patent citations. We recognize that analyzing the information stemming from these sources is not the most accurate way to infer firms' capabilities or strategic behaviors. However, this approach is not new to the empirical research on subsidiaries, given the scant sources of secondary data available (Frost; 2001; Ambos et al., 2006; Almeida and Phene, 2004; Phene and Almeida, 2008). In future studies, we propose to use a survey methodology to better capture the phenomenon of analysis, and to complement our results.

Finally, our study offers only a description of the link between the patterns of knowledge spillovers and the subsidiary-level antecedents considered. We draw some assumptions

regarding mechanisms of knowledge reciprocity that explain the effect of subsidiaries' sourcing capabilities on knowledge outflows, as well as regarding the protective attitudes that drive subsidiaries with high knowledge quality to limit local spillover. However, we are not able to indicate the actual arrangements subsidiaries use to foster or restrict the flow of their knowledge in the host-region. Again, in future studies, we hope to focus on the concrete knowledge management measures subsidiaries carry out in order to optimize the interaction with the local knowledge network.

Table 1. Correlation matrix

	1.	2.	3.	4.	5.	6.	7.	8.	9.				
1. Knowledge Flows	1.000												
2. Sourcing_Cap	0.635 **	1.000											
3. Quality	0.190 **	0.003	1.000										
4. Sub_Size	0.546 **	0.639	0.091 *	1.000									
5. Ptf_Age	-0.025	0.037	-0.385 **	-0.083 *	1.000								
6. Sub_Age	0.473 **	0.316	0.583 **	0.394	-0.338	**	1.000						
7. HQ_Know_Stock	0.091 *	0.043	0.110 *	0.047	-0.047	0.374	**	1.000					
8. Region_Size	0.220 **	0.145	0.315 **	-0.074	-0.090	*	0.230	**	0.054	1.000			
9. Region_Tech_Prox	0.175 **	0.195	0.249 **	0.145	-0.102	*	0.363	**	0.154	**	0.148	**	1.000
Mean	3.658	2.820	3.383	15.050	0.268	10.487	1180.948	128.792					0.832
Standard deviation	7.940	5.536	2.831	35.947	0.246	6.543	779.361	120.067					0.250

1) * p<0.05, ** p<0.01.

Table 2. Subsidiary Knowledge Outflows: negative binomial regression with random effects

<i>Dependent Variable: Knowledge Flows (MSA Level)</i>	<i>Baseline Model</i>	<i>Knowledge Creation Model</i>	<i>Knowledge Protection Model</i>	<i>Interaction Model</i>		
	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>		
<i>Independent Variables</i>						
Sourcing_Cap	<i>Hp. 1</i>	0.022 (0.006)	***	0.020 (0.006)	***	
Quality	<i>Hp. 2</i>			-0.150 (0.053)	***	
Sourcing_Cap*Quality	<i>Hp. 3</i>				-0.012 (0.004)	***
<i>Controls</i>						
Sub_Size		0.000 (0.003)	0.000 (0.003)	0.001 (0.003)	0.003 (0.003)	
Ptf_Age		0.148 (0.316)	*** 0.159 (0.328)	*** 1.145 (0.329)	*** 0.873 (0.337)	**
Sub_Age		0.146 (0.029)	*** 0.123 (0.028)	*** 0.137 (0.029)	*** 0.105 (0.028)	***
HQ_Know_Stock		0.001 (0.000)	*** 0.001 (0.000)	*** 0.001 (0.000)	*** 0.001 (0.000)	***
Region_Size		0.001 (0.001)	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)	
Region_Tech_Prox		0.866 (0.667)	0.506 (0.664)	1.051 (0.667)	0.397 (0.671)	
Const		-4.511 (1.115)	*** -3.974 (1.085)	*** -3.263 (1.126)	*** -3.733 (1.082)	***
LR chi-squared		116.70	*** 87.81	*** 107.86	*** 89.25	***
Wald Statistic		354.03	*** 402.28	*** 371.64	*** 408.32	***
N		462	459	459	258	

1) Standard errors in parentheses.

2) * p<0.1, ** p<0.05, *** p<0.01.

3) All models include year dummies, MSA dummies and Home-Country dummies.

Table 3. Subsidiary Knowledge Outflows: negative binomial regression with random effects – Robustness Checks

<i>Dependent Variable: Knowledge Flows (MSA Level)</i>		<i>Full Model with Sourcing Capability built over a 1-year period</i>		<i>Full Model with Sourcing Capability built over a 5-year period</i>		<i>Dependent Variable: Knowledge Flows (State Level¹)</i>	
<i>Independent Variables</i>							
Sourcing_Cap	<i>Hp. 1</i>	0.038 (0.013)	***	0.018 (0.005)	***	0.018 (0.003)	***
Quality	<i>Hp. 2</i>	-0.102 (0.047)	**	-0.116 (0.049)	**	-0.102 (0.047)	**
Sourcing_Cap*Quality	<i>Hp. 3</i>	-0.023 (0.009)	***	-0.006 (0.002)	**	-0.008 (0.002)	***
<i>Controls</i>							
Sub_Size		0.003 (0.003)		0.002 (0.003)		0.005 (0.003)	*
Ptf_Age		1.238 (0.356)	***	0.743 (0.344)	**	0.798 (0.313)	**
Sub_Age		0.111 (0.028)	***	0.110 (0.027)	***	0.129 (0.029)	***
HQ_Know_Stock		0.001 (0.000)	***	0.001 (0.000)	***	0.001 (0.000)	***
Region_Size		-0.000 (0.001)		0.001 (0.001)		0.001 (0.001)	
Region_Tech_Prox		0.603 (0.666)		0.437 (0.672)		0.364 (0.806)	
Const		-4.164 (1.090)	***	-3.627 (1.083)	***	-2.798 (0.929)	***
LR chi-squared		96.74	**	85.77	***	142.60	***
Wald Statistic		396.60	***	427.81	***	520.35	***
N		459		458		458	

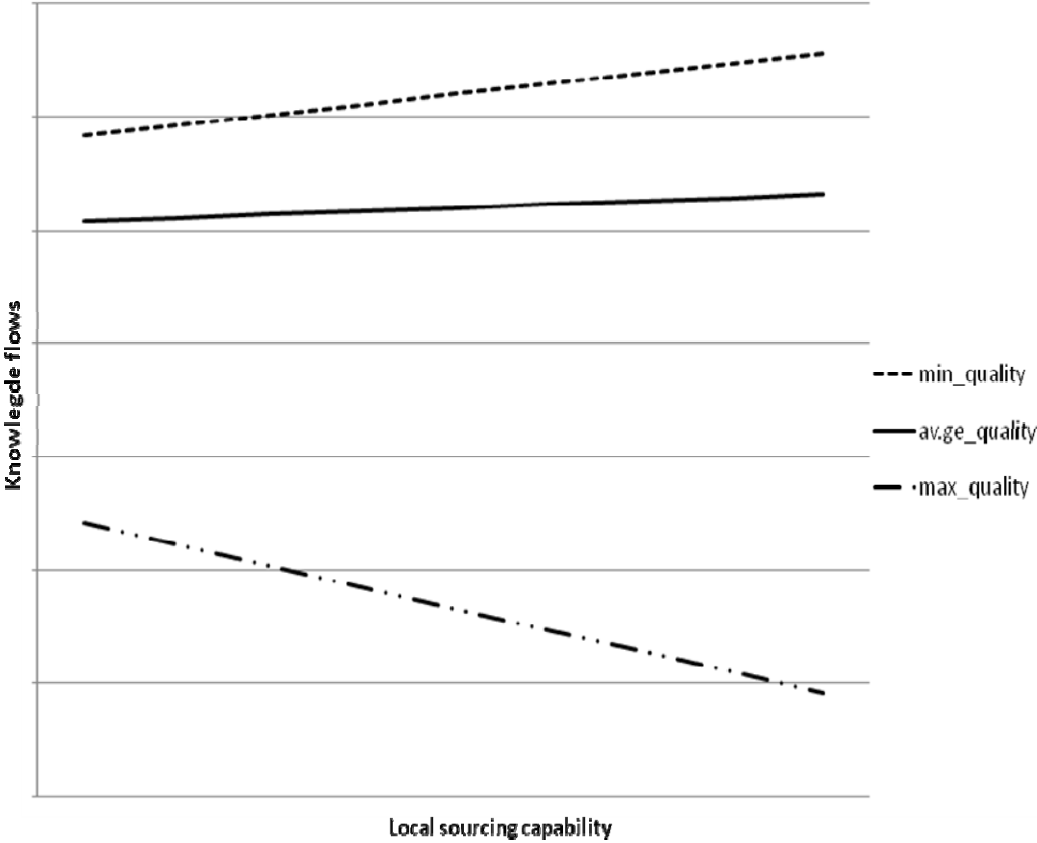
1) Alternative definition of the Host-Region.

2) Standard errors in parentheses.

3) * p<0.1, ** p<0.05, *** p<0.01.

4) All models include year dummies, MSA/State dummies and Home-Country dummies.

Figure 1. Subsidiary Knowledge Outflows: interaction effects.



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ESSAY 3

**BALANCING THE TRADE-OFF BETWEEN LEARNING PROSPECTS AND
SPILLOVER RISKS: MNC SUBSIDIARIES' VERTICAL LINKAGE PATTERNS IN
DEVELOPED COUNTRIES**

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Abstract

This paper investigates the pattern of subsidiaries' local buyer-seller linkages under varying levels of competition and subsidiary capabilities. Contrary to most previous literature, we explicitly account for the double role of such vertical linkages as conduits of potential learning benefits as well as potential channels for outward spillovers to competitors. We find a curve-linear relationship between the extent of competitive pressure and the quality of a subsidiary's set of local linkages. Furthermore, the extent to which a subsidiary possesses capabilities moderates this relationship: Very capable subsidiaries in strongly competitive environments tend to shy away from high quality linkages. We discuss our findings in light of literature on spillovers and inter-organizational linkages.

Keywords: Quality of vertical local linkages, competitive pressure, subsidiary capabilities, learning, outward spillovers.

1. Introduction

An important consequence of foreign direct investment (FDI) lies in the phenomenon of local linkages, i.e. non-equity relationships that subsidiaries develop with local firms in their host countries (Chen et al., 2004). The study of local linkages has recently given rise to a substantial strand of literature, which has characterized linkages' attributes (Giroud and Scott-Kennel, 2009; Santangelo, 2009; Scott-Kennel, 2007; Scott-Kennel and Enderwick, 2004), investigated their antecedents (Belderbos et al., 2001; Giroud and Mirza, 2006; Jindra et al., 2009), and analyzed their consequences (Andersson et al., 2002; Saliola and Zanfei, 2009; Hansen et al., 2009). It is well-accepted that local linkages act as a major channel through which MNCs diffuse their tacit knowledge to local firms (Blomstrom and Kokko, 1998; Driffield et al., 2002; Ghauri and Buckley, 2006) as well as learn from the domestic environment (Andersson et al., 2002 & 2007). Therefore, they might expose subsidiaries to a trade-off between inward and outward spillovers (Sanna-Randaccio and Veugelers, 2007; Santangelo, 2010).

However, not all local relationships have the same potential for learning (i.e. inward spillovers from the local environment) and outward spillovers from the foreign affiliate to host countries. It depends on the type of linkages as described in both sub-streams of literature on subsidiaries embeddedness (Andersson 1997; Andersson and Forsgren 1996 & 2000; Forsgren et al., 2005) and on linkage creation (Giroud and Scott-Kennel, 2009; Saliola and Zanfei, 2009; Santangelo, 2009). Linkages of high quality are characterized by partners' interdependence and extensive social interaction. They are more effective than arm's length relationships when it comes to the enhancement of the local process of knowledge flows. Quality of local linkages is about the stability and worth of inter-firm relationships as those are relationships in which both the subsidiary and the local partner

have invested substantial amounts of resources, and whose preservation they are strongly committed to (Duanmu and Fai, 2007). Thus, quality linkages offer high-value learning opportunities from local partners for foreign subsidiaries, but simultaneously expose the foreign units' knowledge to the risk of outward spillover to the host-economy (Blomstrom and Kokko, 1998; Mudambi and Navarra, 2004, Sanna-Randaccio and Veugelers, 2007; Santangelo, 2010).

Despite their importance, empirical evidence on the antecedents of quality of local linkages remains limited (Jindra et al., 2009; Santangelo 2009; Scott-Kennel, 2007) to some extent due to the fact that previous research focused on attributes of quantity rather than of quality. Moreover, empirical research on the linkages' impact on host-countries has mainly focused on less advanced and developing economies (Moran et al., 2005; Hansen et al., 2009; Jindra et al., 2009; Santangelo, 2009). While this approach increases our understanding how such countries can profit from linkages between their locally-owned firms and local affiliates of MNCs (Hoekman and Smarzynska Javorcik, 2006; Kugler, 2006), it prevents to predict the patterns of linkages in situations where domestic actors are highly competent, equipped with absorptive capacity, and located in very competitive industries. These conditions make local firms desirable vertical partners but they simultaneously increase the risk of an erosion of competitive advantage due to outward spillovers. Hence, in these environments, the effective management of the trade-off between potential learning and potential spillovers becomes crucial.

We address this limitation and seek to explain the extent to which foreign subsidiaries develop high-quality buyer-supplier relationships in developed countries. We suggest that subsidiaries perceive high quality linkages not just as learning mechanisms but also as potential threats through which their proprietary knowledge may reach host-country competitors. As a result, we posit that the extent to which the subsidiary perceives the local

environment as highly competitive as well as the level of the subsidiary's capabilities affect the trade-off between local learning opportunities and the degree to which the subsidiary want to avoid potential outward spillovers. In turn, this influences the subsidiaries' investments into their local relationships, i.e. subsidiaries adapt their linkages to these characteristics. Our results support our view and show that the local competitive pressure increases the quality of linkages up to a point after which the investment in local vertical relationships drops. In addition, the level of the subsidiary's capabilities moderates this curvilinear relationship by affecting subsidiaries' incentives to link to local firms. That is, the interaction of own capabilities and the local competitive pressure help explain patterns of buyer-supplier relationships between foreign MNC affiliates and domestic host-country firms.

We contribute to the literature by specifically researching the *quality* of vertical local linkages rather than the quantity which still prevails in most of current research. Furthermore, we contribute to the literature studying the relationship between linkages and spillovers by shifting the focus of the analysis from the host-country perspective to the subsidiary's perspective on local linkages. We account for the possibility that subsidiaries choose the optimal level of resources to invest in vertical local linkages based on their assessment of the strategic consequences that close interaction with local firms will instigate, both in terms of potential inward and outward spillovers. Our finding of a moderated, inverted u-shaped relation between to the quality of vertical local linkages and competitive pressure shows that adaption processes regarding inter-organizational strategies of subsidiaries are complex undertakings that take into account firm-internal as well as firm-external factors. By acknowledging that vertical local linkages are prone to activating the bi-directional knowledge flow we find that the effect of local competition

has to be differentiated, i.e. local competitive pressure has a dual role as it both facilitates and inhibits the quality aspect of the vertical local linkages depending on its strength.

The remainder of the paper is organized as follows. In the next section, we review the existing research on local linkages' attributes and their impact on host-countries and subsidiaries' characteristics, and recall the relevance of focusing on quality linkages. We then elaborate on the "trade-off" between local learning and unwanted knowledge dissemination associated with quality linkages. Afterwards, we develop and test our model that explains the extent to which subsidiaries operate with high-quality linkages. Finally, we present our model and discuss the empirical results.

2. Literature Background

2.1 Local Linkages Research

Subsidiary relationships with vertical local business partners represent the channels through which local firms may access valuable and unique sources of knowledge. Such relationships also help foreign units to gain a better understanding of the local markets, and to access location-specific "pockets of expertise" and resources (Chen and Chen, 1998; Fosfuri and Motta, 1999; Giroud and Scott-Kennel, 2009).

Most of previous research on local linkages has focused on the quantitative dimension of the phenomenon, which has been measured either as the value of the amount of goods and services a subsidiary buys or sells in the host-economy (Belderbos et al., 2001; Driffield and Noor, 1999; Iguchi, 2008), or as the number of relationships it develops with local suppliers and customers (Scott-Kennel, 2007). The quantity of vertical linkages provides information on the benefits from the increased demand for products and services FDI creates within host-countries (Giroud and Scott-Kennel, 2009). However, scholars have begun to point to the limited significance of this attribute when it comes to evaluating

the impact of subsidiaries on local firms' learning and upgrading, and vice-versa (Giroud and Scott-Kennel, 2009; Scott-Kennel, 2007). Indeed, only some linkages will last over time, inducing the development of shared vision and co-evolution (Duanmu and Fai, 2007; Li, 2005), and thereby become sources for learning (Andersson et al., 2002), while other linkages will just be arms-length relationships much less important in facilitating learning.

To account for such differences, scholars have recently begun to pay special attention to the *quality* of local linkages as a more meaningful attribute of relationships (Giroud and Scott-Kennel, 2009; Scott-Kennel, 2007). Mainly, quality linkages act as a mechanism for knowledge sharing and improvement (Giroud and Scott-Kennel, 2009; Gulati, 1995; Gulati and Gargiulo, 1999). In fact, the social dimension characterizing these linkages is the major premise for effective bi-directional learning . Thanks to on-going interactions between organizational structures and people among firms, relationship partners develop common cognitive models, trust, and value-creating ties through which they exchange resources and share unique knowledge (Gulati, 1995; Gulati and Gargiulo, 1999).

Notwithstanding its importance, existing studies on the quality of local relationships seldom provide a direct assessment of the underlying social dimension, thus neglecting the main mechanism through which knowledge and competences flow.

2.2 The trade-off of quality linkages

MNCs are commonly considered as central actors in the dynamics of international knowledge transfer. In less advanced contexts, the MNCs' local linkages have been identified as contributing to local firms' competitiveness (Jindra et al., 2009) through outward spillover mechanisms (Blomstrom and Kokko, 1998). Shifting the context of analysis to more advanced settings, scholars have instead focused on the subsidiaries' gains from high-quality vertical local linkages. These relationships have been found to

increase subsidiaries' market performance and to foster their technical competences (Andersson et al., 2002), as well as to originate power and influence within the MNC's internal network (Andersson et al., 2007).

However, when considering developed countries, greater attention should be paid to the *bi-directional* knowledge flows that vertical quality linkages are able to activate (Mudambi and Navarra, 2004; Sanna-Randaccio and Veugelers, 2007; Santangelo, 2009). Indeed, in such contexts, local partners' greater competitiveness is not only an opportunity, but also a threat. On the one hand, domestic customers and suppliers possess high-value business and technical resources, to which it is more attractive to connect. On the other hand, their greater absorptive capacity makes them more able to internalize the subsidiary's knowledge and, eventually, to further channel it to the subsidiary's local competitors. Notice, that spillovers may be intentional or unintentional (Mudambi and Navarra, 2004). When the knowledge receivers are the subsidiaries' vertical partners (i.e. local suppliers or customers), the transfer of technology is usually intentional (Mudambi, 2002), as it fosters mutual understanding, learning and facilitates the relationship's stability. Knowledge flows to local competitors are usually unwanted by subsidiaries, since they may imply the erosion of the distinctive nature of their competitive advantage (Kachra and White, 2008; Schrader, 1991; Von Hippel, 1987).

Although subsidiaries tend to avoid direct exchanges with local competitors (Aitken and Harrison, 1999; Gorg and Greenaway, 2002), they might not be completely able to prevent them from acquiring some of their knowledge. Leakage of knowledge may in reality occur through mediated contacts between the subsidiary and its local competitors since the set of information and resources shared within a vertical relationship might be channeled also to other agents within the local context (Spencer, 2008). Indeed, when a vertical linkage is embedded in an influential inter-firm business network, the subsidiary's

local partners may turn into a bridge between its competitive resources and other local firms. Under these conditions, the knowledge the subsidiary's local partners have gained *via* the direct relationship with the foreign firm may diffuse to other network participating agents (Ghauri et al., 2005; Gulati, 2007).

The abovementioned reasoning is consistent with the findings of recent literature on networks that strongly emphasizes the existence of a “*tension between the hope to acquiring new capabilities and the fear of losing control over one's resources*” (Brass et al., 2004; p.808). In addition, within the literature on subsidiary embeddedness, Santangelo (2010) provides empirical evidence on the tension of information sharing between competing firms entertaining quality relationships with local actors.

How do subsidiaries manage such tension? We assume that subsidiaries located in advanced settings are usually “advanced” agents themselves having capabilities to screen the competitive dynamics and to recognize existing opportunities and threats. As a consequence, they adapt their investments in vertical local linkages to different external as well as internal conditions on which we will elaborate in the next section.

3. Hypothesis development

3.1 Quality of local linkages and the local competitive pressure

The importance of the host-country competitive conditions for the theory of foreign direct investment has been largely recognized in literature (Kogut and Chang, 1991). However, scarce attention has been paid to the understanding of how the *local competitive pressure* affects the pattern of linkages creation.

In general, market competition makes firms' relative position uncertain, as their advantages and distinctive resources are less stable and more difficult to preserve (Cool and Dierickx, 1993). In presence of increasing market rivalry, firms are pushed towards

upgrading and innovating (Grant, 1991; Porter, 1990), in an attempt to win the competitive race and gain future market power (Cassiman and Veugelers, 1999; Schumpeter, 1942). However, developing innovation internally is costly and time-consuming, especially if environmental conditions are uncertain and fast-changing, as in the case of high competition. In such situations, firms reduce investments into internal innovation processes since there is a high risk that the output will soon become obsolete.

Building cooperative linkages with local firms is an alternative and effective way to gain access to new practices and technologies (Chen et al., 2004), incremental upgrading of products or processes (Chen, 2008), and knowledge, while maintaining a certain extent of flexibility (Arikan, 2009). Many studies suggest that the personal interaction between individuals across firms, and the subsequent relational capital and reciprocity in knowledge transfer, are pivotal mechanisms for learning and innovation (Dahl and Pedersen, 2004; Kachra and White, 2008; Kale et al., 2000; Saxenian, 1994).

Therefore, in presence of high competition, when firms are exposed to the pressure to innovate (Santangelo, 2010) leveraging relationships with business partners might be crucial. Such linkages can help to pool useful information and provide access to new distinctive resources, thus ultimately inducing innovation. This is especially true for subsidiaries of foreign MNCs investing in developed countries. In fact, in such contexts, local partners are more advanced either in technical and/or in business practices, and represent a potentially rich source of relevant information, knowledge and resources to learn from. While in less advanced countries the subsidiaries' liability of foreignness may be significantly counterbalanced by the managerial and technological advantages they are presumed to enjoy with respect to local firms, in developed economies the competitive distance between local and foreign firms might be shorter. As a consequence, the integration with the local business network through high quality local linkages becomes

even more important for subsidiaries, in order to overcome the disadvantages deriving from being an external actor, i.e. the liability of foreignness (Hymer, 1976). Building on this reasoning, we expect that the competitive pressure in domestic markets increases the potential benefits of local learning opportunities, driving the quality of linkages.

However, when competitive pressure becomes too high, subsidiaries may perceive further increase of the quality of local linkages as too risky. In presence of fierce competition, firms may find it difficult to maintain the control over their proprietary assets. Tumultuous and crowded competitive arenas might prevent even more skilled subsidiaries from avoiding the leakage of their knowledge as this would require committing a large amount of resources to monitoring activities and implementing private protection strategies. Moreover, as suggested by Scherer (1965), it is a moderate level of competition which seems to be the most conducive to innovation: scarce appropriation opportunities lower the firms' incentive to innovate, thus reducing the willingness to learn from the local environment, and to commit in high quality local linkages. Finally, the turbulence stemming from increased competition may harm the general trust and social capital on which the focal relationships between the subsidiary and its local partners leverage (Cooke, 2001), thus increasing the risk of being exposed to opportunistic behaviors. Research suggests that when knowledge is shared within a non-trust based environment, it is more likely to be transferred to third parties who are outside the control of the knowledge source (McCann and Mudambi, 2005). Integrating these arguments, we expect that, in presence of very high levels of local competitive pressure, the risk of spillover increases and eventually exceed the value of potential local learning opportunities. In turn, this leads to lower

investments in vertical local linkages and a decrease in their quality¹⁰. We therefore expect that the following:

Hypothesis 1: *There is an inverted U-shaped relationship between the local competitive pressure and the quality of vertical local linkages.*

3.2 The role of subsidiary capabilities

Previous research has suggested that the characteristics of foreign firms strongly influence the type of relationships they develop in the host-countries (Hanson et al., 2009; Iguchi, 2008; Jindra et al. 2009; Santangelo, 2009, 2010; Scott-Kennel, 2007). Following this approach, we claim that a subsidiary's level of capabilities affects the quality of their vertical local linkages.

In addition to the direct effect that subsidiary perceptions of competitive pressure have on vertical quality linkages, we suggest that the effect is moderated by how much the subsidiary potentially can lose. In other words, a subsidiary's capabilities are crucial regarding the relationship between local competitive pressure and the quality of vertical local linkages. Indeed, according to our reasoning, when dealing with local partners, subsidiaries are "*seeking to gain information, while not giving too much away*" (Brass et al., 2004, p. 809). Following the approach of Birkinshaw and Hood (1998, p.24), subsidiary capabilities may be defined as "*the capacity to deploy resources, usually in combination, using organizational processes to effect a desired end*". Beyond being a

¹⁰ Notice that this risk of spillovers is not merely dependent on the objective level of competition of a given setting. Rather, it results from the assessment each subsidiary makes of the network of interdependent relationships (Gulati et al., 2000) in which the subsidiary itself, and its vertical linkages, are embedded. Therefore, we emphasize and refer to the role of the perceptions of spillover risks.

source of subsidiary competitive advantage (Barney, 1991), these capabilities simultaneously contribute to their evolution within the MNCs' hierarchy (Andersson et al., 2007; Birkinshaw and Hood, 1998). Therefore, they might be seen as the opportunity set on which subsidiaries can leverage in order to achieve both their external and their internal success.

Subsidiaries with high level of capabilities are attractive to their counterparts (Håkansson and Nobel, 2001) and therefore local partners of high capable subsidiaries have strong incentives to learn from the subsidiary. They might seek to build quality linkages to gain access to the subsidiary's extensive set of competences. However, if capabilities diffuse to competitors and become replicable, they lose their strategic value. As a consequence, *"firms have every reason to prevent others from accessing a valuable body of knowledge they possess so that the knowledge remains rare and a source of competitive advantage"* (Arikan, 2009; p. 666). Therefore, subsidiaries tend to be highly motivated to prevent the leakage of their capabilities to the local rivals. A recent study by Faria and Sofka (2010) supports this claim. Their results show that subsidiaries of foreign MNCs protect their knowledge from spillovers more extensively than local firms do.

Subsidiaries that enjoy a high level of capabilities have much more to lose from the interaction with local partners. Therefore, we expect that such subsidiaries react to high levels of competition even stronger, i.e., the combined effect of high potential loss and high competitive pressure makes subsidiaries reduce their investments into quality linkages stronger than if the subsidiary has less to lose because of a limited resource base. Further, a limited resource base makes further learning, and thereby quality of vertical linkages, more interesting. Similarly, subsidiaries with high capabilities might increase their investments into vertical quality linkages slower when competitive pressure starts off because their

marginal enhancement of their capabilities is relatively small. Based on this reasoning, we formulate the following hypothesis:

Hypothesis 2: *Subsidiary capabilities negatively moderate the inverted U-shaped relationship between the local competitive pressure and the quality of vertical local linkages.*

4. Methods

The sample used in this study includes Swedish multinationals involved in a variety of manufacturing industries, such as paper, telecommunications, petrochemicals, hard materials, power systems, and equipment manufacturing. Initially we approached the managing directors of 20 international divisions/business areas, belonging to 13 Swedish MNCs. The MNCs were chosen from the Swedish OMX 'Large Cap' list, excluding firms in the financial, insurance and banking sectors. We chose to sample on the divisional/business area level of the firms as we wanted to focus particular products or groups of products at the subsidiary level. In order to study the quality of local linkages it is necessary to pinpoint the particular relationships between the subsidiary and the local counterpart. It is very often necessary to limit the search for vertical local linkages using a particular product or product line as the subsidiary might be involved in several product lines. Therefore, to make the interviews focused on specific relationships and the internal resources, capabilities and structures in the subsidiary 'devoted' to the specific relationships, it is necessary to start in the product end of the MNC, i.e. at the subsidiary level. As several of our measures are reported by the headquarters it is necessary that the headquarters respondent has a thorough knowledge of the particular product or product line

in the subsidiary why the divisional/business headquarters is a more relevant level compared to the MNC headquarters.

All divisions studied were highly international, 75 percent of them having more than half of their employees outside the home country. In these international divisions we gathered data from 97 subsidiaries located in European countries and in North America¹¹. Although the majority of the subsidiaries were based in Europe, the subsidiaries are widely distributed between northern, central, western, and southern parts of Europe. On average, five subsidiaries were studied in each division, although the variance is between two and nine. The divisions' headquarters assisted in the selection of subsidiaries that were representative for the division's business activities with the intention of increasing the possibility of drawing general conclusions. On average, the subsidiaries in the sample accounted for over 50 percent of the divisions' combined operations measured in terms of the number of employees. In 25 percent of the divisions, the subsidiaries investigated accounted for more than 80 percent of the division's total operations, whilst they accounted for between 10 and 60 percent in the remaining divisions. The number of employees in the subsidiaries varied from 50 to over 5,000. The subsidiaries investigated all performed their own production and sales. Product development and production process development are, therefore, important activities in all subsidiaries studied.

The data used to test the model were administered through face-to-face interviews, using a standardized questionnaire, with managers at the subsidiary level. The questionnaire was carefully developed incorporating feedback from several academics, which identified questions that were vague, ambiguous or the source of possible bias, and pilot tested on an experienced manager in an MNC not approached in the actual study.

¹¹ Analysis is mainly done with 96 subsidiaries due to missing values.

Subsequently, we modified some of the initial questions, eliminated some and added others to the revised instrument. We also took precaution to limit potential common method variance by placing dependent and independent variables or items for constructs at different positions in the survey, also scale anchors were changed. In order to reduce the effects of consistency artefacts (Salancik and Pfeffer, 1977) we placed the dependent variables after the independent variables in the questionnaire. From the flow of the questionnaire it was improbable that respondents could guess hypothesized relations between constructs thereby avoiding social desirability bias. Further, the items asked about in the questionnaire are indicators used for complex constructs such as quality of local linkages and competitive pressure and the models tested include quadratic effects further limiting the possibility of common method variance (Siemsen et al., 2009).

The interviews were carried out with three managers in each subsidiary, subsidiary top, sales and purchasing manager. The subsidiary CEO answered questions regarding the subsidiary's general status and MNC internal standing. The sales and purchasing managers answered questions specifically about the relationships to the subsidiaries' most important business partners for a specific product or product group. The personal interviews lasted for about two hours each, during which time, problems involving concepts in and interpretations of the questionnaire could be discussed and explained if necessary.

5. Measures

5.1 Dependent variable: the quality of vertical linkages

In order to account for the “social-interaction” perspective we propose an alternative empirical assessment of local linkages. The quality of linkages is related to the *degree of interdependency* such vertical relationships originate, but also to the amount of *direct interactions* between organizational areas (and hence individual managers) from the local

firm and the subsidiary. In particular, we build a measure of quality of vertical local linkages which is based on the appraisal made by the subsidiary of the *degree of technical and business adaptations* that have occurred between the foreign and the local partners, as well as of the *number of functional areas involved in direct contact with people from the business counterpart* (suppliers or customers). This measure provides an effective way to capture the extent to which a market-based vertical relationship can go beyond its pure transactional content, allowing its partners to *exchange more* than what they contractually agreed to do. To this end, we first asked the subsidiary sales and purchasing managers to indicate the six most important (for any reason) relationships with external customers (3) and external suppliers (3). Secondly, the respondents provided information about the extent of technical as well as of business adaptation that each *external* relationship had produced: technical adaptation was measured as the degree of adaptation in production process development and product development, while business adaptation was captured by the degree of adaptation of the overall business conduct. A Likert scale ranging from 1 (not at all) to 5 (very much) was used. Finally, sales and purchasing managers were asked to assess the number of different functional areas from which individuals are involved in direct contacts with customers and suppliers. These functional areas are the chief executives, the administration, the purchasing department, the sales department, the production department (technical staff), and the R&D department. For each of the four indicators informed by the subsidiary managers, we summated the scores of the subsidiaries' external relationships, and then divided the obtained value by the total number of external relationships investigated. These subsidiary-level indicators load on one single factor, leading to a construct reliability of .849. They were used to create the subsidiary's average quality of vertical local linkages.

The advantage of this measure is that it allows to point directly to “quality linkages”, thanks to the choice made by the subsidiaries’ managers, responsible for the relevant functions: through this technique, rather than considering the whole set of heterogeneous local relationships of the subsidiary, we concentrate on those which have been screened by an internal agent, who is the most privileged witness of the relationships’ status, in terms of quality. This procedure meets our goal to focus on relationships which play a *strategic role* for the subsidiary, thus allowing for considerations on the trade-off subsidiaries face between the benefits of local learning opportunities and the threat of dissemination of their competitive resources¹². While the focus on *adaptation* allows us to depict the extent to which subsidiaries invest in local linkages, upgrading them from simple arm’s length relationships to high-interdependency ties, the emphasis on the *different functional areas involved* points to the “social dimension” of linkages. Through this latter indicator, we are able to respond to recent literature’s call for greater attention on the “*social interaction aspects*” of local vertical relationships (Giroud and Scott-Kennel, 2009). Moreover, embracing the idea that the highest-level capabilities of the firm are the “*cross-functional capabilities*” (Grant, 2008), which derive from the combination of more specialized, functional capabilities, it becomes clear that – through the interaction with different subsidiaries’ functional areas (captured by our quality linkages measure) – vertical partners can access the most important competitive assets of the subsidiaries. Therefore, we are able to assess the extent to which local linkages allow for the sharing of the “highest-level” capabilities. A limitation in this study is that only vertical linkages, to customers and suppliers, are included in our measure. This means that we might underestimate the risks of

¹² Note that we therefore generalize our findings only to the most important relationships that subsidiaries might have – and not the whole network.

spillover, but on the other hand the focus on local customers and suppliers increase the precision and the relevance of technological knowledge compared to a more heterogeneous set of local partners. Our measure of quality of local linkages is based on the assessment made by only one of the relationships' partners. Of course, incorporating also the local firms' evaluation of the linkage quality would have added a lot of reliability to our empirical results. However, we believe that our focus on the subsidiary perspective reduces the relevance of this issue; moreover, it has been shown by Hallén et al. (1991) that the adaptation of one party in the relationship is a demonstration of reciprocal commitment and trust.

5.2 Local competitive pressure

We measure the local competitive pressure by asking the subsidiary purchasing and sales managers to evaluate the extent to which they experience competitors influencing their business activities. This results in a perceptual measure of competitive pressure in the subsidiary's local environment, which is consistent with our aim to investigate how environmental conditions impact the subsidiary's choice to invest in local linkages. The point is that only when subsidiaries *perceive* the competitive pressure, they will assess the consequent costs and benefits of quality linkages, and adapt their strategic behavior, thus adjusting their degree of commitment to the local relationships. In other words, managers act on their perceptions about the environment and not necessarily on "objective" facts (Boyd et al., 1993; Weick and Roberts 1993). Asking both the sales and purchasing managers to assess the extent they perceive competitors influence the subsidiary's business activities ensures that we have the most knowledgeable respondents assessing this and that we get a better measure compared to the case of one single respondent. The indicator of influence was measured on a five-point Likert scale from 1 (not at all) to 5 (very much).

We averaged the scores attributed by the two respondents. The resulting indicator represents the average competitive pressure perceived by the subsidiary within its local business network.

5.3 Subsidiary capabilities

It is difficult to objectively measure capabilities. To overcome this limitation, we focused on the results of such capabilities (cf. Ambos et al., 2006; Phene and Almeida, 2008 for similar approaches). We asked the subsidiary top management to assess the extent to which the subsidiary has responsibility for other units' purchasing and sales activities on a 5 point Likert-type scale. We assume that the higher the level of responsibility for other units the more the subsidiary is a "center of excellence" and hence, the higher its capability base (cf. Frost et al., 2002). We summated the scores of the two indicators to create a proxy for the extent to which the subsidiary possesses important capabilities (Construct reliability .717)

5.4 Controls

We controlled for several industry-specific and firm-specific factors. Following previous literature on local linkages (Jindra et al., 2009) we included a measure that accounts for the type of entry mode, and created a dummy indicating whether the foreign investment was made through acquisition. We also controlled for subsidiary size (Scott-Kennel, 2007), as captured by the number of subsidiary employees, as well as for subsidiary age, measured by the number of years the subsidiary has been located in the given location (Scott-Kennel, 2007). Industry-effects have been accounted for through the introduction of two industry-dummies. Following Chen et al. (2004, p. 329), we split subsidiaries into three groups: high-tech industries, which cover electrical and electronics,

machinery and precision instrument sectors; producer-driven industries, which cover chemicals, basic metals, metal products, non-metal mineral sectors; buyer-driven industries, which cover textiles, food, paper, wood products and leather.

We also controlled for the geographical distance between the subsidiary and the headquarters, by introducing a dichotomous variable that takes the value of 1 for long distances and 0 otherwise. We used the fact that some HQ-subsidary relationships crossed the Atlantic Ocean to signify those as “long distance”. In fact, nearly all inner-European distances do not exceed 2000 kilometers and there is maximum 1 hour time lag. Hence, we coded those as “short distance” or “0” in our sample. Following previous literature (Jindra et al., 2009) we also accounted for subsidiary autonomy measured as the extent to which the subsidiary can decide about organizational structure, investments, investments in R&D, and acquisitions. We averaged the values of the items of this 5-point scale to derive an average measure of subsidiary autonomy (Construct reliability .772). Table 1 presents a correlation table and descriptive of our constructs.

----- Table 1 about here -----

6. Results

To test our hypotheses, OLS regressions were used. To account for the fact that several subsidiaries belong to the same firm division and that their linkage patterns might, therefore, be correlated, we applied the robust cluster procedure¹³. We checked for the normality of the residuals and the absence of multicollinearity. We obtained an average

¹³ This was not necessary for several subsidiaries belonging to the same country as intra-class correlations are very low and insignificant.

variance inflation factor of 1.41 indicating no apparent risk of multicollinearity (Hair et al., 2006). We standardized the variable of local competitive pressure before squaring it in order to avoid multicollinearity. We used the mean centering technique for Subsidiary Capabilities to calculate the interaction effect with competitive pressure. Table 2 shows the results. The baseline model (Model 1) explains 10% of the variance and shows that sub-units in *producer-driven* industries have significantly lower quality in their local linkages than subsidiaries operating in high-tech industries. None of the other regressors turns out to be significant.

----- Table 2 about here -----

Model 2 tests the curvilinear relationship between local competitive pressure and the quality of vertical linkages. The explained variance increases to 33.3%. Both competitive pressure coefficients are significant with the linear effect being positive and the quadratic effect being negative. This supports our hypothesis 1. The effects remain stable across the remaining specifications. In Model 3, we add the variable subsidiary capabilities which is not a significant predictor of the quality of the local vertical linkages. In Model 4 we add the interactions between subsidiary capabilities and the local competitive pressure terms to test Hypothesis 2 with the subsidiary capability being centered. The model explains 38% of the variance. The estimation shows that the interaction of subsidiary capabilities with the linear term of competitive pressure is significant ($p < .05$). The interaction with the quadratic term, however, is not significant. This result lends some support to our Hypothesis 3. We have depicted the interaction result in Figure 1¹⁴. Figure 1 shows that the

¹⁴ High and low were defined as 1 standard deviation above and below the mean value of subsidiary capabilities.

overall shape of the curve does not change with the level of subsidiary capabilities (because of the non-significance of the interaction term with the quadratic effect). However, for any level of competitive pressure, the slope of the curve of the subsidiary with higher capabilities is smaller than the slope of the curve of the subsidiary with lower capabilities. This shows that, with beginning competitive pressure, highly capable subsidiaries increase the level of quality linkages slower than low-capability subsidiaries. Furthermore, at higher levels of competitive pressure, highly capable subsidiaries decrease the level of quality linkages more strongly than low-capability subsidiaries.

----- Figure 1 about here -----

Hence, the effect of competitive pressure on the quality of vertical linkages depends on the level of capabilities that the subsidiary possesses. Notice, that not all curves in our Figure 1 have a tipping point where the level of quality linkages falls again. The tipping point is at competitive intensity levels of 2.5 for low-capability subsidiaries, at 1.4 for average-capable subsidiaries; at 0.4 for highly capable subsidiaries. Hence, the tipping point of the curve moves to the left with an increase of the level of capabilities that subsidiaries possess¹⁵. Subsidiaries with very low capabilities experience a decreasing marginal effect but even under highest levels of competition they will not *reduce* their level of investments into their linkages – they have nothing to lose, but still a lot to learn.

¹⁵ Note that the competitive intensity variable is standardized so that these values represent standard deviations.

7. Discussion and Conclusions

In this paper, we aim to contribute to the literature that investigates the relationship between foreign affiliates' buyer-suppliers linkages and spillovers. Shifting the focus of the analysis from the host-country to the firm, we are able to explicitly account for the double role quality linkages play for subsidiary's competitiveness. On the one hand, building strongly interdependent relationships with local partners allows for gathering information on the foreign markets and to develop new capabilities. On the other hand, it encompasses the risk of unintended knowledge dissemination to the host-economy. We show that by being aware of the opposing effects stemming from vertical linkages subsidiaries in developed countries adapt the investment into their local relationships. Their linkages patterns adapt to both external and internal factors, notably the extent of local competitive pressure and the level of the subsidiary's capabilities. Specifically, our results suggest that increasing competitive pressure fosters the importance of sourcing resources for innovation from the local context. However, when competition becomes too high, subsidiaries tend to lower the quality of their local linkages, in order to protect their competitive assets from the increased risk of knowledge spillover in the external environment. This finding is consistent with recent research on networks and inter-firm relationships, stating that "*inter-organizational networks offer a variety of knowledge, innovation, performance, and survival benefits, but the issue of competition, information control, and trust in partners makes the problem of building effective networks highly complex*" (Brass et al., 2004; p. 807). Moreover, we find that when subsidiaries possess a high degree of capabilities, they leverage more on the relationships with local partners when competition is low, but they also reduce their commitment more to such relationships when the perceived pressure from the competitive environment exceeds a certain threshold, since – in this latter case - their potential loss from outward spillover could be too high.

Previous literature has either focused on the linkages' effects on domestic firms' competitiveness (Javorcik, 2004; Scott-Kennel and Enderwick, 2005), or emphasized the beneficial consequences of embeddedness for subsidiaries (Andersson et al, 2002; Chen and Chen, 1998). We believe that, in both cases, considering the trade-off associated with quality linkages is relevant. On the one hand, in order to appraise FDI impact on host-country firms through linkages, it is important to recognize that subsidiaries are aware of the risk of knowledge spillovers they face in the local context, and react to it adapting their investment in local relationships: this finding supports the view that FDI-mediated knowledge spillovers do not happen automatically (Driffield et al., 2010; Marin and Bell, 2006), but rather depend on the subsidiaries' strategic behavior within host-countries. On the other hand, when discussing local linkages as a driver of subsidiaries' performance, it should be considered that they are not only beneficial to them, but may also give rise to some costs, which subsidiaries may or may not decide to bear, depending on the influence of both internal and external factors.

This study also adds to the literature on quality of local linkages. Despite the recent call for a more thorough analysis of this linkages' attribute (Giroud and Scott-Kennel, 2009; Scott-Kennel, 2007), scant attention has been paid in literature to how the characteristics of the local competitive environment and the subsidiary individual profile affect the quality of linkages. We make a contribution by using a measure that tries to capture two relevant components of local linkages' quality: (1) the degree of interdependency between partners (mutual adaptation in product and process development); and (2) its underlying "social dimension" (number of direct contacts between different functional areas and the local counterpart).

This paper has several managerial implications. First, it confirms the strategic importance of linking with local partners, as a way to manage the external environment

and to leverage on subsidiary capabilities. Simultaneously, it shows that managers should be aware that local linkages, when they encompass knowledge sharing and interdependency within an advanced business network, might turn into a channel of spillovers to local competitors, through which the subsidiary resources might lose their distinctive nature. Moreover, as suggested by our results, subsidiary managers should learn to assess under which external and internal conditions the advantages of local learning opportunities overbear the drawbacks of the risk of spillover, and vice-versa.

Our study also suffers from some limitations. Our analysis of vertical local linkages quality and the risk of knowledge dissemination do not cover the effects of other types of “spillover-controlling” mechanisms, such as the formal protection strategies (De Faria and Sofka, 2010). However, this should not be of any major concern for our study, since once such “regulating restrictions” are in place, they automatically reduce the quality of local linkages, because they signal distrust to local partners.

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Table 1: Descriptive statistics and correlation matrix.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Quality of Vertical Linkages	1.000												
2 Entry Mode (1 = Acquisition)	0.068	1.000											
3 Sub. Size	0.124	0.056	1.000										
4 Sub. Age	-0.022	-0.169	0.055	1.000									
5 Producer-Driven Industry Dummy	-0.120	0.114	-0.080	0.051	1.000								
6 Buyer-Driven Industry Dummy	-0.089	-0.244	-0.125	0.184	-0.228	1.000							
7 Large Distance Dummy	-0.093	0.079	0.004	-0.118	-0.211	-0.079	1.000						
8 Sub. Autonomy	0.081	-0.028	-0.080	0.033	0.247	-0.364	0.111	1.000					
9 Local Competitive Pressure	0.466	0.118	0.098	0.054	-0.025	-0.038	0.062	0.071	1.000				
10 Local Competitive Pressure Squared	-0.190	0.168	-0.026	-0.160	-0.199	0.060	0.108	-0.129	0.056	1.000			
11 Sub. Capabilities	0.176	0.046	0.082	-0.008	-0.131	-0.149	-0.128	-0.121	0.058	-0.101	1.000		
12 Sub. Capabilities x Local Competitive Pressure	-0.207	-0.012	0.051	-0.172	-0.039	-0.117	-0.066	-0.098	-0.138	0.153	0.230	1.000	
13 Sub. Capabilities x Local Competitive Pressure Squared	0.210	0.025	0.020	-0.168	-0.004	-0.142	0.006	0.027	0.168	-0.194	0.601	0.433	1.000
Means	2.796	0.216	684.3	29.9	0.082	0.361	0.598	3.586	0.000	0.990	3.835	0.111	-0.232
Std. Dev.	0.686	0.414	1612.3	27.8	0.277	0.483	0.493	0.99	1.000	1.197	1.913	1.700	2.514

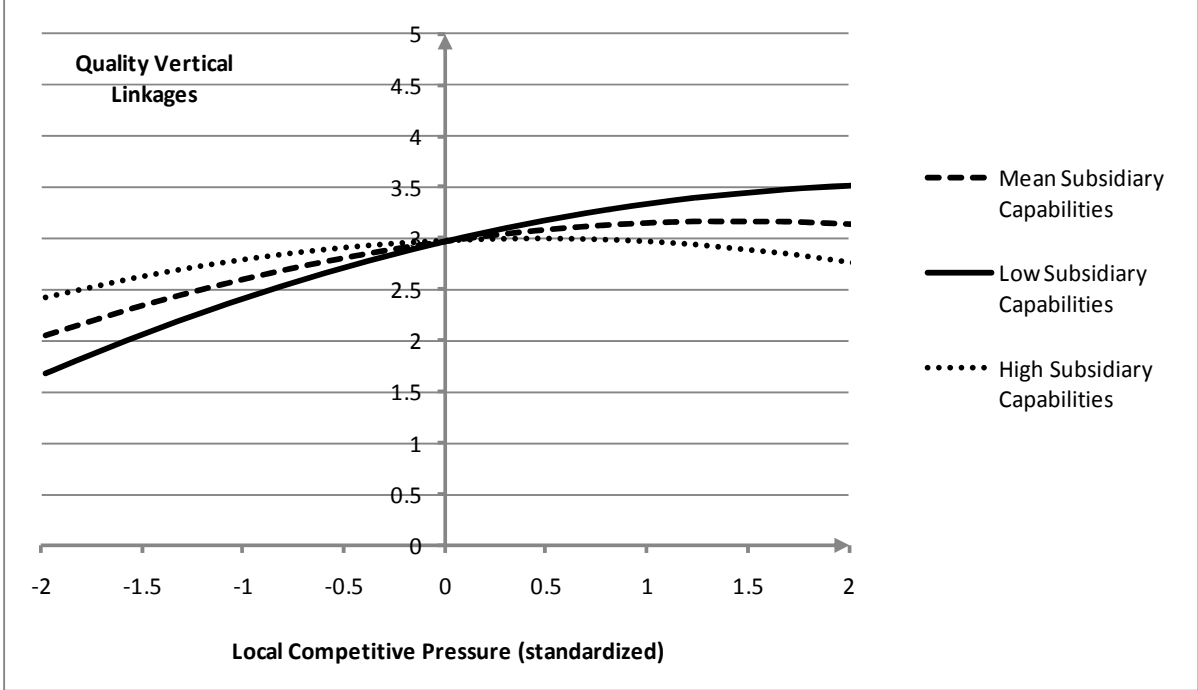
Table 2: OLS regression results for dependent variable quality of vertical linkages.¹⁾

Specifications		(1)	(2)	(3)	(4)
Hypothesized relationships	H1: Local Competitive Pressure		0.321 *** (0.056)	0.317 *** (0.054)	0.275 *** (0.068)
	Local Competitive Pressure Squared		-0.143 *** (0.038)	-0.137 *** (0.040)	-0.095 ** (0.044)
	Sub. Capabilities			0.027 (0.038)	0.009 (0.042)
	H2: Local Competitive Pressure x Sub. Capabilities				-0.100 ** (0.046)
	Local Competitive Pressure Squared x Sub. Capabilities				0.047 (0.028)
Controls	Entry Mode (1 = Acquisition)	0.127 (0.172)	0.109 (0.165)	0.104 (0.167)	0.076 (0.192)
	Sub. Size	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
	Sub. Age	-0.001 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)
	Producer-Driven Industry Dummy (baseline: high-tech industry)	-0.513 *** (0.154)	-0.552 *** (0.105)	-0.513 *** (0.121)	-0.527 *** (0.123)
	Buyer-Driven Industry Dummy (baseline: high-tech industry)	-0.092 (0.194)	-0.077 (0.139)	-0.050 (0.123)	-0.099 (0.108)
	Large Distance Dummy	-0.220 (0.146)	-0.235 (0.155)	-0.218 (0.166)	-0.256 (0.156)
	Sub. Autonomy	0.107 (0.095)	0.055 (0.058)	0.063 (0.060)	0.043 (0.043)
	Constant	2.578 *** (0.447)	2.967 *** (0.264)	2.807 *** (0.339)	2.968 *** (0.340)
	Firm-Controls ²⁾	Yes	Yes	Yes	Yes
	F	6.09 ***	36.14 ***	36.28 ***	32.71 ***
R-squared	0.08	0.33	0.34	0.38	
Mean VIF				1.41	

1) Unstandardized regression coefficients. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, Ψ p<0.1. Number of observations n=96 except for specification 1 where 97 observations are used for the estimation.

2) Controls for potential intercorrelations between subsidiaries belonging to the same firm included in the model (Robust clusters procedures as in STATA 10).

Figure 1: The relationship between Local Competitive Pressure and Quality of Vertical Linkages for different levels of Subsidiary Capabilities.



ESSAY 4

**DOES FDI ACCELERATE THE LOCAL SPILLOVER EFFECT?
THE ROLE OF MULTINATIONAL FIRMS' AND HOST-REGIONS' OPENNESS**

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Abstract

Despite the strategic importance of the FDI knowledge spillover effect for local firms' competitiveness, no study has focused on the speed at which this phenomenon takes place. However, this issue is crucial since the speed at which firms absorb external knowledge influences the time they need to carry out subsequent innovations, and – hence - their capacity to adapt to external changes, react to competitors, and enter new markets, thus ultimately affecting their chances to obtain a competitive advantage. This paper tries to fill this gap, by investigating the temporal patterns of knowledge flows between foreign subsidiaries and firms located in host-regions. Combining International Business literature with insights on Open Innovation, we find that both MNCs' and host-regions' openness foster the speed of local spillover processes.

Keywords: knowledge spillover, open innovation, speed, foreign subsidiaries, host-regions.

1. Introduction

Innovation has been described as the ability to create new recombination of existing knowledge (Schumpeter, 1942). However, relying just on the knowledge residing within a firm's organizational boundaries may not always be sufficient to activate successful innovative processes. An increasing number of studies has indeed demonstrated the importance of external knowledge sourcing as a determinant of innovation (Von Hippel, 1988; Szulanski, 1996; Laursen and Salter, 2006). Yet, literature has suggested that a firm's search for external knowledge inputs tends to be "*technologically and geographically bounded*" (Rosenkopf and Almeida, 2003: 751).

In order to innovate, firms located in a given region can leverage on the set of knowledge sources available in the surrounding external environment (Almeida, 1996). However, to be successful and outperform rivals, firms must do more than simply absorbing knowledge from outside; most importantly, they must do it *quickly*. The speed of this process can determine a firm's capacity to adapt to external changes, foresee and react to competitors, and enter new markets (Salomon and Martin, 2008). Indeed, the ability to accelerate the innovation process is crucial to obtain a competitive advantage (Eisenhardt and Martin, 2000).

Subsidiaries of foreign Multinational Corporations (hereafter, MNCs) represent a critical source of knowledge for co-located firms, since they embody the MNC's superior technology and may be themselves very active in terms of knowledge creation (Almeida and Phene, 2004). In fact, Foreign Direct Investment (hereafter, FDI) is considered a catalyst for local firms' technological upgrading (Singh, 2007; Haskel et al., 2007). Although scholars from various disciplines have extensively analyzed the intensity of the knowledge flows from MNCs to local firms (Almeida, 1996; Branstetter, 2006; Singh, 2007), as well as their antecedents (Wang and Blomstrom, 1992; Perez, 1997; Driffield and Love, 2007) and the channels through which they take place (Song et al., 2001; Cassiman and Veugelers, 2003), research has failed to consider the *time patterns* of this process, thus neglecting the role that *a prompt access* to external knowledge

inputs can play for the success of a firm's innovation. In this paper, we try to fill this gap by analyzing the time it takes to foreign subsidiaries' knowledge to diffuse within the host-region and be used by local firms. In doing so, we build on the insights from the "Open Innovation" literature, and suggest that the speed of local dissemination of a MNC subsidiary's knowledge increases with both the multinational firm's and the host-region's "*openness*". We define "openness" as the attitude to downsize the importance of knowledge protection, while emphasizing the relevance of external knowledge sourcing. In fact, the "Open Innovation" approach stresses the need to broaden the scope of a firm's external search in order to capture potential learning opportunities, which can feed the innovation funnel (Laursen and Salter, 2006). Our starting point is therefore the idea that a widespread propensity to openness within both the multinational firm and the host-region increases the likelihood of local interaction between the firm and its surrounding environment and activates new and more "porous" channels of knowledge sharing, thus fostering the process of boundary-spanning knowledge flows.

This study aims to contribute to the International Business literature that studies knowledge spillovers between MNCs and host-country firms in two ways. First, it explicitly investigates the speed of the process of knowledge diffusion between these agents. Literature has already recognized the strategic importance – for firms' competitiveness - of both the FDI knowledge spillover effect (Haskel et al., 2007; Singh, 2007) and the pace of innovative processes (Markman et al., 2005); yet - to the best of our knowledge - no study has combined these insights and investigated how knowledge flows from foreign subsidiaries to local firms manifest in time, thus accelerating the local knowledge creation process. Second, building on the literature on "Open Innovation", it explores the role of openness on the local spillover effect, which – as far as we now – has been overlooked by previous research.

The remainder of this paper is organized as follows. First, we review literature on FDI spillovers and underline the relevance of the temporal dimension of the innovation process. Second, we develop a theoretical framework in which we use the “Open Innovation” literature to explain the time patterns of local spillovers. Third, we elucidate the proposed research design and present descriptive statistics for our sample. Finally, we discuss the expected results.

2. Literature review

The role played by foreign direct investment in enabling technology transfer to host countries has been central in both international economics and international business literatures. Research has highlighted that MNCs’ presence is crucial for local firms’ technological capabilities (Haskel et al., 2007; Marin and Bell., 2006, 2010), and that foreign subsidiaries generate knowledge spillovers to domestic organizations (Almeida, 2006; Singh, 2007). As a matter of fact, when foreign firms are located in a region and conduct research within the local knowledge network (Cohen and Levinthal, 1990), proximity drives them to interact, thus exchanging information and know-how with the domestic counterparts. Hence, their knowledge is subject to a process of local diffusion, which takes place through several formal and informal channels (Almeida, 1996). In the perspective of local firms, the opportunity to gain access to subsidiaries’ knowledge is crucial. By internalizing knowledge spillovers, local firms acquire “*modern technology as well as management, distribution and marketing skills*” (Singh, 2007; p.765). Therefore, thanks to proximity to foreign subsidiaries, they can “*improve their products and processes at little or no cost and, thereby, enhance their performance*” (Shaver and Flyer, 2000; p. 1176). Due to this strategic role for local firms’ competitiveness, much literature has analysed the direction, the scope and the channels through which knowledge spillovers from FDI take place (Teece, 1977; Rodriguez-Clare, 1996; Almeida, 1996; Song *et al.*, 2001; Feinberg and Majumdar, 2001; Chung, Mitchell and Yeung, 2003; Javorcik, 2004; Haskel *et. al*, 2007; Singh,

2007; Driffield et al., 2010). Yet, no study has analysed the *speed* at which such spillovers occur within subsidiaries' host-regions.

This issue is relevant because the ability to speed up innovation is crucial to obtain a competitive advantage (Eisenhardt and Martin, 2000). Being the first to introduce a change into the competitive arena may confer early-mover advantages, through which fast innovators accelerate the rate at which subsequent novel opportunities can be exploited, and create a competitive distance between themselves and rivals (Lieberman and Montgomery, 1987). In addition, since money has a time value, markets reward prompt technological advances more than delayed ones (Espina and Markman, 2005; Merges and Nelson, 1990), as they generate early cost-savings (Markman et al., 2005). Speed is a crucial capability especially in high-technology sectors, where products life cycle is shorter and the rate of obsolescence highly challenging.

In general, competition makes firms' relative position uncertain, as their advantages and distinctive resources are less stable and more difficult to preserve (Cool and Dierickx, 1993). Contemporary markets' conditions push firms towards upgrading and innovation (Porter, 1990; Grant, 1991), in an attempt to win the competitive race and gain future market power (Schumpeter, 1942; Cassiman and Veugelers, 1999). However, developing innovation internally is costly and time-consuming, especially if environmental conditions are uncertain and fast-changing. Firms may find that investing resources in internal innovative processes is not worthy, since there is a high risk that the output will become obsolete very soon. In such situation, the search for knowledge inputs outside the boundaries of the firm is an alternative and effective way to gain access to new practices, technologies and incremental upgrading of products or processes, while maintaining a certain degree of internal flexibility (Arikan, 2009). In this case, the speed at which external knowledge is acquired determines the rate at which subsequent innovations that build upon the external knowledge absorbed can be carried out, thus allowing the firm to leapfrog competitors and to gain a strategic advantage.

Subsidiaries of foreign MNCs embody a unique and attractive knowledge base on which local firms can build upon, especially if they are wholly domestic and, hence, do not have the chance to overcome the limitations of local search as multi-location firms do. As a consequence, the speed at which local firms are able to capture the knowledge flows originating from foreign subsidiaries is a relevant dimension along which to evaluate the benefits – for firms in a given location - arising from the presence of multinational corporations. Especially in high-tech industries, where imitation, constant new discoveries and obsolescence reduce the length of technology-based advantages (Markman et al., 2005), the rate at which new knowledge diffuses to the agents of a given context, allowing them to build on its innovative content, might be more important than the mere expectation that such dissemination will happen, sooner or later.

Research on the speed of knowledge transfer has mainly focused on the *intra-organizational knowledge diffusion processes*, due to the importance of establishing the conditions that help firms to promote the internal sharing of know-how, good practices and experience, in order to exploit potential sources of competitive advantage across the whole organization.

Within this stream of research, scholars have suggested that the *characteristics of the knowledge to be transferred* influence the diffusion process. As an example, Zander and Kogut (1995) find that the degree of codification affects the speed of knowledge transfer within the firm. Complexity and tacitness of the knowledge increase the difficulty of its transfer (Teece, 1977; Kogut and Zander, 1992; Simonin, 1999). Szulanski shows that the “stickiness” of knowledge acts a barrier to the internal diffusion of best practices (Szulanski, 1996).

As knowledge becomes more explicit, the ease of transfer increases and a problem of external imitation arises (Zander and Kogut, 1995). Firms, however, can effectively develop *strategies to reduce the risk of knowledge expropriation*. Literature shows indeed that firms can use heterogeneous governance modes to manage their knowledge assets, as well as a broad set of

formal and informal protections strategies (Harabi, 1995), which help to better appropriate the benefits of their assets, but can simultaneously hinder the internal process of knowledge transfer.

Also the *environmental conditions* in which the knowledge transfer occurs affect the speed of the process. As an example, it has been highlighted that knowledge transfer capacity within the firm is enhanced by the context of “social community” that characterizes organizations (Zander and Kogut, 1995). The existence of channels for the transfer of knowledge, like relational structures or common languages, fosters the chances of effective knowledge diffusion.

In sum, existing research on inter-organizational knowledge transfer suggests a set of influencing elements of the speed of this process, which can be synthesized in *technological*, *strategic* and *environmental* factors. Conversely, literature on the time patterns of knowledge diffusion across organizations is not particularly rich. One of the most important contribution to this research provides empirical evidence that the process of knowledge transfer is characterized by a “localization effect”, which fades over time. In fact, knowledge tends to diffuse to nearby agents in the period immediately subsequent to its creation, while proximity ceases to act as an enabling factor for its transfer, as time goes by.

Applying this reasoning to our context of analysis, we expect that when a foreign subsidiary locates in a given region, local firms will be able to take advantage of proximity and absorb subsidiaries’ knowledge quickly. However, in our specific case, the knowledge sources (foreign agents) and the knowledge recipients (local agents) have peculiar characteristics and operate in a specific local context. We believe that this idiosyncrasy calls for a deeper analysis of the predicted patterns of diffusion. Therefore, in this paper, we try to account for the sources of such idiosyncrasy to understand how foreign subsidiaries’ knowledge diffuses within their host-regions.

3. Open innovation and the local spillover effect

In the management of their knowledge assets, firms are subject to two main *imperatives*: a need for *knowledge creation*, which requires them to continuously feed their innovation processes with novel knowledge inputs, and a need for *knowledge protection*, which drives them to exploit the benefits of their own knowledge stock, thus preventing others to expropriate it (Arikan, 2009). Open Innovation literature suggests that firms can deliberately adopt strategies aimed at acquiring knowledge from different external sources (Laursen and Salter, 2006), through the involvement in interactive relationships, networks and communities of practice.

Being open for innovation allows firms to successfully pursue their “*knowledge creation imperative*”. In fact, openness fosters a firm’s ability to capture knowledge inputs and learning opportunities that originate in its surrounding environment and can be useful to nourish its innovation processes. However, the mirror consequence of openness is that firms’ “*knowledge protection imperative*” loses priority, since a high willingness to absorb knowledge from external agents prevents firms to be too focused on the effective management of their internal resources. In other words, a firm’s motivation to intercept knowledge from external sources generates a lower attention toward the need to appropriate its own knowledge assets. Following this reasoning, a firm’s openness can be seen as a characteristic that facilitates the creation of both inward and outward spillovers.

Research on MNCs has strongly emphasized the importance of sourcing knowledge from the outside (Frost, 2001; Almeida and Phene, 2004). In fact, multinational firms are commonly defined as geographically distributed networks of innovation, whose main ability is to assimilate, create and integrate knowledge on a global basis (Bartlett and Ghoshal, 1989; Kogut and Zander, 1993; Frost et al., 2002). Through the establishment of foreign subsidiaries abroad, MNCs pursue the objective to tap into geographically distributed pools of knowledge.

Based on this reasoning, we might expect that openness is a common strategy in multinational firms. We conceptualize the MNC's openness through the use of two constructs which allow to depict the mechanisms through which firms adopt a more or less "open" attitude during and after the process of knowledge development: the MNC's *knowledge integration* and the MNC's *knowledge appropriation*. We define the MNC's knowledge integration as the firm's adoption of an inward focus in the process of development of innovations: the more an MNC builds on its own knowledge resources within the process of new innovations' development, the lower is its openness toward external knowledge sources. On the other hand, the MNC's knowledge appropriation refers to the firm's protective behaviour with respect to the management of its knowledge assets: the more the firm protects its knowledge and individually appropriates the benefits deriving from its exploitation, the lower is its openness toward its surrounding environment.

4. Hypotheses

The speed of knowledge diffusion and the localization effect. Traditionally, there has been a general consensus among academics and policymakers about the role of geography in the process of knowledge diffusion (Jaffe et al., 1993). Research on the speed with which knowledge spreads geographically has mainly be positioned in the related literature as a further proof of the phenomenon of the localization of knowledge diffusion. Jaffe and Trajtenberg (1999) claim that, since knowledge is expected to follow a diffusion process through geographic, institutional and technological spaces, "*researchers that are nearby along each of these dimensions would be particularly likely to benefit disproportionately in the time period immediately after the antecedent innovation occurs*". In their study of the patterns of citations among patents developed by inventors in the U.S., the U.K., France, Germany and Japan, they find that patents whose inventors are from the same country cite each other systematically more than inventors

from other countries, and that these citations come sooner. Thus, the process of knowledge transfer is characterized by a “localization effect”, that fades over time: this implies that knowledge tends to diffuse to nearby agents in the period immediately after its creation, while proximity does not act as an enabling factor for its transfer as time goes by. The reason for this relationship between time and the “localization effect” of knowledge diffusion lies in the nature of knowledge itself. Knowledge created recently, indeed, is believed to be more tacit (Griffith et al., 2006). Such attribute makes face-to-face interactions associated with proximity extremely important for its transfer. Going ahead with its life-cycle, knowledge becomes more explicit and easy to transfer even without the need of intensive personal communication; as a consequence, its dissemination is less bounded to geography. The basic idea underlying this reasoning is that proximity increases the frequency of face-to-face interaction and eases the development of interfirm trust, both factors that are critical for the process of tacit knowledge transfer (Bathelt, Malmberg and Maskell, 2004; Lawson and Lorenz, 1999; Maskell, 2001; Storper and Venables, 2004).

In contrast to this view, in recent times, researchers are starting to push the idea of the “death of distance” (Friedman, 2005; Morgan, 2001; Cairncross, 1997; Coyle, 1997), according to which the new communication and travel systems help knowledge to easily flow around the world, leaving no role for geography in this process. Griffith et al. (2007) obtain results that partially support this latter perspective. They focus on the speed with which the technology embodied in patents spreads geographically, through the analysis of the very first patents that cite the focal ones, and report no evidence of “home-bias” in the phenomenon of technology spillovers in high-tech sectors, while suggesting that geography still matters in more traditional industries, even if to a lesser extent than in the past.

Since we want to focus on the time patterns of the knowledge flows between foreign subsidiaries of MNCs and co-located firms, and specifically we want to examine the effects of *knowledge*,

strategic and *environmental* conditions on the speed of this process, we consider the existence of a localization effect as the starting point of our analysis. Therefore, we suggest that MNCs' foreign subsidiaries' knowledge diffuses to co-located firms earlier than to other firms, and we assume this relationship as our main effect:

Hypothesis 1: Co-location increases the speed of foreign subsidiaries' knowledge's diffusion.

Subsidiary knowledge creation and the spillovers to local firms. International business theory suggests that the very existence of multinational corporations is explained by their ability to manage and exploit their superior knowledge across a geographically distributed network of innovation. According to traditional models of the multinational firm, such knowledge is developed and centrally accumulated at the headquarter-level. Subsequently, thanks to its “public good” nature, it is transferred to MNCs' affiliates located abroad, whose task is to exploit it through the adaption of products and processes to the characteristics of foreign markets (Hymer, 1976; Buckley and Casson, 1976). This “linear” view of the process through which MNCs create value from knowledge (Almeida and Phene, 2004) provides the basis for the so-called “pipeline” mechanism (Marin et al., 2006), according to which spillovers of superior technology from the MNC parents diffuse to local firms through the means of foreign subsidiaries (Hymer, 1976; Vernon, 1966; Caves, 1971, 1982; Marin et al., 2006). Specifically, it suggests that the MNCs' internationalized network acts as a conduit for the transfer of knowledge between parents companies and local firms, and that subsidiaries are just “leaky containers” (Marin and Bell, 2007) through which the MNCs' knowledge spills over the host-region.

Along the years, both theoretical and empirical research has pushed forward this early model, suggesting that the process of knowledge management within the multinational firm is much more complex. Literature has clarified that MNCs' innovative processes are carried out through interactions and bi-directional exchanges that involve not only the headquarter, but also other

affiliates belonging to the MNC internal network, as well as the local contexts in which the MNC is embedded. Several studies on the organizational structures of international firms have highlighted that “*technical, market, and functional knowledge is sourced from various locations and generated continuously in all parts of a company, and shared across the organization*” (Almeida and Phene, 2004; p. 848). In this view of the modern multinational corporation, subsidiaries play a crucial role for the whole firm’s innovative process: they benefit from the knowledge received from the head-quarter, but they also share resources with other MNCs’ affiliates; moreover, they are exposed to the knowledge inputs originating from their host-environment. Thus, far from being passive agents, subsidiaries in this model are represented as very advanced actors of the MNCs knowledge creation processes.

Consequences of the evolution of the subsidiary role can be glimpsed also in the literature on the knowledge spillovers from FDI. Research on how subsidiaries transfer knowledge to the local economy through horizontal and vertical linkages highlights the importance of the subsidiary profile and strategy for the emergence of true learning effects (Giroud and Scott-Kennel, 2009; Santangelo, 2010). Studies on the knowledge protection strategies of MNCs recognize the active role played by subsidiaries into the management of their knowledge assets within the host-country (Faria and Sofka, 2010). In general, in the networked corporation, subsidiaries are recognized to play a role into the process of knowledge spillover to local firms, since through their interactive behaviour and their knowledge strategies, the patterns of knowledge diffusion within the host-region can be altered. Of course, then, MNCs and subsidiaries’ behaviour in term of knowledge management affects the speed at which their knowledge will spread through the host region.

The MNC’s knowledge integration

When innovators rely on internal routines and firm-specific knowledge, external agents may find it difficult to absorb resulting information, due to their limited understanding of the general

structure of technology (Rajan and Zingales, 2001). The organization of the innovative process can indeed influence the knowledge transfer across the boundaries of the firm. As an example, research has suggested that the availability of complementary assets is crucial to the full exploitation of a given innovation (Teece, 1986). The internal network of MNCs allows their subsidiaries' to rely on each other's competences, to collaborate and share knowledge and expertise for their innovative processes, as well as to combine and integrate each other's specialized resources. When this internal integration for innovation takes place, local firms' ability to absorb subsidiaries' technology is subject to the constraint of accessing to their complementary knowledge. Such knowledge, whose locus is within other MNCs' subsidiaries - beyond being firm-specific - is also geographically distant and, therefore, more difficult to acquire for local firms (Zhao, 2006). The more a subsidiary develops its knowledge in collaboration with other ties of the MNC network, the greater the effort local firms need to allocate to codify and understand it, the greater the time needed for its diffusion. Hence:

***Hypothesis 1.** The MNC's knowledge integration reduces the speed at which its knowledge spills over the host-region.*

The MNC's knowledge appropriation

If proximity facilitates the creation of channels that foster local knowledge diffusion, firms are not defenceless in front of the risk of external appropriation of their technology. Traditional research on MNCs' knowledge protection strategies suggests that firms manage the risk of involuntary technology leakage through a cautious assessment of their location strategies (Cantwell and Piscitello, 2005). More recently, literature has suggested that the management of location choices is not the only precaution that MNCs use against local firms' imitation. Faria and Sofka (2010) highlight the active role that subsidiaries play into the protection of their

knowledge assets within their foreign location. They show that subsidiaries defend their knowledge more extensively than local firms do, by using very broad and differentiated sets of protection mechanisms (Faria and Sofka, 2010). Zhao (2006) focuses on the risks of conducting R&D in countries with weak Intellectual Property Rights, and finds that MNCs try to internalize their technology by using it more extensively within the MNCs' network; in addition, in order to discourage local firms' attempts to imitate their knowledge, they create strong internal linkages in order to make their knowledge more difficult to understand.

Recently created innovations are more difficult to codify than mature knowledge (Griffith et al., 2006). However, tacit knowledge can be more efficiently shared and used within a firm (Kogut and Zander, 1993). Since the knowledge created by a subsidiary can be used by other affiliates within the MNCs' network, the MNC can increase the opportunities of internal exploitation of a new technology. MNCs that promote the internal use of the pieces of knowledge developed worldwide are able to appropriate a higher share of the value of such knowledge, thus reducing local firms' opportunities to benefit from it. When most of the opportunities that follow a given innovation are captured within the MNC, local firms' attempts to capture this knowledge require a great effort, in terms of resources and time devoted to this task, and have a limited chance to be successful. As a consequence, we expect that a high level of MNCs' knowledge appropriation will slow down the process of knowledge spillover:

Hypothesis 2. *The MNCs' knowledge appropriation reduces the speed at which its knowledge spills over the host-region.*

The host-regions' openness to MNCs' foreign subsidiaries

Integrating our consideration about MNC's openness and knowledge spillover, we have posit that multinational firms' openness fosters the process of local dissemination of their knowledge,

since - in an attempt to maximize the knowledge absorbed from the local environment – open MNCs will lower the control over their own resources, thus speeding up the outward spillovers. On the other hand, when MNC adopt a more inward-looking innovation strategy, they lose the chance to benefit from external knowledge resources, but at the same time increase their ability to protect their knowledge, thus hindering the spillover process.

Beyond the role played by the MNCs' openness, we posit that also the characteristics of the host-region are crucial to foster the local spillover effect. Within our focus on "Open Innovation", we suggest that the openness of host-regions is another crucial factor that can accelerate the dynamics of MNCs' knowledge dissemination, since it can intensify the opportunities for cooperative behaviours and create new and effective channels for knowledge diffusions. To account for this effect, since we focus on the process of local dissemination of a specific type of knowledge - that is, MNCs' knowledge - we include into our analysis a factor reflecting the degree to which host-regions are open to foreign knowledge sources, that is to MNCs' foreign subsidiaries. A host-region's high degree of openness to foreign subsidiaries implies that the local business environment is highly willing to accept external agents. The propensity to be open toward foreign investors is likely to influence also local firms' knowledge sourcing strategies. Indeed, a high level of foreign subsidiaries located in a region exposes local firms to the world's technology, and induces them to consider the knowledge opportunities they embody. In a region that has never been the location of firms originating from abroad, local actors could be more reluctant in accepting foreign subsidiaries as a source of knowledge, and may find it difficult to interact with them and understand their technology. Conversely, in regions that register a high presence of MNCs' foreign direct investment, subsidiaries are more legitimate as actors participating to the local business network (Henisz and Delios, 2001). Moreover, an extensive presence of foreign subsidiaries in a region drives local actors to become more familiar with them and with their resources, thus being better able to eventually assimilate and recombine their

technology with their internal knowledge base. Finally, a significant presence of foreign subsidiaries may have created past opportunities for local firms to acquire their knowledge. Since learning processes are subject to economies of experience, and the experience accumulated in the realization of a given task will provide information on the task itself and ease its accomplishment, we expect that potential future opportunities of knowledge absorption will be exploited faster. Based on this reasoning, we claim that:

***Hypothesis 3.** The host-region's openness to MNCs' foreign subsidiaries increases the speed at which the MNC's knowledge spills over the host-region.*

5. Data and Methods

The objective of this analysis is to examine (1) the time patterns of subsidiaries' knowledge diffusion within their host-region, and (2) the technology-level, strategy-level and region-level conditions that affect this phenomenon. To this aim, the empirical strategy we pursue is to compare the speed of the subsidiaries' knowledge diffusion process across situations of co-location and non co-location, and subsequently to analyse how the above-mentioned conditions affect the local knowledge diffusion process.

We test our hypotheses on a sample of patents developed by US-based subsidiaries of European and Asiatic firms from the semiconductor industry. The semiconductor industry seems to be the most appropriate empirical setting of this research. In fact, the U.S. semiconductor industry has historically been the target of a large number of inward FDI (Almeida, 1996). Therefore, how to profit from knowledge inflows coming from foreign subsidiaries is a fundamental issues for local agents affiliated to this industry. In addition, the extensive use of patents that characterizes this sector allows for an appropriate tracking knowledge flows phenomena.

In this paper, we use patent citation data to identify the knowledge outflows generated by multinational subsidiaries in their host regions. Therefore, our level of analysis is the citing patent – cited patent pair. To avoid bias due to abnormal patterns of citations along time, we consider only forward citations occurring in the ten years subsequent to the filing date of the focal subsidiary patents. In fact, since the typical life-cycle of a semiconductor product is 5 years (Stuart and Podolny, 1996), allowing for a 10-years observation window seems a fair choice. In addition, our focus of the speed of knowledge transfer seems to be consistent with the establishment of a limited observation period. Since semiconductor firms commonly use the U.S. patent system to record their innovations (Almeida and Phene, 2004), to the aim of this study, we consider only patents filed under this system.

The advantages of using patent citation data to analyze the knowledge spillover phenomenon stem from the rich information content provided by patent documents, which includes the geographic location of both the inventor and the “owner” of the innovation, as well as its time and technology. Thanks to this information, patents allow to identify the locus of the innovative activity, the organization to which the patent is assigned, and – most importantly - the temporal characteristics of the invention. In addition, what is pivotal for knowledge spillover studies is that patent documents report a list of citations to other patents which serves the function to indentify the technological antecedents to the particular innovation (Almeida, 1996), and whose inclusion is mandatory in the U.S. patent system.

As literature has widely documented, there are certainly several potential limitations to using patent citation data to investigate knowledge flows. First of all, patents and patent citations represent by definition the codified part of technology, and do not allow to capture the transfer of tacit knowledge, thus encompassing a potential systematic under-estimation of the knowledge flows phenomenon. However, this problem is partially mitigated by the fact that codified knowledge and tacit knowledge have been found to be correlated and complementary (Mowery,

Oxley, and Silverman, 1996). An additional issue deals with the examiner-added citations, which might create noise in the quantification of knowledge flows, since not all the citations contained in the patent document are spontaneously indicated by the inventor. Notwithstanding this limitation, empirical spillover analysis has long recognized the effectiveness of the citation measure (Jaffe et al., 1998; Fogarty et al., 2000; Alcacer and Gittelman, 2004; Branstetter, 2006), and lets us be confident about its general significance.

To create our sample, we followed the procedure used by Almeida and Phene (2004) and Phene and Almeida (2008). We considered the largest semiconductor companies by sales leaders, in year 2005, and select the first 10 European and Asiatic MNCs. This list of firms was compiled using information from Gartner Dataquest and Osiris. For this set of MNCs, we indentified every U.S. subsidiary engaged in innovation between 1983 and 2000¹⁶, and the set of patents these subsidiaries developed in the US host-region. Our final sample is composed of 1.530 patents, which were filed over an 18-years period. For each of these patents, we traced the patterns of forward citations, i.e. the subsequent patents that cite them as their technological antecedents, to infer the existence of a knowledge flow between the organizations to which the patents were assigned, and analyzed the filing date and the first inventor's address in order to build measures on the speed of knowledge transfer and on co-location. Patent data were obtained from an on-line database supplied by Derwent Inc., as well as from the U.S.P.T.O. Firm level data were obtained from Orbis/Osiris.

¹⁶ This means that, in order to be part of our sample, a U.S. subsidiary had to have registered for at least one semiconductor patent during the whole period. Moreover, we checked for the existence of the subsidiary since its establishment until the end of our period of observation. Note that, even if the period of observation of patents stops in 2000, we gathered citation level data up to 2006.

5.1 Variables operationalization

Dependent variable: speed of subsidiaries' knowledge transfer. To measure the speed of subsidiaries' knowledge diffusion, we use log of the number of months between the subsidiaries patent application date and the application date of the patents that cite it as prior art. This measure provides an indication of the pace with which subsidiaries' knowledge was utilized in subsequent innovation. Trajtenberg et al. (1997) suggest that the average forward lag between an innovation and its antecedents is a measure of the "remoteness in time" of a patent. The shorter this time, the younger is the knowledge source upon which the patent builds, and the higher the speed of its diffusion.

Independent variable: co-location. In order to test our main effect (*hypothesis 1*), we need to identify situations of co-location between the subsidiary's patents and the citing patents. Therefore, we use a dummy variable that takes the value of 1 if the subsidiary patent and the citing patent belong to the same US State, and 0 otherwise.

Independent variable: MNCs' knowledge integration. Subsidiaries' knowledge internal integration aims to capture the extent to which a subsidiary's knowledge has been realized through the collaboration with other ties of the MNC network, and relying on the MNC complementary knowledge inputs. To this aim, we combine indicators of these two phenomena (Zhao, 2006), namely (1) the number of inventors, among those listed in the subsidiary's patents, belonging to other ties of the MNC (the headquarter or other subsidiaries), and (2) the number of backward citations referred to other MNC's patents.

Independent variable: MNCs' knowledge appropriation. The ability of the MNC to use its internal network of distributed nodes to better internalize the knowledge developed worldwide is captured by the number of MNC patents that cite the subsidiary focal patents (this number includes both self-cites by the subsidiary itself and citations by other member of the MNC network). A high value of this indicator reflects the ability of the MNC to pursue its

appropriation strategy effectively. Indeed, literature has provided evidence of the link between the self-cites ratio and value internalization (Hall et al., 2001; 2003).

Independent variable: host-regions' openness to MNCs' foreign subsidiaries. A region's exposure to international knowledge sources is captured by the extent to which the region (in this case, the US State) has been the target of foreign direct investment that could have increased its familiarity with international knowledge sources. We use data provided by the US Bureau of Economic Analysis (for US States) and OECD (for other countries) to build a measure of the cumulated inflow of foreign direct investment up to the year of the forward citation. Since our analysis focuses on the semiconductor industry, only FDI inflows into this sector should be accounted for. However, since data at this level of industry disaggregation are not available, we refer to the macro-industry that includes the semiconductor segment, i.e. the electronic industry.

Controls. The patterns of knowledge spillovers in a specific region can be influenced by the underlying distribution of the technological activities within that area (Jaffe et. al, 1993). Therefore, to control for the technological “closeness” between the subsidiary's patent and its local context, we introduced in our model the variable “Region_Tech_Prox”, as a measure of “technological proximity”¹⁷ between the subsidiary's patent and the local knowledge network (Jaffe et al., 1986). Moreover, we cleaned the analysis for any effects due to time, by including a year dummy representing the application year of the focal patents. In addition, since patents that have a high innovative content can be expected to diffuse more rapidly, we include a measure of the patent's “quality”, measured as the number of total forward citations that the patent receives within the 10 years window of observation. To control for differences in the degree of local

¹⁷ We build this measure following Jaffe (1986): $PROX_{it} = (\text{FitFmsat}) / [(\text{FitFit})(\text{FmsatFmsat})]^{1/2}$, as the angular separation between the two vectors (Fit and Fmsa) representing the distribution of semiconductors patents in sub-classes for the subsidiary and its host-location.

embeddedness of the MNC in the host country, we also added a variable that accounted for the “subsidiary age”.

6. Discussions and expected results

Preliminary descriptive statistics on our sample of patent-pairs suggest that it takes on average 4,5 years to foreign subsidiaries’ patent to be cited. The maximum number of MNC’s patents that a subsidiary cites in developing its own inventions (MNC_Knowledge_Integration1) is 6, while the maximum number of inventors from other sub-units that cooperate to a subsidiary’s innovation process (MNC_Knowledge_Integration2) is 8. However, the low average values of these measures let us suggest that a certain number of MNCs in our sample are “open”, in the sense that they do not rely too much on the firms’ internal resources within their innovative processes. The same consideration applies to the measure of Knowledge Appropriation, whose maximum value is 9, while on average reports the value of 0.95.

We expect that local spillovers occur faster when MNCs do not rely heavily on their internal resources and organization within their innovative processes, and when they are not too focused on the internal exploitation of their knowledge assets: these results would the existence of a positive effect of openness on the local spillover process. In addition, we also presume that the relationship between a host-region’s openness and the speed of local spillover assumes the expected sign, showing that contextual factors also affect the time patterns of this phenomenon.

Notwithstanding the limitation of the analysis, which will require us to search for more accurate measures for MNCs’ openness, and to adjust the empirical strategy to the multilevel structure of our data, we believe that our paper provides some interesting contributions to the extant literature on FDI knowledge spillover, by adding a temporal dimension to the analysis of this phenomenon, and by merging it with recent insights on “openness”. In addition, the analysis here is of interest to both local firms and MNCs, as well as for policy makers. In the perspective

of local firms, it provides a better evaluation of the potential advantages of being co-located to highly innovative agents like MNCs' subsidiaries; in the perspective of MNCs, it gives information about the time in which their investment in innovation will provide them a rent, before local competitors' will be able to imitate them. Finally, in the perspective of policy makers, it suggests that the speed of subsidiaries' knowledge local diffusion process is a novel indicator, which can be useful to evaluate the advantages of attracting new FDI within their regions.

Table 1. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Time_to_citation	3669	4.433	2.092	0	10
Co_location	3669	0.140	0.347	0	1
MNC_Knowledge_Integration1	3669	0.226	0.607	0	6
MNC_Knowledge_Integration2	3669	0.537	1.239	0	8
MNC_Knowledge_Appropriation	3669	0.952	1.422	0	9
MNC_Knowledge_Quality	3669	25.741	19.729	1	71

Table 2. Correlation matrix.

	1.	2.	3.	4.	5.	6.
1. Time_to_citation	1.000					
2. Co_location	-0.074	1.000				
3. MNC_Knowledge_Integration1	0.035	-0.075	1.000			
4. MNC_Knowledge_Integration2	0.101	0.002	0.073	1.000		
5. MNC_Knowledge_Appropriation	0.140	0.034	0.042	0.101	1.000	
6. MNC_Knowledge_Quality	0.144	-0.024	-0.057	0.206	0.135	1.000

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CONCLUSIONS AND FURTHER RESEARCH

This thesis aims to contribute to the International Business literature that investigates the knowledge flows between foreign and domestic firms. Research on this topic has under investigated the role that subsidiaries may play in influencing the extent of knowledge that can diffuse within the local environment. To fill this gap, it proposes a conceptual framework that reconciles traditional models of FDI-mediated knowledge spillovers with new perspectives in Strategic Management and International Business, in which knowledge spillovers are identified as crucial events that can alter the foreign and local firms' relative competitive position. In doing so, it specifically focuses on the individual subsidiary level of analysis, thus highlighting the importance of reading the local knowledge spillover phenomenon through a more micro-founded lens.

Previous research suggests that, within the MNC's organization, headquarters are the subjects that have the responsibility to manage the spillover risks in host-countries. Adding to this literature, the empirical analysis of this dissertation provides support to the idea that also subsidiaries can influence the local spillover effect, and that this happens not only because of their structural characteristics (like the subsidiary type or the local activity developed in the foreign location), which – at a closer look – represent anyway the consequences of headquarters' choices. Indeed, foreign subsidiaries can actively handle potential local spillovers, based on the knowledge strategies pursued within the host location, as well as on the assessment of both internal and external factors that affect the trade-off between potential learning opportunities originating from the local environment and risks of knowledge expropriation.

These findings are consistent with recent research that has emphasized the relevance of analysing subsidiaries' strategic behaviour within host countries, in recognition that these agents are not just passive implementers of head-quarters' plans. Especially in developed countries, where local firms can represent advanced and dangerous rivals, subsidiaries are able to scan the

competitive environment and to recognize opportunities and challenges, thus adapting their local behaviour to a set of specific contingencies that can be relevant to make the right strategic choice.

In an attempt to deeply investigate the spillover effect in the light of firms' strategy and competitiveness, this thesis also offers a preliminary outline for the analysis of the time patterns of this phenomenon. In fact, assuming the perspective of the foreign and the local firms involved in the spillover event, the temporal dimension acquires a great importance, since it affects the likelihood that the knowledge flow will actually have consequences on their relative competitive position, since the time in which firms lose or acquire pieces of knowledge is determinant to assess to what extent this event can damage or benefit them. In doing so, this dissertation makes a theoretical contribution in that it combines traditional theory on FDI spillovers with insights on Open Innovation, a perspective that – to the best of my knowledge – has been almost overlooked in the International Business research.

The findings of this thesis have implications for three main audiences of practitioners. In the first place, for foreign subsidiaries' managers, it shows the importance of considering both opportunities and challenges emerging from the external environment, and to adapt their local behavior and strategies to their own internal assets and capabilities. Being highly integrated in the host-location and building interdependent interactions with domestic partners – thus creating channels through which the subsidiary's own knowledge can flow to local firms - can be beneficial when the subsidiary needs to gain access to resources that are embedded in the host environment and can be useful to the innovation processes, to adapt to the local market and business network as well as to improve its hierarchical role and importance within the MNC. In such cases, it is worth accepting the leakage of part of the subsidiary's knowledge, since the benefits of the consequent incoming spillovers are more important to pursue the subsidiary's strategy. On the contrary, when the subsidiary already possesses a valuable endowment of

knowledge and capabilities that allows her to successfully compete in the local environment, her attitude to the protection of knowledge should be more pronounced, since potential benefits in terms of learning from the host-location are too narrow compared with the drawbacks that may originate from outward spillovers. In fact, for MNCs' foreign subsidiaries, the superior knowledge they possess is often one of the main competitive assets that allow them to successfully face the local rivalry and enter the host-market, thus counterbalancing the structural disadvantages due to their liability of foreignness. Lowering the control over this high-value knowledge just to gain access to local resources could not be an appropriate strategy for subsidiaries, since it would mean to disclose the main source of their uniqueness and competitiveness, in exchange of resources that are probably moderately spread within the local environment, and whose nature - as a consequence - is not so distinctive.

In the second place, this thesis is interesting for local firms. To these agents, the results of the empirical analyses suggest three main considerations, of which they should be aware: first, that being collocated with foreign subsidiaries does not always imply the opportunity to benefit from their knowledge, since the mechanism of spillover is not automatic but depends - among other things - on the subsidiary's choices in terms of knowledge management; second, that - even if they are able to intercept part of the subsidiaries' knowledge - this phenomenon does not usually come without costs, given that subsidiaries might expect to obtain something in exchange (due to the reciprocity mechanism); third, that when the subsidiary's knowledge easily spills over to the domestic environment, it is more likely to have a moderate value and competitive content, since subsidiaries tend to protect knowledge that is not crucial to their success to a lower extent, thus facilitating its local dissemination.

Finally, also policy makers may find the results of this dissertation interesting, since they provides a description of the conditions under which subsidiaries will participate more to the domestic environment, thus contributing to enhance the host-location's innovation productivity.

Specifically, subsidiaries with technologically advanced assets might not be willing to share them with local firms: this finding casts some doubts on previous research that has suggested that head-quarters whose investing motive is the exploitation of strong competitive advantages enjoyed within their home-countries are more likely to generate spillovers to the host-economy (Driffield and Love, 2007), since the assets they bring in the foreign location constitute the source of high learning opportunities for local firms. The results of this dissertation suggest that this reasoning might not always apply to reality, since subsidiaries that possess valuable knowledge assets can activate mechanisms to protect these sources of competitiveness from external appropriation by domestic counterparts, thus hindering the spillover process. In addition, this thesis underlines the importance to evaluate other and novel spillovers' attributes to comprehensively assess the potential benefits of FDI - rather than only focusing on the magnitude of the outward knowledge flows - like for example the scope of potential spillovers (that is the range of fields to which they can be usefully be applied) as well as the speed at which they actually occur, thus creating time-based advantages for local firms.

This thesis is afflicted by several limitations that have been highlighted in the essays. Among them, the strongest one, which requires some more attention, refers to the use patent citations to infer knowledge flows.

When applying for a patent, inventors have to indicate the citations to previous inventions on which a patent builds. This practice is mandatory in the U.S. patent system, though patent examiners can add citations others than those spontaneously selected by the inventor, when they believe there is a clear link between the content of the innovations.

While adding “extraneous” citations, as well as deliberately excluding appropriate citations is not likely, because it would respectively mean to narrow the innovative scope of the patent (Jaffe *et al.*, 1993) and to get exposed to sanctions by the U.S. Patent and Trademark Office (Branstetter, 2006), the citations eventually added by the examiners can represent a relevant

problem since, as a matter of fact, examiner-added citations create noise in the quantification of *true* knowledge spillovers. Notwithstanding this limitation, empirical spillover analysis has long recognized the effectiveness of the citation measure (Jaffe *et al.*, 1998; Fogarty *et al.*, 2000; Alcacer and Gittelman, 2003; Branstetter, 2006).

Beyond the examiner-added citations problem, using a citation-measure requires the fixation of an accurate definition of what we mean for the term “knowledge spillovers”: indeed, it should be taken into account that this measure allows to catch only a specific type of knowledge externalities, i.e. those which generates further innovation. Following Branstetter (2006), in this study I consider as knowledge spillovers only those processes “*by which one inventor learns from the research outcomes of others’ research projects and is able to enhance her own research productivity with this knowledge, without fully compensating the other inventors for the value of this learning*”. Unfortunately, the setting of such a strict definition entails a potential systematic under-estimation of this phenomenon. Indeed, when assessing the knowledge contribution that MNCs’ subsidiaries can provide to local firms, many other aspects – which cannot be captured by the citation measure – should be accounted for.

First of all, the localization of FDI may induce domestic firms to the *imitation* or the *adoption* of existing technologies “imported” in the host country by the MNCs’ subsidiaries: although these mechanisms do not generate further innovation, and hence cannot be captured by the citation measure, they do improve the competitiveness of local firms, and should be considered when evaluating the knowledge effects of MNCs’ localization.

In addition, when a MNCs’ subsidiary locates in a foreign country, its best organizational practices may spread to domestic competitors: Rodriguez-Clare and Alfaro (2004), for instance, highlight that the idea of a MNC in the maquila sector in Honduras to provide a free breakfast to employers (thus boosting their incentive to work, and productivity) rapidly diffused to other

firms, becoming a standard for the industry. These effects do not fall within a citation-based spillover definition, although they clearly have beneficial effects for indigenous firms.

In sum, citations are just a partial and indirect measure of knowledge spillover, though by now the only one available, and extensively used (Jaffe et al, 1993; Almeida, 1996; Frost, 2001; Branstetter, 2006; Zhao and Islam, 2007; Agarwal et al., 2009).

Another potential problem of the empirical analysis presented in the patent-based essays of this thesis resides on the lack of accurate firm level data on subsidiaries' strategies and capabilities, which forced me to infer these through the analysis of the outcomes of these strategies. Unfortunately, when the unit of analysis is the subsidiary, one has to face the limits stemming from the fact that foreign subunits of multinational firms, especially if they are just R&D laboratories that MNCs locate abroad to conduct research, are not subject to the need to public their own information. The solution that we used to address this problem, which is based upon the use of patents and patent citations, although with its strong limits, is in reality very frequent in studies which focus on subsidiaries' knowledge management (Frost, 2001; Almeida and Phene, 2004; Ambos et al., 2006; Phene and Almeida, 2008). The only alternative way to get rid of the issue of data deficiency would have been to conduct a survey on the activity of MNCs' subsidiaries abroad. Luckily, the third essay of this dissertation uses this kind of data to analyze the way subsidiaries manage spillovers, even if the focus is on a different mechanism for knowledge transfer, which is vertical linkages. The fact that the empirical results of this essay are in line with our patent-based analysis makes me feel more confident about the reliability of the patent-based essay. Both the essays, indeed, confirm the prediction according to which subsidiaries are able to influence the extent to which they contribute to the host-environment's knowledge, by adapting their local behavior to their own strategies and needs, which in turn depend on both external and internal conditions.

Future research should account for the role that the multinational firms' internal hierarchical network can play in influencing the knowledge spillover effect generated by subsidiaries abroad. International business literature has indeed underlined that MNC's headquarters often try to obstruct the process through which subsidiaries become highly embedded in the domestic environment (Andersson et al., 2007), since this could generate the subsidiaries' acquisition of excessive autonomy and importance within the internal network. This headquarters' behavior, however, could not be in line with the subsidiary's local knowledge needs. Looking at how headquarters' and subsidiaries' wills interact to influence the knowledge spillover effect could be interesting for future analysis.

In addition, the focus on subsidiary's role assumed within this dissertation implies the need to analyze how subsidiaries' local cooperative agreements affect the spillovers to the host-location. Previous literature has long analyzed the vertical collaborations within subsidiaries and local partners, however research has failed to look at the subsidiaries' collaboration for R&D. In the following abstract, the outline of a future research project on this issue is presented.

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**LOCAL SPILLOVER EFFECTS AND R&D CO-PRACTICES BETWEEN
FOREIGN AND DOMESTIC FIRMS: THE EFFECT OF TECHNOLOGICAL AND
GEOGRAPHICAL DIVERSITY**

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Abstract

Notwithstanding the wide literature on Foreign Direct Investment spillovers, no study has investigated how R&D co-practices between multinational firms' subsidiaries and local firms can contribute to this effect, thus increasing the host-regions' innovation productivity. However, R&D collaboration has been recognized as a channel for spillovers, that can generate externalities for both partner and non-partner firms. Building on these insights, we analyze the patterns of local spillovers generated by R&D co-practices between subsidiaries and local firms. In addition, we explore the effect of partner firms' technological and geographical diversity, and suggest that the local spillover effect is emphasized in presence of heterogeneous technological and geographical profiles of partner firms.

Keywords: multinational firms, foreign subsidiaries, R&D co-practice, knowledge spillover, local firms, technological diversity, geographical diversity.

1. Introduction

The literature on Foreign Direct Investment (FDI) spillovers argues that foreign subsidiaries of multinational corporations (hereafter, MNCs) generate knowledge externalities that are highly beneficial to domestic firms, since they are the repositories of the MNC's superior technology (Haskel et al., 2007). Research has widely investigated the channels through which such spillovers take place. Labour mobility is one of the most studied mechanisms that allow local firms to gain access to MNCs' competitive knowledge and best practices (Fosfuri et al., 2001; Glass and Saggi, 2002; Spencer, 2008). Spillovers also manifest through the so-called "demonstration effect", arising from local firms' opportunity to be exposed to MNCs' activities, which may lead them to emulate their foreign counterparts' productive, marketing and organizational techniques (Blomstrom and Kokko, 1998). Furthermore, the vertical linkages between the subsidiary and its local suppliers and distributors have been analyzed as mechanisms that facilitate the diffusion of the MNC's knowledge within the host-region (Rodriguez-Clare, 1996). In fact, when a foreign subsidiary undertakes a business relationship with a local firm, the partnership becomes a privileged conduit for knowledge sharing. Moreover, beyond flowing between the relationship's partners, the knowledge shared through such cooperative tie may be channeled also to other agents within the local context (Spencer, 2008).

Notwithstanding the strategic role that cooperation between subsidiaries and local firms plays for the occurrence of spillovers, research has overlooked a particular type of collaborative mechanism, R&D collaboration, as a possible conduit for the MNC's knowledge diffusion within host-regions. According to Cassiman and Veugelers (2002), R&D collaborations display two opposite effects: inward and outward spillovers. In other words, such collaborations are conducive of positive externalities both for partner and non-partner firms, in terms of new pieces of knowledge that are generated from the partnership and that can ignite the innovation process of those firms that are able to capture them. Inspired by these insights, this paper aims to

contribute to this under-investigated area of research by exploring the role of *R&D co-practices* between foreign subsidiaries and domestic firms. These activities can be defined as innovation-oriented undertakings carried out jointly by a MNC's foreign subunit and a domestic firm (Frost et al., 2005). We believe that *R&D co-practices* can be considered as an important channel through which local firms can gain access to subsidiaries' knowledge. Indeed, not only they signal the existence of a collaborative relationship between the subsidiary and a local partner – which by itself represents a premise for the knowledge spillover effect, but they practically involve the collaborative partners into the execution of knowledge creation processes, which by definition have a great potential in terms of spillover generation.

The aim of this paper is to explore how *R&D co-practices* between foreign subsidiaries and local firms contribute to the host-regions' innovation productivity through knowledge spillovers. We will scrutinize whether and how this effect is amplified when collaborating partners are technologically distant from each other and geographically dispersed.

The remainder of this paper is as follows. In the next paragraph, we will introduce the relationship between R&D co-practice and spillover effects, first in general and then in the specific case of foreign-local firms co-practices. Consequently we will put forward the two main hypotheses related to the diversity of partners in terms of technological endowments and geographical regions. In the section entitled "Empirical Analysis", we will describe the data collection procedure and the variables included in the regression. We finalize the paper with the discussion of the preliminary results and some indications for the future developments of the analysis.

2. R&D co-practice and the knowledge spillover effect

R&D collaborations allow partner firms to develop advanced technologies (Baumol, 2002), share the costs and risks associated with the innovation process, and access to each other's tacit knowledge (Hagendoorn, 1993).

The relationship between R&D collaborations and spillovers has been widely investigated by existing literature. Research demonstrates that cooperative R&D agreements are characterized by a problem of imperfect appropriability of the outcomes of the innovation process (Cassiman and Veugelers, 2002), which displays two contrary effects: inward and outward spillovers. In fact, firms may have an incentive to undertake joint R&D activities, when they are able to intercept high incoming spillovers from partners and non-partners. Simultaneously, firms' R&D investment in joint research projects may generate positive knowledge externalities for agents who are external to the agreement (Greenlee and Cassiman, 1999), thus leading to free-riding behaviors (Shapiro and Willig, 1990; Kesteloot and Veugelers, 1995). In sum, R&D collaborations are considered to represent an effective channel for the occurrence of spillovers, both to partner and to non-partner firms (Cassiman and Veugelers, 2002).

In the perspective of multinational corporations, R&D collaborations with firms located in their host-regions represent a crucial mean to tap into geographical distributed pools of knowledge. In fact, several studies have demonstrated that sector-specific technology develops in geographically concentrated areas (Marshall, 1920; Porter, 1990), and that countries follow different patterns of industrial specialization (Cantwell, 1989; Patel and Pavitt, 1991). Local firms are therefore an important source of knowledge for MNCs' foreign subsidiaries, since they may act as a privileged channel to gain access to distant and localized pockets of expertise. This is consistent with the "learning-oriented" perspective on FDI (Cantwell, 1989; Dunning, 1994), which has increasingly provided evidence about the knowledge opportunities offered by host-

regions, in a departure from the traditional view of the host-country as a mere channel to develop new markets or obtain cheap resources.

Consistent with this reasoning, research demonstrates that, over the last decades, multinational firms have increasingly developed research-based partnerships with local suppliers and distributors, competitors and knowledge institutions (Dunning, 1994; Archibugi and Iammarino, 1999). In fact, through inter-firm interaction and joint-problem solving, these partnerships may allow foreign firms to easily acquire tacit and complex knowledge (McEvily and Marcus, 2005), thus lowering the barriers to knowledge sourcing across distance (Lahiri 2003, Frost and Zhou 2005). While a large attention has been paid to the effects of these collaborative mechanisms in terms of “inward spillovers”, that is to the benefits that multinational firms could achieve through a research-based agreement with local firms, the other face of the coin - the “outward spillovers” - remains under-investigated. However, the effects of R&D partnerships are not bounded to the firms directly involved within the agreement. As an example, cross-regional collaborations have been highlighted as a mean through which the network of co-located agents gathers fresh knowledge inputs through the mechanism of localized spillovers (Zhao and Islam, 2007), due to the interaction between long-distance partners. Following this perspective, we believe that, beyond contributing to MNCs’ ability to explore and take advantage of the host-regions’ knowledge resources, R&D collaborations are also important in that they generate externalities that feed the local innovative processes.

In this paper, we focus on a specific type of cooperative arrangement: the R&D co-practices between MNCs’ foreign subsidiaries and their local partners. R&D co-practices are research-based activities that require the joint participation of the foreign and the local agent. As a consequence, they imply a strong interaction aimed at the achievement of an innovative outcome, during which the participating firms share their own technological resources and explore new search paths. Through these mechanisms, the knowledge created within the process

of co-practice can flow toward the local community and give rise to new ideas, thus benefiting firms that are external to the collaboration.

2.1 Technological diversity and Local Spillover Effects

Studies on collaborations have emphasized the role of technological proximity among parties as the main reason to enter the partnership and the main source of learning from it. According to Kim and Vonortas (2006) similar technological profiles of interested parties will involve lower transaction costs and thus ease the negotiation process. Also, the transfer of the technology will be facilitated as the licensee is more able to understand and absorb the knowledge and thus implement it faster. Accordingly, Mowery, Oxley and Silverman (1998) suggest that the extent of a firm's absorption of technological capabilities from its alliance partners depends on pre-alliance level of technological overlap with partners. Following these lines, Rosenkopf and Almeida (2003) hypothesized and tested that a firm will most likely draw upon the knowledge stock of another firm if they are characterized by similar technological profile. The underlying concept of this reasoning and evidence is that of (technologically) *local search*, which is pervasive in literature on innovation and technological development. According to the authors, firms in their innovation process tend to rely on similar pools of knowledge and consequently, when they search for external partners, to engage with other firms and individuals with similar technological expertise.

The idea of local search mirrors the concept of *search depth* by Katila and Ahuja (2002), which is defined as the degree to which firms reuse knowledge in their invention processes, facilitating the predictability of the search pattern, and thus enabling the firm to identify valuable pieces of knowledge, which the firm has a deep understanding of. However, although local search may improve the absorptive capacity of the partners firms, it may be also an obstacle for the discovery of serendipitous outcomes along the innovation process. More distant search -

through, for instance, collaborations with heterogeneous partners - may be conducive of more variations and thus potential recombination of knowledge leading to novel and original innovation outputs (Fleming and Sorenson, 2001). This idea is captured by the *search scope* variable, introduced by Katila and Ahuja (2002), which is defined as the degree to which firms use new and prior unexplored knowledge in their invention activities, fostering the invention process through a selection effect of variation and by extending the number of combinatorial possibilities (Katila *et al.*, 2002: 1185).

Within R&D co-practices between local and foreign firms, it is very likely that firms do not operate on a basis of similar background knowledge, given their different origins and backgrounds (Phene and Almeida, 2003). Also, MNC's reason to cooperate with these firms generally reflects the desire to have access to disparate sources of knowledge to ignite their innovation funnel (Almeida and Phene, 2004). Thus, since the two parties do not master the same domains of knowledge, this will increase the chance of unintended knowledge spillovers that may benefit also non-partner firms. Moreover, since the combination of knowledge from distant technological bodies generates innovations that impact on a broader set of technological areas (Rosenkopf and Nerkar; 2003), the knowledge spillover effect originating from the collaboration between technologically heterogeneous partner firms can be expected to be wider, since the collaboration's knowledge outcomes can be potentially intercepted and used by a large and differentiated set of local firms. On the basis of these consideration, we hypothesize:

Hypothesis 1. *The higher the technological diversity of the R&D co-practice's partners, the higher the local knowledge spillover.*

2.2 Geographical Diversity and Local Spillover Effects

Literature demonstrates that knowledge and expertise are spatially constrained (Jaffe et al., 1993); therefore, it is complex to access them from a distance. Multi-location firms have the chance to locate their subsidiaries abroad to tap into the heterogeneous pockets of expertise available worldwide. In fact, through the establishment of foreign affiliates, highly valuable knowledge linkages can be built with the local knowledge network (Almeida and Kogut, 1999; Phene and Almeida, 2004). These linkages may act as “information gathering devices” (Phene and Almeida, 2004: 852), useful to gain insights on the research horizons that local actors pursue within distant regions. In addition, the knowledge acquired by MNCs’ geographical distributed affiliates can circulate within their internal knowledge network (Gupta and Govindarajan, 2000), and can be used by other sub-units to generate new and more valuable knowledge (Almeida and Phene, 2004; Phene and Almeida, 2008). Also, some works suggest suggests that the quality of multinational firms’ innovation depends on their ability to recombine their own technology with the inputs stemming from the geographical distributed learning opportunities they are exposed to (Almeida and Phene, 2008; Singh, 2008). In fact, the creative use of distant and, hence, diverse sets of knowledge lead to distinctiveness and uniqueness. In sum, we can state that differentiated geographic search increases the innovation productivity (Ahuja and Katila, 2004), since it fosters firms’ awareness about the manifold localised technological domains available worldwide (Kuemmerle, 1999), and ease their ability to access to them (Almeida and Phene, 2004).

Within R&D collaborations, MNCs’ subsidiaries and local firms pool their existing sets of technology to create new knowledge. We posit that, when the sources of these sets of technology are more geographically dispersed, the resulting knowledge will have a higher potential to generate local spillovers. Such knowledge is indeed highly productive for local firms, since it originates from heterogeneous and distant locations, and it is further enriched within the process of co-practice. Therefore, it brings new perspectives to the local community, allowing co-located

firms to overcome the limitations of local search (Rosenkopf and Almeida, 2003), and providing them with a window through which being exposed to different and distant sources of expertise and technology, otherwise not available. The higher the geographic diversity of the partner firms technology distribution, the lower the knowledge redundancy of the collaborative outcome, the higher the potential for local spillovers:

Hypothesis 2. *The higher the geographical diversity of the R&D co-practice's partners, the higher the local knowledge spillover.*

3. Empirical analysis

To study the hypotheses we apply a OLS regression model estimating the extent of local spillover depending on the technological and geographical distances among R&D co-partners.

The research setting of our analysis is the US semiconductor industry. In order to identify R&D co-practices, we first selected a sample of US foreign subsidiaries of European and Asiatic multinational corporations. The list of multinational firms was compiled using information from Gartner Dataquest and Osiris. For this set of MNCs, we indentified every U.S. subsidiary engaged in innovation between 1983 and 2005. In order to be part of our sample, a U.S. subsidiary had to have registered for at least one semiconductor USPTO patent during the whole period. Moreover, we did not infer the presence of a subsidiary in a given location just from the existence of patents developed in that location, but we checked for its existence through different data sources like Uniworld Online, the reports "Foreign Direct Investment in the United States" compiled by the US Dept. of Commerce, as well as the company websites, etc. R&D co-practices were identified with those semiconductor patents who were co-assigned to both a MNCs' subsidiary and a local firm, and whose first inventor's address belonged to the host-region.

3.1 Dependent variable

Local Spillovers. Following most of the studies about knowledge flows, to capture the knowledge spillovers originating from the R&D co-practice to local firms, our dependent variable is defined as the number of (forward) citations made to a subsidiary's patent portfolio by the universe of local-invented patents. Moreover, in order to select the relevant *local* citations, following recent trends in management and IB literature (Tallman and Phene, 2007; Zhao and Islam, 2007), we define the host-regions based on the boundaries of the Metropolitan Statistical Areas (MSA), as identified by the United States Office of Management and Budget (OMB).

3.2 Independent variables

Technological Diversity. The measure of technological diversity was created by comparing the semiconductor patent portfolios of the partner firms. Following the procedure used by Rosenkopf and Almeida (2003), for each firm, we first identified all semiconductor patents they were assigned up to the year of the R&D co-practice. In order to select the relevant patents, we referred to the classification proposed within the Derwent Database, and retained only patents belonging to the first four Derwent patent classes included in the section "Semiconductors and Electronic Circuitry" (Alcacer and Zhao, 2007), which in turn include fifteen four-digit International Patent Classes¹⁸. Then, we built the distribution of the firms' patents along these fifteen semiconductor International Patent Classes. Finally, we calculated the Euclidean distance between each partner firms' pair. The higher the value of this measure, the higher the technological diversity of partner firms' domains.

¹⁸ The selected International Patent Classes are the following: C30B, H01L, G11C, H03K, H03L, H03M, H03B, H03C, H03D, H03F, H03G, G05F, H02M, H03H, H03J.

Geographical Diversity. To measure the geographical diversity of the partner firms, we used the information included in the USPTO database relating to patents' assignees. For each partner firm, we identified the set of worldwide locations in which the assignee had developed patents, and built an index that compares the distributions of geographical locations of the innovative activities of each partner-firms' pair.

3.3 Control variables

We added a set of control variables to our analysis. First, following Jaffe (1986), we build a measure that compared the patent class of the focal patent with the distribution of patents across technology classes. This will avoid that our dependent variable, the number of local forward citations to the patents developed in the R&D-practice, could be biased by the underlying distribution of innovative activity in the region,. Moreover, we cleaned the analysis for any effect that could be due to time, by including a year dummy representing the application year of the R&D co-practice. To control for differences in the degree of local integration of the foreign subsidiary, we also added a variable that accounted for the subsidiary age. Finally, since we expect that the number of citations an R&D co-practice will receive depends on the partner firms' reputation for innovation, we also controlled for the size of their patent portfolio, a count-based measure of the patents the firms have successfully applied for up to the application year of the R&D co-practice.

4. Discussion

Notwithstanding the limitations of the analysis, which will require us to improve the construction of the variables we employed and to account to other factors which may interfere with the relationship investigated – e.g. the experience of the foreign firm to deal with local

firms in the same region; the ability of the partner firms to appropriate the outcome of the collaboration - we believe that our paper provides some relevant contributions to the extant literature on both international business and innovation process and strategy of the firm.

In conclusion, our study aims to provide some insights on the role that research-based collaborations between foreign and local firms can play in contributing to regional patterns of innovation, as well as on the characteristics of the partner firms that may increase such contribution. More specifically, it suggests that these cooperative agreements have strategic consequences for local partners, since adopting a cooperative attitude with foreign agents may generate benefits to all the co-located firms. Similarly, multinational firms should be aware of the fact that building cooperative relationships with local firms in order to access to the local pool of knowledge does not come without costs, but rather implies losing control over part of their proprietary knowledge.

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