How does Industry 4.0 affect international exposure? The interplay between firm innovation and home-country policies in post-offshoring relocation decisions

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ABSTRACT

This paper investigates whether and how Industry 4.0 innovation intensity, which is developed through patenting and which provides a firm-specific ownership advantage, relates to "relocation of second degree" (RSD) of manufacturing activities, i.e. the movement of previously offshored activities to either the home country (RHC) or a third country (RTC), thus representing a reconfiguration of the firm's extant international exposure. Moreover, we analyse the role of Industry 4.0 policies adopted in the home country, which offers a location advantage that can possibly moderate this relationship. Our findings, based on a sample of 118 RSD implemented by European companies, reveal that both Industry 4.0 innovation intensity (at the firm level) and policies (at home-country level) have an impact, with the former pushing firms towards RTC, unless the latter are in place at the home country, thus showing the pivotal role of Industry 4.0 policies in re-attracting Industry 4.0 innovative companies.

Keywords: Location advantage; Location choice; Ownership advantage; Industry 4.0; Innovation Intensity; Policies; Reshoring; Relocations of second degree; Patenting.

1. Introduction

Over the past decades, firms have offshored manufacturing activities to low-cost countries offering cheaper labour and raw materials (Kedia & Mukherjee, 2009; R. Mudambi, 2008). As a result, more fragmented and geographically dispersed value chains have started to emerge, either on a global (e.g. Gereffi & Lee, 2012) or on a regional (e.g. Arregle et al., 2009; Asmussen, 2009; Rugman & Verbeke, 2004) scale. This trend is not over; yet, in recent years, we are also witnessing the spatial reconfiguration of these supply chains, which is driven, e.g., by the emergence of new low-cost destinations, as well as by the different fluctuations in cost factors among countries, which modifies their relative attractiveness (Ellram et al., 2013). Other alternatives include mitigation – i.e. not revising the offshoring decision but reducing the related risks - and toleration – i.e. a more passive approach given either the inability or the unwillingness to react (Manning, 2014). Companies' intentions to change their manufacturing source is increasingly shifting from "offshore" being the predominant option, to "move between low-cost countries" and "backshore" (i.e., return to the home country) being viable alternatives to offshoring (The Economist, 2013), also for strategic aims (e.g. the made-in effect, product quality, research and development (R&D) and production vicinity; Fratocchi et al., 2016). When a company moves (totally or partially) its manufacturing activities from the current host country to another, it undertakes a post-offshoring relocation, also labelled as "Relocation of Second Degree" (RSD) (Barbieri et al., 2019). Particularly, RSDs have been characterized as either "Relocations to the Home Country" (RHC) or "Relocations to a Third Country" (RTC) – the latter assuming a movement towards a second host country, different from the home country. It is worth noting that RHCs represent a form of de-internationalization, since their implementation reduces – if not cancels – the firm's international footprint in terms of number of foreign countries where the company operates either in-sourced or out-sourced manufacturing activities. In contrast, RTCs – independently of the chosen second host country (either one in the firm's home region or in a faraway one) – do not reduce the firm's international footprint and may even increase it, as in the case of a partial RSD from the second host country to the third one. Therefore, the concept of RTC differs from re-internationalization, which implies re-entering international markets after a period of exit (Chen et al., 2019; Surdu et al., 2018).

Both scholars (Brennan et al., 2015; Enderwick & Buckley, 2020) and Political Institutions (De Backer et al., 2016; UNCTAD, 2020) have highlighted that, among the factors that are affecting the ongoing reconfiguration of international production – such as trade policy, changing cost conditions in the emerging economies, riskiness of globally extended supply chains, and sustainability considerations – the rise of new digital technologies – i.e., the so-called "Fourth Industrial Revolution", or "Industry 4.0" – plays a prominent role. The term Industry 4.0 denotes the emergence and diffusion of several new, integrated digital industrial technologies that are widely acknowledged to hold a truly disruptive potential on manufacturing systems, products, and business models (Frank et al., 2019; Strange & Zucchella, 2017). Particularly, access to the heavily automated, highly productive manufacturing technologies of Industry 4.0 – favoured by the falling costs of robots, automated lines, additive manufacturing and hardware and software solutions – can reduce a firm's interest in searching for low-cost locations (Ancarani et al., 2019; Dachs et al., 2017; Strange & Zucchella, 2017) as long as these technologies will also ensure equally low production costs in high-income countries. At the same time, such technologies may support companies in enhancing their product quality and innovation processes as well as improving their environmental performance (Ancarani & Di Mauro, 2018; Ancarani et al., 2019; Fratocchi, 2018; Moradlou & Tate, 2018). Therefore, through Industry 4.0 technologies, firms may switch from complex and multi-tier to integrated and shorter value chains that can be concentrated in one (or fewer) locations, including the home country. On the other hand, information and communication technologies (ICTs), which are at the core of Industry 4.0, allow the increase of connectivity across countries, between firms and within the network of subsidiaries (Chen & Kamal, 2016). Therefore, Industry 4.0 might instead promote a further extension of the firm's international production network. A recent literature review, based on both empirical and non-empirical studies, concludes that "Industry 4.0 has introduced new elements that tend to stretch value chains in different directions. However, these direction are neither clear nor unique nor generalizable." (Castagnoli et al., 2021).

Although extant literature has acknowledged Industry 4.0 technologies as a possible driver of the decision to bring back manufacturing activities to the home country (Fratocchi & Di Stefano, 2020), empirical studies on how the two phenomena relate are scarce and lead to quite contrasting results

(Kamp & Gibaja, 2021). Besides, these studies considered only the RHC option, thus neglecting RTC as an alternative relocation that could relate to Industry 4.0 technologies. Against these backdrops, this paper aims to disentangle whether and how Industry 4.0 technologies relate to the firm's decision to undertake either RHC or RTC. Moreover, while previous studies evaluated such a relationship referring to the *adoption* of such technologies, we propose to focus on their *development* by looking at firm's Industry 4.0 innovation intensity expressed in terms of number of patents related to Industry 4.0 technologies. This innovative approach is consistent with the extant International Business (IB) literature on the role of patents as a support to export and Foreign Direct Investment (FDI) firms' strategies (Briggs & Park, 2013; Lejpras, 2015; Nam & An, 2017; Tomiura, 2005). Based on such an approach and referring to the Dunning eclectic paradigm, we conceptualize the firm's Industry 4.0 innovation intensity as an asset-based ownership advantage (Dunning, 1988; Lundan, 2010) which induces a preference for RTC rather than RHC. In other words, we argue that when companies undertake an RSD, they prefer to exploit their advantage by pursuing their international exposure. Besides, we investigate the moderating role of Industry 4.0's policies by exploring whether they can enhance the likelihood of RHC (instead of RTC) when the firm's home country enacted an Industry 4.0 industrial policy and the host country did not, thus providing a home-country location advantage (Dunning, 1980).

We tested our hypotheses on data retrieved from the European Restructuring Monitor (ERM) database, which provides, among others, information about the relocation announcements involving firms' subsidiaries across the EU28 Member States (plus Norway). Our results confirm that firms developing Industry 4.0 technologies are more likely to undertake RTC, rather than RHC; however, they tend to opt for RHC when their home countries have an Industry 4.0 policy in place (while the host countries do not). This study contributes to the recent stream of IB literature that is inquiring how the traditional internationalization theories, such as the eclectic paradigm, evolve in the era of digital revolution (Alcácer et al., 2016; Banalieva & Dhanaraj, 2019). This is achieved by showing that firms possessing an Industry 4.0 ownership advantage are willing to pursue and update their internationalization strategy towards new locations; however, when the home country is able to develop an Industry 4.0 location advantage, the firm might rather prefer to exploit its Industry 4.0 ownership advantage from the home country, thus reducing its international exposure.

2. Theoretical background and hypotheses development

2.1 Offshoring and Relocations of Second Degree

As noted by Gereffi & Lee (2012), in the 1990s and 2000s firms have increasingly moved manufacturing activities to foreign countries, leading to an expansion in the geography of value chains "from regional production-sharing arrangements to fully-fledged global supply chains"[i] (p. 25). Extant literature suggests that several factors concurred in the surge of offshoring, including trade liberalization, lower Customs duties, and falling transport costs (Casson, 2013), as well as access to new markets (Haleem et al., 2018). Quality improvements and availability of skilled workers have also been found to be drivers of offshoring (Arlbjørn & Lüthje, 2012; Di Mauro et al., 2018), showing that the latter does not necessarily have to be directed towards low-cost locations. Yet, offshoring decisions have been recognized as being primarily driven by a cost minimization priority (Bailey & De Propris, 2014; Canham & Hamilton, 2013; Contractor et al., 2010), for both US firms (Lewin & Couto, 2007) and European ones (Fratocchi et al., 2015; Kinkel & Maloca, 2009; Schmeisser, 2013).

In spite of the promising opportunities it offers, offshoring also raises significant challenges for the involved companies (Schmeisser, 2013) mainly due to the inherent difficulties in running operations in distant, less familiar locations, and in managing the fragmented and geographically dispersed value chain. Besides, due to changes in the global economy, host countries may vary in their relative attractiveness (Martínez-Mora & Merino, 2014), and firms themselves can revise their strategic approach to internationalization (Di Mauro et al., 2018). As a consequence, previous offshoring decisions can be subject to change over time (Bettiol et al., 2019), giving rise to RSDs (Barbieri et al., 2019) in the form of either "Relocations to the Home Country" (i.e., RHCs) – typically denoted in the literature as "reshoring" or "backshoring" – or "Relocations to a Third Country" (RTCs).

Reshoring (i.e., RHC), particularly, has attracted considerable attention from scholars (Barbieri et al., 2018; Ciabuschi et al., 2019; Stentoft et al., 2016; Wiesmann et al., 2017) policy-makers (Elia et al., 2021) and practitioners (The Economist, 2013). While not a mass trend (Ancarani et al., 2015), this phenomenon involves from 2.2% to 7.9% of manufacturing companies in different European countries (Dachs et al., 2019a), reaching evidence amounting in number to no less than 1,500 at the worldwide level (Fratocchi & Di Stefano, 2020). Moreover, based on his extensive analysis on German reshoring companies, (Kinkel, 2014, 2020) estimates that "every fourth to sixth offshoring activity is countered by a backshoring activity" (Kinkel, 2020, p. 202), thus supporting the idea that changes in the spatial configuration of the supply chain may continue to happen in both directions. In terms of geography, while home countries were mainly the US and EU, the most sampled host country was China. However, EU companies often also reshore within the home region (Eastern and Western Europe) (Barbieri et al., 2018).

Motivations driving manufacturing relocation decisions have been heavily studied in the extant literature (Barbieri et al., 2018) providing evidence that they do not regard only economic issues (such as labour cost) but also supply chain-related (e.g., delivery time) and strategic ones (e.g., made-in effect, proximity between production and R&D). Conversely, despite its potential relevance as a relocation option (The Economist, 2013), we are aware of very few scholarly studies that also take RTC into account when studying firms' relocation choices after offshoring. Interestingly, both Manning (2014) and Barbieri et al. (2019) found evidence that RTC can indeed be a preferred alternative when firms pursue a cost-reduction priority in their manufacturing internationalization strategy.

2.2 Industry 4.0

The full integration of ICT in the context of manufacturing is paving the way towards a new industrial stage frequently termed the "Fourth Industrial Revolution" or "Industry 4.0" (Meniere et al., 2017). This phenomenon is mainly based on Cyber Physical Systems, which include "smart machines, warehousing systems and production facilities that have been developed digitally and feature end-to-end ICT-based integration, from inbound logistics to production, marketing, outbound logistics and service" (Kagermann et al., 2013, p. 14). The labels Fourth Industrial Revolution and Industry 4.0 point out the potentially disruptive effects of the phenomenon over the architecture of the manufacturing systems and the nature of the business processes – particularly, the automation of entire sets of tasks, including repetitive intellectual ones (Meniere et al., 2017). They also emphasise its pervasiveness to the entire economic system, given the large variety of sectors it can have an impact on.

Industry 4.0 integrates a set of emerging and convergent technologies adding value to the *whole product lifecycle* (Dalenogare et al., 2018). Inherent to this observation is that, although advanced manufacturing technologies ("Smart Manufacturing") are central to the concept, Industry 4.0 also embraces technologies related to the product dimension ("Smart Product"), e.g., allowing new functions and capabilities (Frank et al., 2019; Porter & Heppelmann, 2014). A broader conceptualization of the Industry 4.0 framework also includes the "Smart Working" and "Smart Supply Chain" dimensions (Frank et al., 2019), whose technologies enable improvements to internal and external processes respectively – by enhancing the productivity of workers' operational activities, and by supporting extensive information exchange and synchronization of operations with suppliers.

Connected smart objects are the basic building block of Industry 4.0 (Meniere et al., 2017) since the widespread diffusion of such intelligent devices allows for an unprecedented opportunity to collect a massive amount of data that can be processed and shared. Based on the information they collected or received from other sources, these objects will then be able to autonomously decide how to act. The range of activities that they can perform – either alone or inside a broader system – is enabled by a set of technologies providing the essential functionalities, such as extended interconnectivity, access to shared computing resources, advanced analytics, etc. Culot et al. (2020) identify four clusters of enabling technologies – characterized by a different share of hardware or software components, and varied connectivity extension – which deliver specific types of function. Particularly, "physical-digital interface technologies" (e.g., Internet of Things and cyber-physical systems) allow the virtualization of physical systems and permit their real-time control and rapid readjustment (Lee et al., 2015). "Network technologies" (e.g., cloud computing) support a device's functionalities through resources it can access remotely. "Data processing technologies" (e.g., analytics, machine learning, artificial intelligence) play a key role in the Industry 4.0 framework, since the functions they provide – e.g., cost- and time-effective elaboration of big data, and the ability to adapt to unforeseen conditions – result in distinctive features such as predictive capabilities and autonomous, increasingly effective decision-making. Finally, "Physical-digital process technologies" (e.g., additive manufacturing, advanced robotics) mostly pertain to the production aspects of Industry 4.0, and they represent innovative production modes with intriguing potential in terms of output uniqueness, and higher flexibility and/or productivity. It is worth noting that while specific functions can be acknowledged for these technologies, mutual interdependences among them exist, and drive their simultaneous adoption in several Industry 4.0 applications (Culot et al., 2020; Lee et al., 2015).

2.3 Industry 4.0 and RSD

There is growing interest in the possible impact of Industry 4.0 technologies on firms' (re)location choices and on the geographical reconfiguration of value chains (Bals et al., 2016; Fratocchi & Di Stefano, 2020; Strange & Zucchella, 2017), since these technologies have the potential to change the nature of competition, and alter location advantages (Ancarani et al., 2019; Strange & Zucchella, 2017) that drive a firm's internationalization strategy. With respect to RSD, extant research has mostly considered the case of RHC, investigating whether the new technologies relate to the decision of repatriating formerly offshored production activities (Ancarani et al., 2019; Ancarani & Di Mauro, 2018; Dachs et al., 2019b; Fratocchi & Di Stefano, 2020; Kamp & Gibaja, 2021; Müller et al., 2017). In this literature it is typically argued that, on the one hand, increased automation and higher productivity enabled by Industry 4.0 technologies weaken, if not eliminate, the location advantage of low-labour cost countries. On the other hand, the high production flexibility these technologies allow, combined with the proximity to customers gained through RHC, envisage the possibility of rapidly responding to individual customer needs on a large scale without significant loss in productivity (Kagermann et al., 2013), thus improving substantially the value delivered by the firm.

However, in spite of the fact that Industry 4.0 is frequently cited by scholars as a possible driver, or at least an enabling factor, of RHC (Fratocchi & Di Stefano, 2020), empirical evidence of the relationship between the two phenomena is scarce, with only mixed and rather inconclusive results available to date (Kamp & Gibaja, 2021). A summary of the extant empirical studies is presented in Table 1.

– Insert Table 1 about here –

While Dachs et al. (2019) found a positive and significant association between reshoring propensity and the use of Industry 4.0 technologies, both Chiarvesio & Romanello (2018) and Müller et al. (2017)

could not identify a clear and direct relationship between them. In a similar vein, Kamp & Gibaja (2021) conclude that “Industry 4.0 technologies did not show a convincing relation with backshoring behaviour of the sampled firms” (p. 9). Ancarani et al. (2019) considered a sample of backshoring companies to analyse the relationship between the competitive priorities underlying the relocation decisions and the degree of adoption of Industry 4.0. They found that the latter is more frequently associated with issues in (a) quality and offshore complexity, and (b) costs of non-compliance. Considering these results, they observed that “reshoring firms seem to be more frequently drawn towards [Industry 4.0] technologies that respond to challenges specifically tied to production and prototyping” (p. 367), while “to date backshoring has largely taken place without investments in new technologies” (p. 368).

On addition to that, the link between Industry 4.0 and RHC has been questioned, even from a theoretical perspective. A massive spread of automation could be hindered by the complexity in fully replacing the human abilities in task performance, and the high investments required to introduce the technology could make its payback difficult to achieve (Butollo, 2020). Accordingly, it is doubtful whether automation can really offset the cost gap between high- and low-cost countries. Actually, companies may find it more convenient to deploy productivity-enhancing automated equipment in offshore factories, or to move production to low-wage countries close to home (i.e., near-reshoring – a type of RTC) if they aim to combine the benefit of automation and of proximity to main end user markets (Andersson, 2018; Butollo, 2020).

As for flexible and rapid response to customized demands – another argument used to support the link between Industry 4.0 technologies and RHC – it has been noted that its pursuit through the new technologies does not necessarily imply the simultaneous repatriation of production. Butollo (2020) argues that advanced logistics systems (“Logistics 4.0”) that combine Artificial Intelligence-based predictive analytics, smart warehousing and smart vehicles, and IoT-enabled tracking systems could make a geographically spread production network as effective as a geographically narrower one in responding to requirements for diversity and rapid time-to-market. He relies on anecdotal evidence from the electronics and the retail industries to support this claim.

Considering the contrasting evidence regarding the possible relationship between Industry 4.0 technologies and the RHC decision and considering that valuable theoretical arguments also exist in favour of different types of RSD, we believe that the inclusion of RTC as a viable alternative to the mere RHC option and the distinction between Industry 4.0 *adopters* and *developers* help to better disentangle how Industry 4.0 technologies relate to firms' relocation choices.

2.4 Industry 4.0 Innovation intensity as an Ownership advantage and RSD

International business scholars have recognized superior technology as a typical advantage of multinational enterprises since the seminal work by Hymer (1976). In this respect, theories regarding FDIs suggest firms invest overseas when they own firm-specific advantages allowing them to transcend comparative disadvantages with local rivals (Caves, 1996). In this respect, the Eclectic paradigm proposed by Dunning (1980) places "considerably more emphasis on the need for the MNE to possess ownership advantages prior to the act of internationalization" (Lundan, 2010, p. 51). More specifically, the pattern and extent of the multi-national enterprise (MNE) foreign activities may be explained only by considering the interplay between the firm's ownership advantage and the location-bound resources in the host country (i.e., the so-called location advantage). In this respect, it must be considered that Dunning (1988) identified two categories of ownership advantage, namely the "asset-based" and the "economies of common governance". While the former is regarding (tangible and intangible) superior competitive assets owned by the company, the latter are based on the cross-border coordination of these assets (Lundan, 2010). Moreover, the asset-based ownership advantage is also in line with the Resource-Based View, according to which the firm's competitive position is based on the possession of valuable, rare, and difficult to imitate or substitute assets (Barney, 1991; Peteraf, 1993).

Patents – which is generally assumed as a measure of the firm's innovation intensity - have been recognized as one of the typical asset-based ownership advantages since they allow the owning company a monopolistic advantage for a certain time. Moreover, the knowledge embedded in patents is generally less imitable when compared to that embedded in the physical capital (Wang et al., 2008). Finally, studies on the influence of patents on the firm's internationalization process reached more conclusive and positive results than those generically referring to the R&D intensity (Becchetti & Rossi, 2000; Kirbach & Schmiedeberg, 2008; Schlegelmilch & Crook, 1988).

The impact of patenting on the firm's internationalization has been investigated by several scholars considering different value chain activities. For instance, Lejpras (2015) and Briggs & Park (2013) found a linear relationship between the number of owned patents and the value of firm's exports. In contrast, Nam & An (2017) showed a reverse U-shape relationship in the healthcare industry, therefore rather excessive patents can have a negative effect on foreign sales. When considering FDIs, Tomiura (2005) found that for Japanese manufacturing companies the higher the number of patents, the higher the possibility to establish foreign subsidiaries (both in Asia and the rest of the world). This finding is consistent with Wang et al. (2008); when analysing high-tech Taiwanese companies, they found the higher the patent count, the higher the likelihood to own a larger number of foreign subsidiaries. Finally, a further, albeit indirect, support for the hypothesis of the patent impact on the firm internationalization process is proposed by Ó hUallacháin et al. (2018) with respect to the automotive industry. More specifically, they found that Asian and European companies heavily invested in US in terms of manufacturing plants, but their patents were mainly developed in the home country. Overall, these contributions suggest that a higher number of patents positively relate with the firm's international exposure, which in our study is reflected by RTCs.

When it comes to patents, the ones related to Industry 4.0 enabling technologies deserve a special note. In this respect, it has been stated that such patents "are very closely related to ICT, with the addition of connectivity" (Behrens & Trunschke, 2020). Moreover, several scholars have recognized ICTs as a factor affecting the firm's internationalization process (Alcácer et al., 2016; Monaghan et al., 2020; Nachum & Zaheer, 2005), since they allow for remote coordination, extending the span of control and reducing its cost (Chen & Kamal, 2016; Leamer & Storper, 2001). Furthermore, they permit companies to "fine slice" their value adding activities and to locate their production in different locations, as in the "global factory" scenario (Buckley, 2011; Buckley & Ghauri, 2004). Therefore, we argue that companies owning this type of software-based patents are induced to revise their manufacturing offshoring strategies in terms of an RTC rather than of an RHC, since the latter is a form of de-internationalization while the former maintains the company abroad (either in the same region or in a further away one) and it allows the reconfiguration of the value chain and reorganization of the production processes that maximize the advantages offered by Industry 4.0 technologies.

In addition, it is worth emphasizing some further differences between patents' developers (who implement the patent application) and patents' adopters (who implement the invented technology protected by the patent). In this respect, patent developers can gain benefits not only from their direct application (similarly to patent adopters), but also from selling the patented technology in multiple countries. Since Industry 4.0 patents are regarding general purpose technologies (Gambardella et al., 2008), they generally support a pervasive use in a wide range of countries and industries and have a far reaching geographic and sectoral applicability (Agrawal et al., 2019; Bresnahan & Trajtenberg, 1995; Cockburn et al., 2019). Given the broad range applicability of Industry 4.0 patents, it is more likely that their developers would increase their international footprint, to leverage on the asset-based ownership advantage. Therefore, if they decide to revise their previous offshoring decision, we expect that they will implement an RTC rather than an RHC alternative.

To sum up, the earlier arguments induce us to hypothesize as follows:

HP 1: The higher the Industry 4.0 innovation intensity, the higher the likelihood to undertake an RTC rather than an RHC when revising previous manufacturing offshoring decisions.

2.5 The moderating effect of Industry 4.0 Home Country Policy-based location advantage

The term "Industry 4.0 policies" refers to the programmes launched by national governments to encourage firms to adopt the technologies enabling Industry 4.0 (Davies, 2015; Lasi et al., 2014). The basic concepts behind these initiatives are technical assistance and the provision of tax cuts or direct financing to firms investing in Industry 4.0 technologies. Additional support provided by policymakers regards training and education programmes for the development of skilled human resources, adoption of common technological standards, harmonization of the regulatory frameworks and design of long-term R&D policies. All these initiatives confirm the idea that Industry 4.0 "implies new interactions between public sector and organizations" (Robinson & Mazzucato, 2019)[ii].

The long-term aim of Industry 4.0 policies implemented by European countries is a deep transformation of the national industrial production, which is pursued by merging conventional manufacturing technologies with digital ones that can connect all the different parts of the value chain (i.e., suppliers, plants, distributors and customers).

This means that the implementation of an Industry 4.0 policy represents not only an instrument to promote the transformation of the industrial system, but also a unique opportunity to develop a strong location advantage also affecting relocation choices. Firms are, indeed, more inclined to relocate their production activity in a country where it is possible to exploit more advanced and reliable technology (Arlbjørn & Mikkelsen, 2014). In this respect, Müller et al. (2017) found that companies – convinced that the adoption of Industry 4.0 enabling technologies would support RHC decisions – evaluated government incentive as the second most relevant reshoring motivation.

Industry 4.0 initiatives are increasingly considered by policymakers as instruments to support their attempt to repatriate activities previously offshored by domestic companies (Deloitte, 2018; Lasi et al., 2014; Schlaepfer et al., 2015). In other words, policymakers are strategically employing Industry 4.0 national programmes to create a new type of "home-country Industry 4.0 policy-based location advantage", able to offset the low-cost or high-productivity location advantage of foreign countries and to stimulate national companies to adopt and develop Industry 4.0 technologies. In addition, the institutional setting of the home country plays a crucial role in shaping the firm-level competitive advantages, by affecting the amount and quality of resources and networks a firm is able to access (Alcácer et al., 2016; Narula, 2014). Therefore, the implementation of an Industry 4.0 policy by the home country is expected to provide firms with Industry 4.0 patents with the possibility not only to take advantage of the direct benefits associated to the national policy (e.g., fiscal incentives, financial support etc.), but also to exploit their Industry 4.0 ownership advantage from their home country offering a favourable institutional setting. For example, companies may still serve the international markets through export or licensing thus reducing the burdens (e.g., liability of foreignness, cultural and institutional distance etc.) associated with stronger forms of international commitment such as RTC. Therefore, firms with Industry 4.0 patents will have an incentive to reconsider their RSD choice by switching from RTC to an RHC when the home country adopts an Industry 4.0 policy (while the host country does not), thus taking advantage of this new home-country Industry 4.0 policy-based location advantage. Accordingly, we forward the following second hypothesis:

HP 2: The Home country Industry 4.0 policy-based location advantage moderates the relationship between the Industry 4.0 innovation intensity and RSD inducing companies to implement RHC instead of RTC decisions.

3. Methodology

3.1 Dataset and descriptive statistics

To test our hypotheses, we collected data from the ERM database, which provides, among others, information about the relocation announcements involving firms' subsidiaries across European countries. The European context represents a good setting for our investigation, given that international business scholars have highlighted that MNEs tend to expand abroad on a regional (rather than a global) scale (e.g., Arregle et al., 2009; Asmussen, 2009; Rugman & Verbeke, 2004). Data are gathered from daily newspapers and business press in the EU28 Member States (plus Norway) and integrated with other sources such as company websites and social media. The criteria employed by ERM to capture the restructuring cases are the following: (i) it must affect at least one European country; (ii) it must reflect a reduction or an increase in employment of at least 100 jobs; (iii) it must involve at least 10% of the workforce in sites with more than 250 employees.

The collection procedure was implemented through the following steps. First, we identified all the initiatives included in the Section "Relocations" of the ERM dataset (thus excluding the ones in the "Offshoring" section) available between 2002 and 2015. From this database, we collected the following information: company name; home country (which is also the final destination in the case of RHC); first host country (which is the destination of the first offshoring decision from which the relocation occurs); second host country (which is the final destination in the case of RTC and which corresponds to the home country in the case of RHC); NACE code at a 2-digits level; announcement date[iii]; the text of the news; and the source of the data (i.e., link to the article).

As a second step, we dropped all cases involving a non-European country as the home, first host and second host country. This choice was driven by two reasons. On the one hand, data involving non-European firms have a limited number and sampling significance, since the ERM database can track with precision and completeness only those relocations that occur within Europe, while the information about the relocations involving non-European countries is more sporadic and random. On the other hand, given that the focus of this paper is to study the choice between RHC and RTC, our sample can include only the RSDs undertaken by European firms, since the RSDs of non-European firms are captured by the ERM database only in case of RTC, while RHC are not included as the home country is outside EU28+Norway. We believe, however, that the European context represents a good setting for our investigation, given that international business scholars have highlighted that MNEs tend to expand abroad on a regional (rather than a global) scale (e.g., Arregle et al., 2009; Asmussen, 2009; Rugman & Verbeke, 2004).

As a third step, we read the available additional information to ensure that each announcement was relevant to our study and we excluded all the cases that were missing critical information and that did not allow us to properly classify the relocations into RHC and RTC. More specifically, a couple of authors independently checked each news item, to verify that each relocation could be properly classified as RSD. In case of different classification by the two authors, a third author was involved for the final decision. Hence, we ended up with a sample of 118 RSDs[iv] undertaken by European firms operating in manufacturing industries (from NACE Code 10 to NACE Code 33) between 2002 and 2015. Most of the RSDs, i.e., 77 observations (corresponding to 65.25% of the sample), refer to RTC, while the remaining 41 observations (corresponding to 34.75% of the sample) refer to RHC.

Table 2 shows the distribution of the RSDs across the years: it is worth noting a peak in the relocation initiatives (especially in terms of RTCs) between the years 2005 and 2009, which is likely to be due to the EU enlargements towards Transition Economies that occurred in 2004 and 2007. At the same time, it is possible to observe a reduction in relocation initiatives since 2010 (except for 2014), which might be ascribed to the economic crisis of 2008-2009.

– Insert Table 2 about here –

Table 3 shows the distribution of observations across industries. Most of the relocations have occurred in the industry of the manufacture of motor vehicles, trailers and semi-trailers (NACE code 29), which involves 23 RSD cases (i.e., about 20% of the total sample), equally distributed between

RHC (12 observations) and RTC (11 observations). Another industry that accounts for a large share of RSD is the manufacture of electrical equipment (NACE code 27), which is responsible for 21 relocations (i.e., about 18% of the total sample) most of which (16 out of 21 observations) take the form of RTC. The manufacture of chemicals and chemical products (NACE code 20) is the third most represented industry, with 13 RSDs (i.e., about 11% of the total sample) being mostly (8 out of 11 observations) RTC cases. The industry with more RHC is again the manufacture of motor vehicles, trailers and semi-trailers (12 out of 44 cases, i.e., about 30% of the RHC sub-sample), while the manufacture of electrical equipment is the industry with the highest number of RTC (16 out of 77 cases, i.e., about 21% of the RTC sub-sample).

– Insert Table 3 about here –

Finally, Table 4 shows the geography of RSDs by reporting the home, the first host and the second host countries (the latter being equal to the home country in the case of RHC). Most of the firms undertaking an RSD originate from Western Europe, Germany being by far the most represented country (36 observations corresponding to 30% of the sample), followed by France (18 observations) and Sweden and UK (14 observations each). However, while in the case of Germany and France more than half of the RSDs correspond to RHCs (the home and the second host country of the third column being the same in 21 cases for Germany and in 10 cases for France), British and Swedish firms prefer to opt for RTC (the home and second host countries being equal only in 5 cases for both countries). As regards the first host country (i.e., the country from which RSDs occur), Italy is the most represented nation (17 observations corresponding to 14.41% of the sample), followed by France (14 observations) and Germany (10 observations). Hence, Western European countries are not only the main promoters of RSDs, but also the main (first) host countries from which RSDs take place. Finally, as regards the second host country (i.e., the countries towards which RSDs take place), besides the RHC cases of Germany and France, the most represented nations are Eastern European countries, led by Poland (22 observations), Czech Republic (10 observations) and Romania (9 observations).

– Insert Table 4 about here –

More details as regards the home, first host and second host countries of each single RHC and RTC are reported in Tables A1, A2 and A3 of the Appendix.

3.2 Variables

Dependent Variable

The dependent variable is a dummy, named *RTC*, assuming a value of 1 if the RSD corresponds to an RTC, and 0 if it corresponds to an RHC. As explained above, the information about the typology of relocation has been obtained from the ERM database.

Explanatory variable

The main explanatory variable is *Firm's Industry 4.0 innovation intensity ownership advantage*. This variable accounts for the extent to which a firm can rely on advanced knowledge and technologies about Industry 4.0 to be exploited across different countries. To capture this advantage, we used as proxy the cumulated number of patents in Industry 4.0-related technologies granted to each firm until the year before the announcement of the RSDs. The number of patents is extracted from the Global Patent Index in the European Patent Office database. Specifically, the patents considered are the ones respecting the criteria of belonging to the Fourth Industrial Revolution. The criteria and parameters for the definition of Industry 4.0 patents are described in the European Patent Office report, published in 2017 (Meniere et al., 2017).

Moderating variable

The main moderator is *Home country Industry 4.0 policy-based location advantage.* This variable is a dummy taking the value of 1 when an Industry 4.0 policy was in force in the home country of the firm and not in the host country in which the firm was located during the year before the relocation decision, and 0 otherwise. The information was retrieved from the "Digitising European Industry Initiative" COM 180 released by the European Commission in 2016[v]. In addition, we also searched for the presence of Industry 4.0-specific policies on the institutional websites (e.g., National Government, Ministry of Economic Development, Ministry of Economy and Finance etc.) of each home, first host and second host country of our sample to detect all possible Industry 4.0 policies available in each European country.

Control variables

We employed a set of control variables that, based on the existing literature, may affect the propensity to choose RHC rather than RTC. First, we tried to capture the main drivers underlying the first offshoring initiative by looking at the country-level location advantages of the first host country compared to the home country. Although we are aware that the driver of an offshoring investment should be captured at firm-level, both the International Business and Supply Chain Management literatures have stressed the importance of also using country-level data to study the motives of offshoring investments. For instance, Buckley et al. (2007) employed macro-economic indicators to identify the reasons underlying the Chinese offshoring investments. Ellram et al. (2013) claim that 'ownership and internalization are very closely related and focus on a firm-level analysis' while 'location advantages can be explained by country-level analysis' (p. 15). In addition, Di Mauro et al. (2018) found that the vast majority of offshoring motivations for their sampled firms lie above the firm's internal level, depending on the external environment. This further confirms that the host country dimension is important when a firm need to decide 'where' to place its manufacturing activities. Finally, Barbieri et al. (2019) have used country-level data to capture the location advantages underlying the offshoring investments in a similar study assessing the drivers of the choice between RHC and RTC. Hence, we believe that country-level data can still be useful to provide a first-hand (although partial) insight on the motivations underlying the offshoring investments of firms (considering also that these data rely on more objective macro-economic indicators than firm-level data based on surveys).

Building on Dunning (1993), we identified four different types of location advantage that can explain the motivations of an offshoring investment, (i) resource-seeking (i.e., cost-saving), (ii) efficiency-seeking (i.e., productivity-enhancing), (iii) market-seeking, and (iv) asset-seeking. To account for the former (cost-saving), we employed the variable *First host country cost-saving location advantage over the home country*, by using the difference between the home and the host country in the unitary labour cost as proxy. It is measured as the average value of the last three years preceding the relocation announcement to smooth fluctuations[vi]. Data have been extracted from the OECD Compendium of Productivity Indicators, measured in the base year 2010=100. In contrast, to evaluate the case of efficiency-seeking decisions, we adopted the control variable *First host country productivity-*

enhancing location advantage over the home country, which is measured as the difference between the host and the home country in the GDP per person employed. Again, we considered the average values in the last three years preceding the announcement of the relocation to smooth the fluctuations[vii]. Data come from the World Bank database. Conversely, the variable *First host country market-seeking location advantage over the home country* captures the extent to which a host country offers market opportunities with respect to the home country. Building on Buckley et al. (2007) and Barbieri et al. (2019), we employed as proxy the difference between the host and the home country in terms of Gross Domestic Product per capita (GDP per capita), by considering the average value in the three years preceding the announcement year of the RSD. This measure is expressed in constant 2011 US dollars and is retrieved from the World Development Indicators database of the World Bank. The use of such a variable is aimed at defining to what extent a country may result in being more attractive than another one in terms of market opportunity, since the GDP per capita of a specific country is considered a proxy of the purchasing power of the population of that country. Finally, we employed the variable *First host country strategic asset-seeking location advantage over the home country*, which captures the extent to which the host country has a location advantage in terms of strategic assets with respect to the home country. The proxy employed is the difference between the host and the home country in the number of researchers in the R&D division per millions of people, again in terms of average value in the three years prior to the announcement year of the relocation. Data come from the World Bank database.

An additional control variable is *Post Crisis,* a dummy that assumes the value of 1 if the observation has an announcement year from 2009 onwards, and 0 otherwise. The aim is to capture the effect of the crisis on the relocation choices in the years following the start of the crisis, which took place at the end of 2008. Other control variables are: *Firm Size,* which is measured as the total assets of the company in thousands of US dollars (source: Orbis database, Bureau van Dijk database); *Cultural distance* between the host and the home country, which is measured by employing the Kogut & Singh index based on Hofstede's items (2001)[viii]; *Industry Dummies,* which account for the dynamics underlying each specific NACE-code (at a two-digit level) of the firms involved in the relocations based on Table 3[ix].

Table 5 shows the correlation matrix and the descriptive statistics of the dependent, explanatory and control variables of the model. Given that the scales of the variables are extremely heterogeneous, we decided to standardize the values before running the econometric analyses. To rule out the multicollinearity problem, we also computed the variance inflation factors and no value is higher than the threshold of 10.

– Insert Table 5 about here –

4. Results

4.1 Main results

Given the dichotomous nature of our dependent variable, we employed a robust Probit model to estimate our results. Columns (i) and (ii) in Table 6 display the coefficients and marginal effects of the baseline results without any interaction. The variable *Firm's Industry 4.0 innovation intensity ownership advantage* displays a positive and significant ($p<0.05$) correlation with the dependent variable, thus confirming our hypothesis 1. The marginal effect shows that the probability to undertake an RTC is 5% higher when a firm doubles its amount of Industry 4.0 patents. Conversely, the moderating variable, i.e., *Home country Industry 4.0 policy-based location advantage*, exhibits a not significant coefficient. As regards the controls, the variables *First host country cost-saving location advantage over the home country* and *First host country productivity location advantage over the home country* display a positive and significant ($p<0.01$ in both cases) correlation with the dependent variable, thus showing that firms searching for low-cost resources or higher productivity are more likely to pursue their internationalization strategy by opting for RTC rather than RHC. Marginal effects show that an increase of 10% in the cost-saving and productivity-enhancing location advantages increase the probability to undertake an RTC of 1.42% and 4.66%, respectively. Conversely, the variable *First host country market-seeking location advantage over the home country* displays a negative and significant ($p<0.01$) coefficient, thus suggesting that firms investing abroad for market-seeking reasons are more likely to return home (rather than relocating to a third country). The magnitude exhibited by the marginal effect shows that the probability to undertake an RTC decreases by 2.85% when the market-seeking driver increases by 10%. On the opposite side, the variable *Cultural distance* shows a positive and significant ($p<0.05$) coefficient, thus suggesting that firms investing in culturally distant countries are more likely to undertake an RTC, the magnitude of the effect being equal to 0.75% for an increase of 10% of the variable.

Columns (iii) and (iv) in Table 6 introduce the interaction between *Firm's Industry 4.0 innovation intensity ownership advantage* and *Home country Industry 4.0 policy-based location advantage,* which displays a negative and significant ($p<0.01$) coefficient, thus fully confirming our hypothesis 2. Given the non-linearity nature of the Probit model, we plotted the results of the interaction term to gain more insights on the negative sign of the moderation effect. Figure 1 clearly shows that the relationship between the Industry 4.0 innovation intensity of a firm and the probability to undertake an RTC is positive only when the home country does not display an Industry 4.0 policy-based location advantage, while becoming negative – thus favouring RHC – when the home country can count on an Industry 4.0 policy-based location advantage and the host country cannot.

– Insert Table 6 and Figure 1 about here –

4.2 Robustness checks and additional evidence

We performed a set of additional analyses to test the robustness of our results and to provide some further evidence that can be helpful to better interpret our main results. First, we performed an analysis to assess the goodness of fit of the main model displayed in Table 7. Our *post hoc* analysis shows that our main model correctly predicts 86.44% of the values of our dependent variable, being the prediction being higher when y=1 (90.67%) than when y=0 (79.07%). We also computed the area under the ROC curve, which is equal to 0.94, thus indicating a high discrimination and, hence, a good predictive power of the model.

Second, we substituted our variable *Home country Industry 4.0 policy-based location advantage* with another one named *Home country Industry 4.0 policy,* which captures whether, in the year before the announcement date, the home country of the company undertaking the RSDs had an Industry 4.0 policy in place without making any comparison with the first host country. In other words, we checked whether our interaction term holds even when the home country of a firm adopts an Industry 4.0 policy regardless of whether such initiative translates into a policy advantage compared to the first host country.

The results, which are displayed in Table 7, fully confirm the negative moderation effect of the variable *Home country Industry 4.0 policy* on the relationship between *Firm's Industry 4.0 innovation intensity ownership advantage* and *RTC*, meaning that Industry 4.0 innovative firms are more likely to undertake an RHC when their home country adopts an Industry 4.0 policy, even when the first host (or other foreign) countries have a similar policy in place.

– Insert Table 7 about here –

Third, we introduced four additional variables capturing the country-level characteristics of the second host country (which corresponds to the home country in the case of RHC). More specifically, we introduced *Second Host country production costs, Second Host country productivity, Second Host country market attractiveness* and *Second Host country strategic assets*[x]. The results, which are displayed in Table 8, fully confirm our hypotheses when using both *Home country Industry 4.0 policy-based location advantage* and *Home country Industry 4.0 policy* as moderator. In Table 9, we have performed the same regressions by using the variables *Second host country cost-saving location advantage over the first host country, Second host country productivity-enhancing location advantage over the first host country, Second host country market-seeking location advantage over the first host country* and *Second host country strategic asset-seeking location advantage over the first host country*[xi], which have been computed as the difference between the second and first host country using the same approach employed to assess the location advantages of the first host over the home country in the main regressions of Table 6. Again, results are confirmed when using both *Home country Industry 4.0 policy-based location advantage* and *Home country Industry 4.0 policy* as moderator. We finally introduced a further specification using the variables *Second host country cost-saving location advantage over the home country, Second host country productivity-enhancing location advantage over the home country, Second host country market-seeking location advantage over the home country* and *Second host country strategic asset-seeking location advantage over the home country,* which have been computed as the difference between the second host and the home country (being equal to zero for RHC, as in this case the second host country is equal to the home country) using the same approach employed to capture the location advantages of the first host over the home country in the main regressions of Table 6. Results are again fully confirmed when using both *Home country Industry 4.0 policy-based location advantage* and *Home country Industry 4.0 policy* as moderator, as shown in Table 10[xii].

– Insert Tables 8, 9 and 10 about here –

Finally, building on Barbieri et al. (2019), who found that firms searching for cost-saving and productivity-enhancing location advantages are more likely to undertake RTC than RHC, we interacted our two main explicative and moderating variables (i.e., *Firm's Industry 4.0 innovation intensity ownership advantage* and *Home country Industry 4.0 policy-based location advantage*) for the variables *First host country cost-saving location advantage over the home country* and *First host country productivity-enhancing location advantage over the home country*, in order to understand whether Industry 4.0 firm-level and home country-level advantage can reverse the preference for the RTC shown by these companies. The results, which are displayed in Table 11, show that firms searching for cost-saving advantage tend to reverse their choice from RTC to RHC when engaged in the development of Industry 4.0 innovation. Instead, firms searching for productivity location advantages tend to reverse their choice from RTC to RHC when their home country develops an Industry 4.0 policy compared to the host country. Only this latter result, however, is confirmed when including all interactions in the same specifications (see last column in Table 11). At the same time, this latter interaction becomes not significant when employing *Home country Industry 4.0 policy* instead of *Home country Industry 4.0 policy-based location advantage* (results showing the not significant interaction are available upon request).

– Insert Table 11 about here –

5. Discussion

After decades of offshoring strategies undertaken by companies in search of new location advantages, a new disruptive phenomenon seems to have started impacting this trend. Industry 4.0, indeed, is providing firms with a unique opportunity to leverage valuable technologies in new host countries, thus pushing them to keep on pursuing their internationalization strategies.

More specifically, our results suggest that the development of patents of Industry 4.0 technologies further reinforces firms' internationalization footprint towards new locations. This result can be explained through the lenses of the Eclectic paradigm (Dunning, 1980), by acknowledging that patents represent an asset-based ownership advantage (Lundan, 2010), further reinforced by the variety of applications provided by Industry 4.0-related patents (Agrawal et al., 2019; Bresnahan & Trajtenberg, 1995; Cockburn et al., 2019). This means that firms with a strong Industry 4.0 innovation intensity are, in general, more willing to further pursue their internationalization process by investing in a new host country. This result seems to suggest that the development of a portfolio of Industry 4.0 technologies provides the firms with an Industry 4.0 competitive advantage that can be exploited in other host countries, thus reflecting a dynamic that is similar to that underlying the first internationalization described by the eclectic paradigm, where firms invest abroad to exploit their ownership advantage. An alternative interpretation of our finding, which is coherent with the most recent IB perspective concerning the conceptualization of innovative MNEs (Alcácer et al., 2016; Mudambi et al., 2018; Narula, 2014; Narula & Santangelo, 2012), is that firms are increasingly moving from a centralized approach − where they innovate by using knowledge developed within the headquarters, to a decentralized approach − in which they source knowledge from geographically dispersed innovative ecosystems by exploiting co-location advantages. In other words, the positive correlation between Industry 4.0 innovation intensity and RTC seems to reflect the attempt of MNEs to develop a new Industry 4.0 ownership advantage by integrating information and knowledge across countries, thus acting as orchestrators of international networks and pursuing a process of value creation that connects globally (or regionally) dispersed specialized knowledge (Dunning & Lundan, 2008; Nohria & Ghoshal, 1997).

Conversely, the emergence of a home-country location advantage – based on the adoption of Industry 4.0 policies – seems to have an impact on firms investing abroad, by reducing their probability to undertake an RTC, even when they have an Industry 4.0 innovation intensity ownership advantage. This is in line with previous literature which states that companies are more willing to move their production activities to countries where it is possible to exploit more advanced technologies (Arlbjørn & Mikkelsen, 2014) or to take advantage of incentives to make investments reducing the overall production costs while, at the same, increasing productivity (Strange & Zucchella, 2017). The introduction of an Industry 4.0 policy in the home country is likely to reduce the gap with respect to the host economy since policies are designed for many companies and are aimed at triggering a deep change in the whole productive system and to increase its competitiveness and its technology intensity. This offers the opportunity to firms located abroad to implement their learning-by-interacting (Alcácer et al., 2016; Bertrand & Capron, 2015) strategy in the home country, thus reducing the probability to opt for an RTC when undertaking a RSD. Notably, the presence of an Industry 4.0 policy-based location advantage in the home country does not directly reduce the probability of implementing an RTC. Instead, the combination of Industry 4.0 ownership advantage and location advantage is reversing the internationalization trend by inducing companies to bring production activities back to the home country.

By looking at the control variables, the results show that when companies choose a first host country providing a cost-saving or a productivity location advantage, in the RSD they tend to prefer the RTC, most likely because they are attracted by even more convenient locations, thus pursuing an efficiency-seeking internationalization strategy. Instead, a market-seeking location advantage characterizing the first host country, is more likely to be related to an RHC. The latter result can be explained by an exhaustion of the market advantage or by a strategic shift (Di Mauro et al, 2018), that may make the firm lose interest in the host country market. Finally, the higher the cultural distance between the first host country and the home country, the more likely is the RTC choice. Therefore, distances matter when it comes to relocations, as they do for the first wave of internationalization (Berry et al., 2010; Boeh & Beamish, 2012; Reuer & Lahiri, 2014).

Our additional evidence shows that, besides the Industry 4.0 policy-based location advantage, the cost-saving location advantage also allows companies with Industry 4.0 ownership advantage to revert the internationalization process towards the home country. first possible explanation for this result may be that the development of Industry 4.0 technologies by cost-saving firms is likely to be conceived as a strategy to exploit new technologies as a substitute for low-skilled labour (Ancarani et al., 2019). This situation offers the extraordinary opportunity to switch from a host country-level comparative advantage based on cost differentials to a firm-level ownership advantage based on Industry 4.0 technology intensity. Such a firm-level ownership advantage is likely to increase the degree of freedom of the firm in the relocation choice, i.e., the number of available RSDs, including the RHC ones. Indeed, after reaching a similar (or even a superior) level of cost-saving thanks to Industry 4.0 technologies, the firm can afford to undertake an RHC in order to exploit its new "Industry 4.0-based" ownership advantage without facing the burden of internationalization, such as coordination and transportation costs, institutional and cultural differences etc. (Stentoft et al., 2016; Wiesmann et al., 2017). Conversely, productivity enhancing firms tend to reverse the relocation choice from RTC to RHC only if the home country has an Industry 4.0 in place. The introduction of an Industry 4.0 policy in the home country is likely to reduce the gap with respect to the host economy, since policies are designed for many companies and are aimed at triggering a deep change of the whole productive system and to increase its competitiveness and its technology intensity. This offers the opportunity to firms located abroad for productivity-enhancing reasons to reach this goal in the home country, thus reducing the probability to opt for a RTC when undertaking a RSD

6. Conclusions

In light of the findings discussed above, we believe that our paper can contribute to the IB literature by taking part in the flourishing ongoing debate concerning the impact of new technologies on the internationalization patterns of MNEs in the information age (Alcácer et al., 2016; Banalieva & Dhanaraj, 2019; Monaghan et al. 2019). Specifically, our results seem to suggest that the development of an Industry 4.0 innovation intensity ownership advantage by the firm or the establishment of an Industry 4.0 location advantage by the home country do not foster a de-internationalization process *per se.* On the contrary, firms developing Industry 4.0 technologies when implementing RSD are even more likely to invest in other countries to exploit or develop further their Industry 4.0 innovation intensity ownership advantage. Nevertheless, de-internationalization seems to become a real option for those firms that developed a firm-level Industry 4.0 innovation intensity ownership advantage and whose (home) country developed an Industry 4.0 policy-based location advantage. Hence, we believe that, by exploring how Industry 4.0 can affect both the ownership and location advantage and the relocation choice of firms, our paper provides a preliminary contribution to the challenges raised in a paper by Monaghan et al. (2020), who set-up a research agenda and call for future contributions to understand how international business theory can be revisited in light of the digitalization changes by adopting interdisciplinary insights, which in our paper arise from the combination of the IB with the Supply Chain and Operations Management literatures.

Our research also contributes to the nascent stream of literature that investigates the linkage between Industry 4.0 and post-offshoring relocation choices. As noted, this literature has not come to conclusive results yet (Kamp and Gibaja, 2021) since only limited evidence was found that the adoption of Industry 4.0 technologies reduces the firm's international exposure by fostering RHC (e.g., Dachs et al., 2019). Our study offers a novel perspective to possibly disentangle this issue, by showing that, when considering the development (instead of the simple adoption) of Industry 4.0 technologies, and when including the RTC option (instead of the RHC only), companies that exhibit a superior degree of Industry 4.0-based ownership advantage tend to expand – or at least maintain – their international exposure. However, consistently with Dachs et al. (2019), we observe that RHC may become a viable option for Industry 4.0 technology developers – even when the RTC alternative is explicitly considered – under two specific contingencies, namely: (a) the existence of an Industry 4.0 policy-based location advantage in the firm's home country, or (b) the pursuit of a cost-saving location advantage by the focal firm.

A further potential contribution of our paper within the IB literature is related to the role of distances. Indeed, previous literature has largely shown that distances matter in driving the internationalization strategies of MNEs (e.g., Berry et al., 2010; Boeh & Beamish, 2012; Reuer & Lahiri, 2014), being the main source of liability of foreignness and outsidership (Johanson & Vahlne, 2009). We provide a further contribution by showing that distances are also relevant in driving the post-internationalization strategies, given that cultural distance increases the probability to undertake a RTC. This result seems to highlight that firms that can manage the liabilities arising from large distances in the first step of internationalization are better equipped to manage the next step and to pursue their cross-border expansion by relocating activities from country to country. Future studies could investigate this topic in greater depth, by exploring the role of other distances (e.g., institutional, geographic, travel time etc.) in affecting the RSDs' strategies.

Our results allow us to emphasize, as a policy implication, the crucial role of Industry 4.0 policies in re-attracting the domestic firms that are located abroad to leverage the Industry 4.0 innovation intensity ownership advantage, due to the opportunity to reduce the competitive gap with the foreign locations. In this respect, it is worth noting that Pieri et al. (2018) point out that "public incentives towards the adoption of intelligent technologies might spur productivity indirectly via inter-industry ICT spillovers" (p. 1850). However, it must be taken into account that policies under discussion "will yield large effects in the medium and long run, will exploit different transmission channels and produce heterogeneous impacts across industries" (ibid., p. 1843).

Our paper is not exempt from limitations, which, however, also represent the possibilities for further developing the investigated topic. First, future studies should try to investigate in greater depth the role of Industry 4.0 technology intensity by capturing not only the development but also the adoption of new technologies, given that firms can simply buy such technologies without developing them through in-house R&D. Second, other studies should try to capture more extensively the characteristics of the offshoring investment preceding the RSD choice, by looking not only at the country-level location advantages, but also at the firm-level drivers underlying each investment, e.g., by employing some *ad hoc* surveys. Third, future research could try to expand and refine the categories of RSDs, by looking, for instance, at the near-shoring and further-offshoring outside Europe. More in general, the RSDs involving also extra-European countries should be considered so to understand the geographic scope of the impact of Industry 4.0 technologies on RSDs. Fourth, scholars working on this topic should try to better disentangle the type of technologies involved in Industry 4.0 patenting activities as well as the type of policies implemented by home countries. As highlighted by Castagnoli et al. (2021), when it comes to location choices, "the different possible directions chosen by companies adopting Industry 4.0 depend on the technologies implemented". Finally, it would also be interesting to also explore the employment effects arising from RSDs that are fostered by Industry 4.0 technologies.

Despite these limitations, we believe that our paper represents one of the first attempts to provide a theoretical insight and empirical evidence on the relationship between the digital revolution and the location advantages, by shedding some light on the internationalization and RSD patterns of MNEs.

REFERENCES

Agrawal, A., Gans, J., & Goldfarb, A. (2019). *The economics of artificial intelligence: an agenda*. University of Chicago Press.

Alcácer, J., Cantwell, J., & Piscitello, L. (2016). Internationalization in the information age: A new era for places, firms, and international business networks? *Journal of International Business Studies*, *47*(5), 499–512. https://doi.org/10.1057/jibs.2016.22

Ancarani, A., & Di Mauro, C. (2018). Reshoring and Industry 4.0: how often do they go together? *IEEE Engineering Management Review*, *46*(2), 87–96.

Ancarani, A., Di Mauro, C., Fratocchi, L., Orzes, G., & Sartor, M. (2015). Prior to reshoring: A duration analysis of foreign manufacturing ventures. *International Journal of Production Economics*, *169*, 141–155. https://doi.org/10.1016/j.ijpe.2015.07.031

Ancarani, A., Di Mauro, C., & Mascali, F. (2019). Backshoring strategy and the adoption of Industry 4.0: Evidence from Europe. *Journal of World Business*, *54*(4), 360–371. https://doi.org/10.1016/j.jwb.2019.04.003

Andersson, J. (2018). *Is apparel manufacturing coming home? | McKinsey*. https://www.mckinsey.com/industries/retail/our-insights/is-apparel-manufacturing-coming-home

Arlbjørn, J. S., & Lüthje, T. (2012). Global operations and their interaction with supply chain performance. *Industrial Management and Data Systems*, *112*(7), 1044–1064. https://doi.org/10.1108/02635571211255014

Arlbjørn, J. S., & Mikkelsen, O. S. (2014). Backshoring manufacturing: Notes on an important but under-researched theme. *Journal of Purchasing and Supply Management*, *20*(1), 60–62. https://doi.org/10.1016/j.pursup.2014.02.003

Arregle, J. L., Beamish, P. W., & Hébert, L. (2009). The regional dimension of MNEs' foreign subsidiary localization. *Journal of International Business Studies*, *40*(1), 86–107. https://doi.org/10.1057/jibs.2008.67

Asmussen, C. G. (2009). Local, regional, or global Quantifying MNE geographic scope. *Journal of International Business Studies*, *40*(7), 86–107. https://doi.org/10.1057/jibs.2008.85

Bailey, D., & De Propris, L. (2014). Reshoring: Opportunities and limits for manufacturing in the UK - The case of the auto sector. *Revue d'Economie Industrielle*, *145*(1), 45–61. https://doi.org/10.4000/rei.5732

Bals, L., Kirchoff, J. F., & Foerstl, K. (2016). Exploring the reshoring and insourcing decision making process: toward an agenda for future research. *Operations Management Research*, *9*(3–4), 102–116. https://doi.org/10.1007/s12063-016-0113-0

Banalieva, E. R., & Dhanaraj, C. (2019). Internalization theory for the digital economy. *Journal of International Business Studies*, 1–16. https://doi.org/10.1057/s41267-019-00243-7

Barbieri, P., Ciabuschi, F., Fratocchi, L., & Vignoli, M. (2018). What do we know about manufacturing reshoring? *Journal of Global Operations and Strategic Sourcing*, *11*(1), 79–122. https://doi.org/10.1108/JGOSS-02-2017-0004

Barbieri, P., Elia, S., Fratocchi, L., & Golini, R. (2019). Relocation of second degree: Moving towards a new place or returning home? *Journal of Purchasing and Supply Management*,

25(3).
Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, *17*, 99–120. https://doi.org/10.1177/014920639101700108
Becchetti, L., & Rossi, S. P. S. (2000). The Positive Effect of Industrial District on the Export Performance of Italian Firms. *Review OfIndustrial Organization*, *16*, 53–68.
Behrens, V., & Trunschke, M. (2020). *Industry 4.0 related innovation and firm growth* (No. 20–070; ZEW Discussion Papers).
Berry, H., Guillén, M. F., & Zhou, N. (2010). An institutional approach to cross-national distance. *Journal of International Business Studies*, *41*(9), 1460–1480.
Bertrand, O., & Capron, L. (2015). Productivity enhancement at home via cross-border acquisitions: The roles of learning and contemporaneous domestic investments. *Strategic Management Journal*, *36*(5), 640–658.
Bettiol, M., Chiarvesio, M., Di Maria, E., Di Stefano, C., & Fratocchi, L. (2019). What happens after offshoring? A comprehensive framework. In *Progress in International Business Research* (Vol. 14). https://doi.org/10.1108/S1745-886220190000014013
Boeh, K. K., & Beamish, P. W. (2012). Travel time and the liability of distance in foreign direct investment: Location choice and entry mode. *Journal of International Business Studies*, *43*(5), 525–535.
Brennan, L., Ferdows, K., Godsell, J., Golini, R., Keegan, R., Kinkel, S., Srai, J. S., & Taylor, M. (2015). Manufacturing in the world: where next? *International Journal of Operations & Production Management*, *35*(9), 1253–1274. https://doi.org/10.1108/IJOPM-03-2015-0135
Bresnahan, T. F., & Trajtenberg, M. (1995). General purpose technologies 'Engines of growth'? *Journal of Econometrics*, *65*(1), 83–108.
Briggs, K., & Park, W. G. (2013). There will be exports and licensing: The effects of patent rights and innovation on firm sales. *Journal of International Trade and Economic Development*, *23*(8), 1112–1144. https://doi.org/10.1080/09638199.2013.843199
Buckley, P. J. (2011). International Integration and Coordination in the Global Factory. *MIR: Management International Review*, *51*(2), 269–283.
Buckley, P. J., Clegg, L. J., Cross, A. R., Liu, X., Voss, H., & Zheng, P. (2007). The Determinants of Chinese Outward Foreign Direct Investment. *Journal of International Business Studies*, *38*(4), 499–518.
Buckley, P. J., & Ghauri, P. N. (2004). Globalisation, economic geography and the strategy of multinational enterprises. *Journal of International Business Studies*, *35*(2), 81–98.
Butollo, F. (2020). Digitalization and the geographies of production: Towards reshoring or global fragmentation? *Competition and Change*, 1–20. https://doi.org/10.1177/1024529420918160
Canham, S., & Hamilton, R. T. (2013). SME internationalisation: Offshoring, backshoring, or staying at home in New Zealand. *Strategic Outsourcing: An International Journal*, *6*(3), 277–291. https://doi.org/10.1108/SO-06-2013-0011
Casson, M. (2013). Economic analysis of international supply chains: An internalization perspective. *Journal of Supply Chain Management*, *49*(2), 8–13. https://doi.org/10.1111/jscm.12009
Castagnoli, R., Büchi, G., Coeurderoy, R., & Cugno, M. (2021). Evolution of Industry 4.0 and International Business: A Systematic Literature Review and a Research Agenda. *European Management Journal*.
Caves, R. E. (1996). *Multinational enterprise and economic analysis*. Cambridge university press.
Chen, J., Sousa, C. M. P., & He, X. (2019). Export market re-entry: Time-out period and price/quality dynamisms. *Journal of World Business*, *54*(2), 154–168.

https://doi.org/10.1016/j.jwb.2019.01.001
Chen, W., & Kamal, F. (2016). The impact of information and communication technology adoption on multinational firm boundary decisions. *Journal of International Business Studies*, *47*(5), 563–576. https://doi.org/10.1057/jibs.2016.6
Chiarvesio, M., & Romanello, R. (2018). Industry 4.0 Technologies and Internationalization: Insights from Italian Companies. In *International Business in the Information and Digital Age* (pp. 357–378). Emerald Publishing Limited.
Ciabuschi, F., Lindahl, O., Barbieri, P., & Fratocchi, L. (2019). Manufacturing reshoring: A strategy to manage risk and commitment in the logic of the internationalization process model. *European Business Review*, *31*(1), 139–159. https://doi.org/10.1108/EBR-02-2018-0046
Cockburn, I. M., Henderson, R., & Stern, S. (2019). *4. The Impact of Artificial Intelligence on Innovation: An Exploratory Analysis*. University of Chicago Press.
Contractor, F. J., Kumar, V., Kundu, S. K., & Pedersen, T. (2010). Reconceptualizing the firm in a world of outsourcing and offshoring: The organizational and geographical relocation of high-value company functions. *Journal of Management Studies*, *47*(8), 1417–1433. https://doi.org/10.1111/j.1467-6486.2010.00945.x
Culot, G., Nassimbeni, G., Orzes, G., & Sartor, M. (2020). International Journal of Production Economics Behind the definition of Industry 4 . 0 : Analysis and open questions. *International Journal of Production Economics*, *226*(October 2019), 107617. https://doi.org/10.1016/j.ijpe.2020.107617
Dachs, B, Kinkel, S., & Jäger, A. (2017). Bringing It All Back Home? Backshoring of Manufacturing Activities and the Adoption of Industry 4.0 Technologies. *Munich Personal RePEc Archive Bringing*, *83167*, 1–32.
Dachs, Bernhard, Kinkel, S., & Jäger, A. (2019a). Bringing it all back home? Backshoring of manufacturing activities and the adoption of Industry 4.0 technologies. *Journal of World Business*, *54*(6), 101017. https://doi.org/10.1016/j.jwb.2019.101017
Dachs, Bernhard, Kinkel, S., Jäger, A., & Palčič, I. (2019b). Backshoring of production activities in European manufacturing. *Journal of Purchasing and Supply Management*, *25*(3). https://doi.org/10.1016/j.pursup.2019.02.003
Dalenogare, L. S., Benitez, G. B., Ayala, N. F., & Frank, A. G. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, *204*, 383–394. https://doi.org/10.1016/j.ijpe.2018.08.019
Davies, R. (2015). Industry 4.0. Digitalisation for productivity and growth. In *European Parliamentary Research Service* (Issue September).
De Backer, K., Menon, C., Desnoyers-james, I., & Moussiegt, L. (2016). *Reshoring : Myth or Reality ?* (OECD Science, Technology and Industry Policy Papers, Issue 27). https://doi.org/http://dx.doi.org/10.1787/5jm56frbm38s-en
Deloitte. (2018). *Deloitte Review: Industry 4.0 : Are you ready? 22*.
Di Mauro, C., Fratocchi, L., Orzes, G., & Sartor, M. (2018). Offshoring and backshoring: A multiple case study analysis. *Journal of Purchasing and Supply Management*, *24*(2), 108–134. https://doi.org/10.1016/j.pursup.2017.07.003
Dunning, J. H. (1980). Toward an Eclectic Theory of International Production: Some Empirical Tests. *Journal of International Business Studies*, *11*(1), 9–31. https://doi.org/10.1057/palgrave.jibs.8490593
Dunning, J. H. (1988). The Electric Paradigm Of International Production : A Restatment and Some Possible Extensions. *Journal of International Business Studies*, *19*(1), 1. https://doi.org/10.1057/palgrave.jibs.8490372
Dunning, J. H. (1993). *Multinational enterprises and the global economy*. Addison-Wesley.
Dunning, J. H., & Lundan, S. M. (2008). *Multinational enterprises and the global economy*.

Edward Elgar Publishing.
Elia, S., Fratocchi, L., Barbieri, P., Boffelli, A., & Kalchschmidt, M. (2021). Post-pandemic reconfiguration from global to domestic and regional value chains: the role of industrial policies. *Transnational Corporations*, *In Press*.
Ellram, L. M., Tate, W. L., & Petersen, K. J. (2013). Offshoring and reshoring: an update on the manufacturing location decision. *Journal of Supply Chain Management*, *49*(2), 14–22. https://doi.org/10.1111/jscm.12019
Enderwick, P., & Buckley, P. J. (2020). Rising regionalization: Will the post-COVID-19 world see a retreat from globalization. *Transnational Corporations*, *27*(2), 99–112. https://doi.org/10.18356/8008753a-en
Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, *210*(January), 15–26. https://doi.org/10.1016/j.ijpe.2019.01.004
Fratocchi, L. (2018). Additive manufacturing technologies as a reshoring enabler: A why, where and how approach. *World Review of Intermodal Transportation Research*, *7*(3), 264–293. https://doi.org/10.1504/WRITR.2018.093565
Fratocchi, L., Ancarani, A., Barbieri, P., Di Mauro, C., Nassimbeni, G., Sartor, M., Vignoli, M., & Zanoni, A. (2015). Manufacturing Back-Reshoring as a Nonlinear Internationalization Process. In *The Future of Global Organizing* (Vol. 10, pp. 365–403). https://doi.org/10.1108/S1745-8862201510
Fratocchi, L., & Di Stefano, C. (2020). Do industry 4.0 technologies matter when companies backshore manufacturing activities? An explorative study comparing Europe and the US. In *Knowledge Management and Organizational Learning* (Vol. 9). https://doi.org/10.1007/978-3-030-43589-9_3
Gambardella, A., Harhoff, D., & Verspagen, B. (2008). *The value of European patents*. *5*, 69–84.
Gereffi, G., & Lee, J. (2012). Why the World Suddenly Cares About Global Supply Chains. *Journal of Supply Chain Management*, *48*(3), 24–32. https://doi.org/10.1111/j.1745-493X.2012.03271.x
Haleem, F., Farooq, S., Wæhrens, B. V., & Boer, H. (2018). Offshoring experience and performance: the role of realized drivers and risk management. *Supply Chain Management*, *23*(6), 531–544. https://doi.org/10.1108/SCM-02-2018-0074
Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. Sage publications.
Hymer, S. H. (1976). The international operations of national firms: A study of direct foreign investment, 1960. *MIT Monographs in Economics, Cambridge, Massachusetts*.
Johanson, J., & Vahlne, J.-E. (2009). The Uppsala internationalization process model revisited: From liability of foreignness to liability of outsidership. *Journal of International Business Studies*, *40*(9), 1411–1431.
Kagermann, H., Helbig, J., Hellinger, A., Wahlster, W., Kagerman, H., Wahlster, W., & Helbig, J. (2013). Recommendations for implementing the strategic initiative INDUSTRIE 4.0: Securing the future of German manufacturing industry; final report of the Industrie 4.0 Working Group. In *Final report of the Industrie 4.0 Working Group*. Forschungsunion.
Kamp, B., & Gibaja, J. J. (2021). Adoption of digital technologies and backshoring decisions: is there a link? *Operations Management Research*, *In Press*. https://doi.org/10.1007/s12063-021-00202-2
Kano, L., Tsang, E. W. K., & Yeung, H. W. chung. (2020). Global value chains: A review of the multi-disciplinary literature. *Journal of International Business Studies*, *51*, 577–622. https://doi.org/10.1057/s41267-020-00304-2
Kedia, B. L., & Mukherjee, D. (2009). Understanding offshoring: A research framework based

on disintegration, location and externalization advantages. *Journal of World Business*, *44*(3), 250–261. https://doi.org/10.1016/j.jwb.2008.08.005
Kinkel, S. (2014). Future and impact of backshoring-Some conclusions from 15 years of research on German practices. *Journal of Purchasing and Supply Management*, *20*(1), 63–65. https://doi.org/10.1016/j.pursup.2014.01.005
Kinkel, S. (2020). Industry 4.0 and reshoring. In L. De Propris & D. Bailey (Eds.), *Industry 4.0 and Regional Transformations* (pp. 195–213). Routledge.
Kinkel, S., & Maloca, S. (2009). Drivers and antecedents of manufacturing offshoring and backshoring-A German perspective. *Journal of Purchasing and Supply Management*, *15*(3), 154–165. https://doi.org/10.1016/j.pursup.2009.05.007
Kirbach, M., & Schmiedeberg, C. (2008). INNOVATION AND EXPORT PERFORMANCE : ADJUSTMENT AND REMAINING DIFFERENCES IN EAST AND WEST GERMAN MANUFACTURING PERFORMANCE : ADJUSTMENT AND REMAINING DIFFERENCES IN EAST AND INNOVATION AND EXPORT PERFORMANCE : *Economics of Innovation and New Technology*, *17*(5), 435–457. https://doi.org/10.1080/10438590701357189
Lasi, H., Fettke, P., Kemper, H. G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business and Information Systems Engineering*, *6*(4), 239–242. https://doi.org/10.1007/s12599-014-0334-4
Leamer, E., & Storper, M. (2001). *``The economic geography of the Internet age''WP 8450*. National Bureau of Economic Research, Cambridge, MA.
Lee, J., Bagheri, B., & Kao, H. A. (2015). A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems. *Manufacturing Letters*, *3*, 18–23. https://doi.org/10.1016/j.mfglet.2014.12.001
Lejpras, A. (2015). Knowledge, location, and internationalization: empirical evidence for manufacturing SMEs. *Economics of Innovation and New Technology*, *24*(8), 734–754. https://doi.org/10.1080/10438599.2014.997460
Lewin, A. Y., & Couto, V. (2007). *Next generation offshoring: The globalization of innovation: 2006 Survey report*. Duke center for international business education and research (CIBER).
Lindner, T., Puck, J., & Verbeke, A. (2020). Misconceptions about multicollinearity in international business research : Identification , consequences , and remedies. *Journal of International Business Studies*, *51*(3), 283–298. https://doi.org/10.1057/s41267-019-00257-1
Lundan, S. M. (2010). What are Ownership Advantages ? *The Multinational Business Review*, *18*(2), 51–70.
Manning, S. (2014). Mitigate, tolerate or relocate? Offshoring challenges, strategic imperatives and resource constraints. *Journal of World Business*, *49*, 522–535. https://doi.org/10.1016/j.jwb.2013.12.006
Martínez-Mora, C., & Merino, F. (2014). Offshoring in the Spanish footwear industry: A return journey? *Journal of Purchasing and Supply Management*, *20*(4), 225–237. https://doi.org/10.1016/j.pursup.2014.07.001
Meniere, Y., Rudyk, I., & Valdes, J. (2017). *Patents and the Fourth Industrial Revolution* (Issue December).
Monaghan, S., Tippmann, E., & Coviello, N. (2020). Born digitals: Thoughts on their internationalization and a research agenda. *Journal of International Business Studies*, *51*(1), 11–22.
Moradlou, H., & Tate, W. (2018). Reshoring and additive manufacturing. *World Review of Intermodal Transportation Research*, *7*(3), 241–263. https://doi.org/10.1504/WRITR.2018.093564

Mudambi, R. (2008). Location, control and innovation in knowledge-intensive industries. *Journal of Economic Geography*, *8*(5), 699–725. https://doi.org/10.1093/jeg/lbn024
Mudambi, Ram, Narula, R., & Santangelo, G. D. (2018). *Location, collocation and innovation by multinational enterprises: A research agenda*. Taylor & Francis.
Müller, J., Dotzauer, V., & Voigt, K. I. (2017). *Supply Management Research*. 165–179. https://doi.org/10.1007/978-3-658-18632-6
Nachum, L., & Zaheer, S. (2005). The persistence of distance? The impact of technology on MNE motivations for foreign investment. *Strategic Management Journal*, *26*(8), 747–767.
Nam, H. J., & An, Y. (2017). Patent, R&D and internationalization for Korean healthcare industry. *Technological Forecasting and Social Change*, *117*, 131–137. https://doi.org/10.1016/j.techfore.2016.12.008
Narula, R. (2014). Exploring the paradox of competence-creating subsidiaries: Balancing bandwidth and dispersion in MNEs. *Long Range Planning*, *47*(1–2), 4–15. https://doi.org/10.1016/j.lrp.2013.10.006
Narula, R., & Santangelo, G. D. (2012). Location and collocation advantages in international innovation. *Multinational Business Review*.
Nohria, N., & Ghoshal, S. (1997). *The differentiated network: Organizing multinational corporations for value creation*. Jossey-Bass Publishers.
Ó hUallacháin, B., Douma, J., & Kane, K. (2018). Globalizing manufacturing but not invention : automotive transplants in the United States. *Regional Studies*, *52*(6), 816–827. https://doi.org/10.1080/00343404.2017.1366652
Peteraf, M. A. (1993). The Cornerstones of Competitive Advantage : A Resource-Based. *Strategic Management Journal*, *14*(3), 179–191.
Pieri, F., Vecchi, M., & Venturini, F. (2018). Modelling the joint impact of R&D and ICT on productivity: A frontier analysis approach. *Research Policy*, *47*(9), 1842–1852.
Porter, M. E., & Heppelmann, J. E. (2014). How Smart, Connected Product Are Transforming Competition. *Harvard Business Review*, *November*, 64–89. https://doi.org/10.1017/CBO9781107415324.004
Reuer, J. J., & Lahiri, N. (2014). Searching for alliance partners: Effects of geographic distance on the formation of R&D collaborations. *Organization Science*, *25*(1), 283–298.
Robinson, D. K. R., & Mazzucato, M. (2019). The evolution of mission-oriented policies: Exploring changing market creating policies in the US and European space sector. *Research Policy*, *48*(4), 936–948.
Rugman, A. M., & Verbeke, A. (2004). A perspective on regional and global strategies of multinational enterprises. *Journal of International Business Studies*, *35*(1), 3–18. https://doi.org/10.1057/palgrave.jibs.8400073
Schlaepfer, R. C., Koch, M., & Merkofer, P. (2015). *Industry 4.0 challenges and solutions for the digital transformation and use of exponential technologies*.
Schlegelmilch, A. B. B., & Crook, J. N. (1988). Firm-level Determinants of Export Intensity. *Managerial and Decision Economics*, *9*(4), 291–300.
Schmeisser, B. (2013). A systematic review of literature on offshoring of value chain activities. *Journal of International Management*, *19*(4), 390–406. https://doi.org/10.1016/j.intman.2013.03.011
Stentoft, J., Olhager, J., Heikkilä, J., & Thoms, L. (2016). Manufacturing backshoring: a systematic literature review. *Operations Management Research*, *9*(3–4), 53–61. https://doi.org/10.1007/s12063-016-0111-2
Stentoft, J., & Rajkumar, C. (2019). The relevance of Industry 4.0 and its relationship with moving manufacturing out, back and staying at home. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2019.1660823
Strange, R., & Zucchella, A. (2017). Industry 4.0, global value chains and international

business. *Multnational Business Review*, *25*(3), 174–184. https://doi.org//10.1108/MRR-09-2015-0216
Surdu, I., Mellahi, K., Glaister, K. W., & Nardella, G. (2018). Why wait? Organizational learning, institutional quality and the speed of foreign market re-entry after initial entry and exit. *Journal of World Business*, *53*(6), 911–929. https://doi.org/10.1016/j.jwb.2018.07.008
The Economist. (2013). *Here, there and everywhere: Special Report Outsourcing and Offshoring.* https://doi.org/10.1214/088342306000000097
Tomiura, E. (2005). Technological capability and FDI in Asia: Firm-level relationships among Japanese manufacturers. *Asian Economic Journal*, *19*(3), 273–289. https://doi.org/10.1111/j.1467-8381.2005.00213.x
UNCTAD. (2020). *World Investment Report 2020: International production beyond the pandemic*. https://doi.org/10.1057/s42214-020-00078-2
Wang, C., Hsu, L., & Fang, S. (2008). Technological Forecasting & Social Change The determinants of internationalization : Evidence from the Taiwan high technology industry. *Technological Forecasting & Social Change*, *75*(9), 1388–1395. https://doi.org/10.1016/j.techfore.2008.03.002
Wiesmann, B., Snoei, J. R., Hilletofth, P., & Eriksson, D. (2017). Drivers and barriers to reshoring: a literature review on offshoring in reverse. *European Business Review*, *29*(1), 15–42. https://doi.org/10.1108/EBR-03-2016-0050

TABLES AND FIGURES

Table 1: Extant empirical studies on the relationship between Industry 4.0 and RHC.

Study	Method	Sample	Measure of Industry 4.0 technology (when applicable)	Main Findings
Müller et al. (2017)	Survey	50 German companies	-	The assessment of Industry 4.0 leading to backshoring is not corroborated.
Ancarani and Di Mauro (2018)	Secondary data analysis	840 backshoring initiatives	Explicit claim of the adoption of one (or more) I4.0 technology	Reshoring companies do not seem to make use of capital investment in technology more often than generally done in manufacturing.
Chiarvesio and Romanello (2018)	Case studies	16 Italian companies	BCG's 9 Pillars of Technological Advancement	No clear and direct relationship among investments in Industry 4.0 and international activities is identified. Despite the Industry 4.0 investments made in the main factories in the home countries, none of the companies that had formerly invested in production subsidiaries in low-cost countries have backshored yet or have plans to do so.
Ancarani et al. (2019)	Secondary data analysis	495 backshoring initiatives	Explicit claim of the adoption of one (or more) I4.0 technologies	Backshoring has largely taken place without investments in new technologies to date. Among backshoring firms, the degree of adoption of Industry 4.0 is more frequently associated with issues in (a) quality and offshore complexity, and (b) costs of non-compliance.
Dachs et al. (2019a)	Survey	1705 companies from Germany, Austria and Switzerland	I4.0 index (additive involvement index capturing the weighted utilization of 8 I4.0 technologies)	Positive and significant association between reshoring propensity and the use of Industry 4.0 technologies.
Stentoft & Rajkumar (2019)	Survey	270 Danish companies	Likert scales on knowledge/relevance/adoption of technologies	Industry 4.0 has no substantial impact on companies that have remained domestic, moved manufacturing back, and moved manufacturing out and back.
Fratocchi and Di Stefano (2020)	Secondary data analysis	1279 instances of backshoring decisions	Explicit claim of the adoption of one (or more) I4.0 technologies as a reshoring driver	Automation and 3D printing are the only Industry 4.0s cited by reshoring companies. However, while the former technology was cited by around 13% of both EU and US sampled companies, the latter was rarely implemented (around 2%) and almost exclusively by US ones.
Kamp and Gibaja (2021)	Survey and case studies	Survey: 63 Basque companies; Case studies:	Composite I4.0 indicator based on BCG's 9 Pillars of Technological Advancement (Russmann et al., 2015) and the European Commission's	Larger amount of Industry 4.0 technologies does not seem to lead to a bigger chance on backshoring (6% of the sub-sample agreed that Industry 4.0 can impact the decision to

	9 Basque companies	Digital Transformation Monitor (2018)	backshore, and actually made concrete decisions to backshore production activities, while another 21% indicated that Industry 4.0 could make future backshoring decisions plausible)

Table 2: Distribution of RHC, RTC and RSDs over the years.

Years	**RHCs**		**RTCs**		**RSDs**	
	No.	**%**	**No.**	**%**	**No.**	**%**
2003	1	2.44	4	5.19	5	4.24
2004	1	2.44	3	3.90	4	3.39
2005	4	9.76	8	10.39	12	10.17
2006	4	9.76	16	20.78	20	16.95
2007	8	19.51	8	10.39	16	13.56
2008	2	4.88	9	11.69	11	9.32
2009	8	19.51	5	6.49	13	11.02
2010	1	2.44	1	1.30	2	1.69
2011	1	2.44	4	5.19	5	4.24
2012	4	9.76	4	5.19	8	6.78
2013	3	7.32	3	3.90	6	5.08
2014	4	9.76	10	12.99	14	11.86
2015	0	0.00	2	2.60	2	1.69
Totals	**41**	**100.00**	**77**	**100.00**	**118**	**100.00**

Table 3: Distribution of RHC, RTC and RSDs across the industries.

NACE Codes	NACE Descriptions	RHC		RTC		RSDs	
		No.	%	No.	%	No.	%
10	Manufacture of food products	2	4.88	5	6.49	7	5.93
12	Manufacture of tobacco products	1	2.44	5	6.49	6	5.08
20	Manufacture of chemicals and chemical products	5	12.20	8	10.39	13	11.02
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	2	4.88	4	5.19	6	5.08
22	Manufacture of rubber and plastic products	1	2.44	2	2.60	3	2.54
24	Manufacture of basic metals	1	2.44	2	2.60	3	2.54
25	Manufacture of fabricated metal products, except machinery and equipment	1	2.44	5	6.49	6	5.08
26	Manufacture of computer, electronic and optical products	3	7.32	6	7.79	9	7.63
27	Manufacture of electrical equipment	5	12.20	16	20.78	21	17.80
28	Manufacture of machinery and not electrical equipment	3	7.32	8	10.39	11	9.32
29	Manufacture of motor vehicles, trailers and semi-trailers	12	29.27	11	14.29	23	19.49
30	Manufacture of other transport equipment	5	12.20	5	6.49	10	8.47
	Totals	**41**	**100.00**	**77**	**100.00**	**118**	**100.00**

Table 4: Distribution of RSDs across home, first host and second host countries.

Countries	Home		First host		Second host	
	No.	%	No.	%	No.	%
Austria	2	1.69	6	5.08	4	3.39
Belgium	4	3.39	6	5.08	2	1.69
Bulgaria	-	-	1	0.85	-	-
Czech Republic	1	0.85	5	4.24	10	8.47
Denmark			3	2.54	1	0.85
Finland	11	9.32	6	5.08	2	1.69
France	18	15.25	14	11.86	10	8.47
Germany	36	30.51	10	8.47	21	17.8
Greece	-	-	-	-	1	0.85
Hungary	-	-	5	4.24	6	5.08
Ireland	-	-	6	5.08	1	0.85
Italy	9	7.63	17	14.41	4	3.39
The Netherlands	3	2.54	6	5.08	4	3.39
Norway	1	0.85	-	-	-	-
Poland	-	-	3	2.54	22	18.64
Portugal	-	-	2	1.69	-	-
Romania	-	-	2	1.69	9	7.63
Russian Federation	-	-	-	-	2	1.69
Slovakia	-	-	1	0.85	4	3.39
Slovenia	1	0.85	1	0.85	3	2.54
Spain	1	0.85	7	5.93	1	0.85
Sweden	14	11.86	7	5.93	5	4.24
Switzerland	3	2.54	-	-	1	0.85
United Kingdom	14	11.86	10	8.47	5	4.24
Total	**118**	**100**	**118**	**100**	**118**	**100**

Table 5: Correlation matrix and descriptive statistics of the dependent and explicative variables

	Variables	**1)**	**2)**	**3)**	**4)**	**5)**	**6)**	**7)**	**8)**	**9)**	**10)**
1)	*RTC*	1.000									
2)	*Firm's Industry 4.0 innovation intensity ownership advantage*	0.011	1.000								
3)	*Home country Industry 4.0 policy-based location advantage*	-0.074	0.154	1.000							
4)	*First host country cost-saving location advantage over the home country*	0.091	0.141	0.143	1.000						
5)	*First host country productivity-enhancing location advantage over the home country*	0.544	-0.005	-0.044	-0.127	1.000					
6)	*First host country market-seeking location advantage over the home country*	0.009	-0.001	-0.031	-0.228	0.504	1.000				
7)	*First host country strategic asset-seeking location advantage over the home country*	-0.045	0.101	0.050	-0.033	0.006	0.235	1.000			
8)	*Post Crisis*	-0.064	-0.014	0.224	0.098	-0.060	-0.080	-0.162	1.000		
9)	*Firm Size*	-0.209	0.175	0.034	-0.042	-0.227	-0.026	0.001	-0.072	1.000	
10)	*Cultural distance*	0.144	-0.057	-0.151	0.036	0.101	0.006	0.079	-0.057	-0.095	1.000
	Observations	118	118	118	118	118	118	118	118	118	118
	Mean	0.653	1858.458	0.051	0.527	13147.930	-2592.635	-779.011	0.517	25800000	1.578
	Std. Dev.	0.478	6299.119	0.221	4.829	25544.970	7670.186	1926.303	0.502	50300000	1.543
	Min	0.000	0.000	0.000	-16.156	-48298.300	-27758.110	-4977.518	0.000	24.337	0.000
	Max	1.000	34707.000	1.000	9.991	68355.700	15732.480	6172.175	1.000	330000000	8.993

Table 6: Results of the Robust Probit Regressions – main model (dependent variable: RTC)

Variables	Baseline model		Interaction model	
	Coefficient (i)	Marginal effects (ii)	Coefficient (iii)	Marginal effects (iv)
Firm's Industry 4.0 innovation intensity ownership advantage	0.285**	0.052**	0.475***	0.080***
	(0.019)	(0.026)	(0.001)	(0.006)
Home country Industry 4.0 policy-based location advantage	0.354	0.052	0.840	0.084**
	(0.677)	(0.590)	(0.319)	(0.049)
First host country cost-saving location advantage	0.786***	0.142***	0.854***	0.144***
over the home country	(0.002)	(0.002)	(0.002)	(0.002)
First host country productivity-enhancing location	2.577***	0.466***	2.611***	0.439***
advantage over the home country	(0.000)	(0.000)	(0.000)	(0.000)
First host country market-seeking location advantage	-1.577***	-0.285***	-1.535***	-0.258***
over the home country	(0.000)	(0.002)	(0.000)	(0.003)
First host country strategic asset-seeking location	-0.086	-0.015	-0.037	-0.006
advantage over the home country	(0.654)	(0.647)	(0.848)	(0.847)
Post Crisis	-0.452	-0.086	-0.576	-0.103
	(0.269)	(0.279)	(0.184)	(0.201)
Firm Size	-0.213	-0.038	-0.121	-0.020
	(0.237)	(0.234)	(0.377)	(0.371)
Cultural distance	0.415**	0.075**	0.465**	0.078**
	(0.024)	(0.020)	(0.018)	(0.011)
*Firm's Industry 4.0 innovation intensity ownership advantage * Home country Industry 4.0 policy-based location advantage*	-	-	-0.782***	-0.132***
			(0.000)	(0.005)
Industry dummies	yes	yes	yes	yes
Constant	2.068		2.169**	
	(0.034)		(0.033)	
Observations	118		118	
Chi Square	71.138***		106.619***	

Please note: * p< 0.10, ** p < 0.05, *** p < 0.01. Standard Errors between brackets.

Table 7: Results of the Robust Probit Regressions – Model with Home country Industry 4.0 policy (dependent variable: RTC)

Variables	**Baseline model**		**Interaction model**	
	Coefficient (i)	**Marginal effects (ii)**	**Coefficient (iii)**	**Marginal effects (iv)**
Firm's Industry 4.0 innovation intensity ownership advantage	0.290**	0.052**	0.472***	0.080***
	(0.017)	(0.023)	(0.001)	(0.005)
Home country Industry 4.0 policy	0.696	0.085	0.961	0.094**
	(0.362)	(0.155)	(0.247)	(0.027)
First host country cost-saving location advantage	0.809***	0.146***	0.860***	0.146***
over the home country	(0.002)	(0.002)	(0.001)	(0.002)
First host country productivity-enhancing location	2.590***	0.466***	2.580***	0.438***
advantage over the home country	(0.000)	(0.000)	(0.000)	(0.000)
First host country market-seeking location advantage	-1.572***	-0.283***	-1.515***	-0.257***
over the home country	(0.000)	(0.002)	(0.000)	(0.003)
First host country strategic asset-seeking location	-0.089	-0.016	-0.036	-0.006
advantage over the home country	(0.642)	(0.635)	(0.852)	(0.850)
Post Crisis	-0.539	-0.103	-0.605	-0.110
	(0.181)	(0.194)	(0.157)	(0.176)
Firm Size	-0.217	-0.039	-0.120	-0.020
	(0.233)	(0.232)	(0.381)	(0.375)
Cultural distance	0.428**	0.077**	0.460**	0.078***
	(0.021)	(0.018)	(0.017)	(0.010)
*Firm's Industry 4.0 innovation intensity ownership advantage **	-	-	-0.757***	-0.129***
Home country Industry 4.0 policy			(0.000)	(0.004)
Industry dummies	yes	yes	yes	yes
Constant	2.139**		2.180**	
	(0.030)		(0.030)	
Observations	118		118	
Chi Square	70.961***		105.686***	

Please note: * p< 0.10, ** p < 0.05, *** p < 0.01. Standard Errors between brackets.

Table 8: Results of the Robust Probit Regressions – Model with Second host country characteristics (dependent variable: RTC)

Variables	Home country Industry 4.0 policy advantage		Home country Industry 4.0 policy	
	Base model (i)	Inter. Model (ii)	Base model (i)	Inter. Model (ii)
Firm's Industry 4.0 innovation intensity ownership advantage	0.277**	0.577***	0.290**	0.577***
	(0.019)	(0.004)	(0.015)	(0.004)
Home country Industry 4.0 policy-based location advantage	0.791	1.471*	-	-
	(0.379)	(0.096)		
Home country Industry 4.0 policy	-	-	1.183	1.632*
			(0.138)	(0.064)
First host country cost-saving location advantage	0.823***	0.915***	0.860***	0.919***
over the home country	(0.004)	(0.003)	(0.004)	(0.002)
First host country productivity-enhancing location	2.017***	2.071***	2.006***	2.024***
advantage over the home country	(0.001)	(0.001)	(0.001)	(0.001)
First host country market-seeking location advantage	-1.142**	-1.092**	-1.120**	-1.054**
over the home country	(0.011)	(0.016)	(0.014)	(0.020)
First host country strategic asset-seeking location	-0.194	-0.169	-0.199	-0.173
advantage over the home country	(0.436)	(0.485)	(0.430)	(0.474)
Second Host country production costs	0.191	0.254	0.146	0.224
	(0.691)	(0.588)	(0.765)	(0.632)
Second Host country productivity	-1.188	-1.580*	-1.251	-1.608*
	(0.125)	(0.069)	(0.114)	(0.068)
Second Host country market attractiveness	0.826	1.204*	0.864	1.226*
	(0.159)	(0.071)	(0.150)	(0.069)
Second Host country strategic assets	-0.545*	-0.599*	-0.565*	-0.603*
	(0.086)	(0.072)	(0.081)	(0.069)
Post Crisis	-1.032*	-1.429**	-1.121**	-1.446**
	(0.066)	(0.023)	(0.047)	(0.022)
Firm Size	-0.138	-0.010	-0.130	-0.007
	(0.349)	(0.937)	(0.366)	(0.955)
Cultural distance	0.539**	0.629***	0.553***	0.619***
	(0.011)	(0.007)	(0.010)	(0.007)
*Firm's Industry 4.0 innovation intensity ownership advantage **	-	-0.968***	-	-
Home country Industry 4.0 policy-based location advantage		(0.000)		
*Firm's Industry 4.0 innovation intensity ownership advantage **	-	-	-	-0.932***
Home country Industry 4.0 policy				(0.000)
Industry dummies	yes	yes	yes	yes
Constant	2.793**	3.242**	2.945**	3.268**
	(0.024)	(0.020)	(0.020)	(0.018)
Observations	118	118	118	118

Chi Square	59.036***	82.999***	54.718***	81.834***

Please note: * p< 0.10, ** p < 0.05, *** p < 0.01. Standard Errors between brackets.

Table 9: Results of the Robust Probit Models over the first host country

Variables	**Home country Industry 4.0 policy advantage**		**Home country Industry 4.0 policy**	
	Base model (i)	**Inter. Model (ii)**	**Base model (i)**	**Inter. Model (ii)**
Firm's Industry 4.0 innovation intensity ownership advantage	0.262**	0.528***	0.261**	0.530***
	(0.043)	(0.000)	(0.048)	(0.000)
Home country Industry 4.0 policy-based location advantage	-0.211	0.208	-	-
	(0.768)	(0.750)		
Home country Industry 4.0 policy	-	-	0.253	0.462
			(0.671)	(0.436)
Second host country cost-saving location advantage	0.500***	0.563***	0.514***	0.569***
over the first host country	(0.008)	(0.009)	(0.008)	(0.008)
Second host country productivity-enhancing location	-2.203***	-2.556***	-2.174***	-2.540***
advantage over the first host country	(0.000)	(0.000)	(0.000)	(0.000)
Second host country market-seeking location advantage	0.951**	1.230***	0.897**	1.222***
over the first host country	(0.018)	(0.008)	(0.020)	(0.008)
Second host country strategic asset-seeking location	-0.338*	-0.446**	-0.335*	-0.450**
advantage over the first host country	(0.073)	(0.038)	(0.075)	(0.036)
Post Crisis	-0.437	-0.602	-0.514	-0.639
	(0.241)	(0.139)	(0.159)	(0.112)
Firm Size	-0.283*	-0.152	-0.303*	-0.153
	(0.084)	(0.139)	(0.091)	(0.138)
Cultural distance	0.410***	0.543***	0.426***	0.544***
	(0.009)	(0.002)	(0.006)	(0.001)
*Firm's Industry 4.0 innovation intensity ownership advantage **	-	-1.014***	-	-
Home country Industry 4.0 policy-based location advantage		(0.000)		
*Firm's Industry 4.0 innovation intensity ownership advantage **	-	-	-	-1.027***
Home country Industry 4.0 policy				(0.000)
Industry dummies	yes	yes	yes	yes
Constant	1.465**	1.532*	1.545**	1.569*
	(0.046)	(0.064)	(0.036)	(0.057)
Observations	118	118	118	118
Chi Square	54.022***	75.975***	50.579***	81.292***

Please note: * p< 0.10, ** p < 0.05, *** p < 0.01. Standard Errors between brackets.

Table 10: Results of the Robust Probit Regressions – Model with Second Host country location advantages over the home country (dependent variable: RTC)

Variables	**Home country Industry 4.0 policy advantage**		**Home country Industry 4.0 policy**	
	Base model (i)	**Inter. Model (ii)**	**Base model (i)**	**Inter. Model (ii)**
Firm's Industry 4.0 innovation intensity ownership advantage	0.357**	0.625**	0.382**	0.616**
	(0.044)	(0.023)	(0.030)	(0.023)
Home country Industry 4.0 policy-based location advantage	1.506	1.745*	-	-
	(0.133)	(0.065)		
Home country Industry 4.0 policy	-	-	1.794**	1.907**
			(0.033)	(0.030)
Second host country cost-saving location advantage	-0.879*	-0.882*	-0.903**	-0.876*
over the home country	(0.054)	(0.072)	(0.042)	(0.064)
Second host country productivity-enhancing location	-3.166***	-3.344***	-3.233***	-3.332***
advantage over the home country	(0.001)	(0.001)	(0.001)	(0.001)
Second host country market-seeking location advantage	0.168	0.348	0.263	0.425
over the home country	(0.827)	(0.651)	(0.738)	(0.594)
Second host country strategic asset-seeking location	-0.350	-0.318	-0.355	-0.317
advantage over the home country	(0.270)	(0.315)	(0.228)	(0.287)
Post Crisis	-0.420	-0.445	-0.495	-0.496
	(0.424)	(0.436)	(0.348)	(0.380)
Firm Size	-0.448	-0.171	-0.435	-0.165
	(0.160)	(0.584)	(0.159)	(0.589)
Cultural distance	0.430**	0.456***	0.441***	0.450***
	(0.011)	(0.009)	(0.008)	(0.009)
*Firm's Industry 4.0 innovation intensity ownership advantage **	-	-0.903**	-	-
Home country Industry 4.0 policy-based location advantage		(0.012)		
*Firm's Industry 4.0 innovation intensity ownership advantage **	-	-	-	-0.854**
Home country Industry 4.0 policy				(0.014)
Industry dummies	yes	yes	yes	yes
Constant	3.099**	2.994**	3.119***	2.949**
	(0.011)	(0.013)	(0.009)	(0.012)
Observations	118	118	118	118
Chi Square	54.472***	91.119***	53.620***	94.635***

Please note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard Errors between brackets.

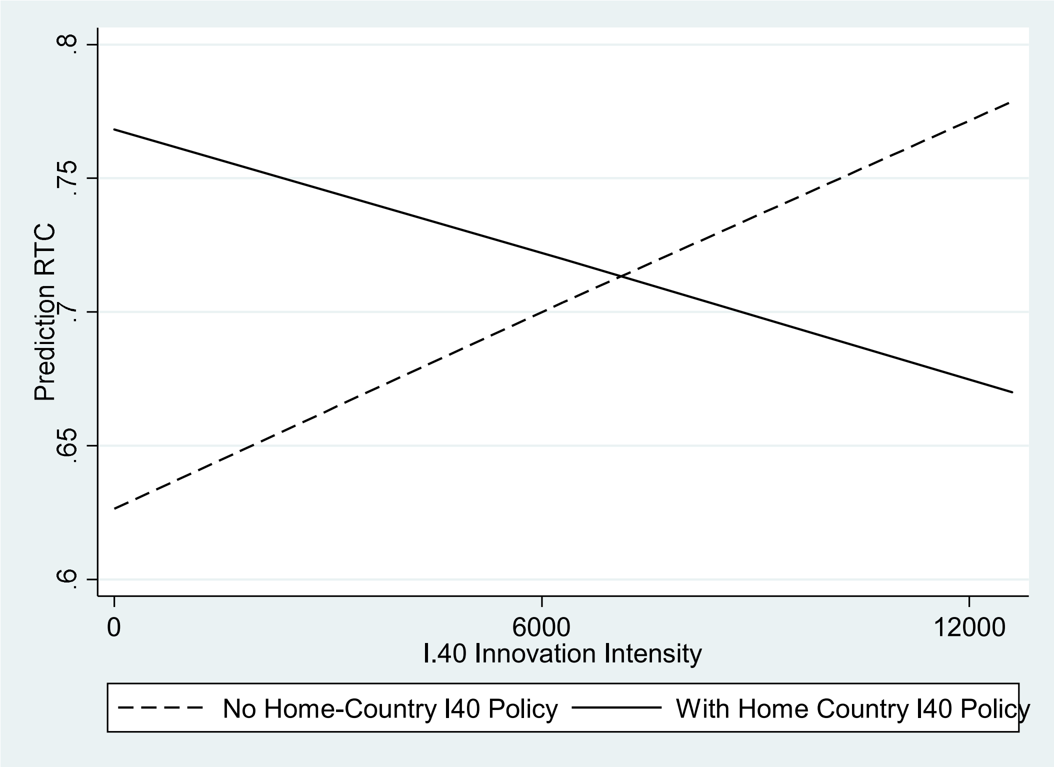
Table 11: Results of the Robust Probit Regressions – Model with interactions between the first host country location advantages over the home country and Industry 4.0 variables (dep. variable: RTC)

Variables	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Firm's Industry 4.0 innovation intensity ownership advantage	0.731**	0.121	0.292*	0.284*	0.520
	(0.007)	(0.492)	(0.016)	(0.021)	(0.360)
Home country Industry 4.0 policy-based location advantage	0.780	0.411	0.579	-0.991	-0.240
	(0.351)	(0.626)	(0.496)	(0.092)	(0.745)
First host country cost-saving location	0.349	0.788**	0.837**	0.802**	0.488
advantage over the home country	(0.165)	(0.003)	(0.003)	(0.002)	(0.146)
First host country productivity-enhancing	2.613***	2.580***	2.637***	2.619***	2.656***
location advantage over the home country	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
First host country market-seeking location	-1.545***	-1.618***	-1.645***	-1.603***	-1.607***
advantage over the home country	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
First host country strategic asset-seeking	-0.070	-0.080	-0.078	-0.093	-0.068
location advantage over the home country	(0.714)	(0.679)	(0.687)	(0.631)	(0.729)
Post Crisis	-0.607	-0.380	-0.526	-0.478	-0.660
	(0.159)	(0.365)	(0.198)	(0.240)	(0.130)
Firm Size	-0.161	-0.226	-0.215	-0.221	-0.163
	(0.221)	(0.256)	(0.242)	(0.234)	(0.234)
Cultural distance	0.476*	0.422*	0.425*	0.418*	0.482*
	(0.014)	(0.025)	(0.023)	(0.024)	(0.016)
*First host country cost-saving location advantage over the home country * Firm Industry 4.0 innovation intensity ownership advantage*	-1.823***				-1.466
	(0.000)				(0.161)
*First host country productivity-enhancing location advantage over the home country * Firm Industry 4.0 innovation intensity ownership advantage*		-0.216			-0.127
		(0.272)			(0.636)
*First host country cost-saving location advantage over the home country * Home country Industry 4.0 policy-based location advantage*			-1.066		-0.872
			(0.213)		(0.239)
*Host country productivity-enhancing advantage over the home country * Home country Industry 4.0 policy-based location advantage*				-2.446*	-2.022*
				(0.028)	(0.018)
Industry dummies	yes	yes	yes	yes	yes
	2.211**	1.999**	2.177**	2.116**	2.116**
Constant	(2.21)	(2.01)	(2.15)	(2.14)	(2.14)
Observations	118	118	118	118	118
Chi Square	81.671***	69.532***	68.822***	75.209***	75.209***

Please note: * p< 0.10, ** p < 0.05, *** p < 0.01. Standard Errors between brackets.

FIGURES

Figure 1: Plot of the interaction between *Firm's Industry 4.0 innovation intensity ownership advantage* and *Home country Industry 4.0 policy-based location advantage*



APPENDIX

Table A1: Distribution of RHCs across host and home (corresponding also to second host) countries.

First host countries (from which RHCs take place)	**Home countries of the companies undertaking RHCs (equal to the second host country towards which RHCs occur)**											
	Austria	Switzerland	Czech Republic	Germany	Finland	France	UK	Italy	The Netherlands	Slovenia	Sweden	Total
Austria	0	0	0	1	0	0	0	0	0	0	1	2
Belgium	0	0	0	1	0	0	0	0	0	0	1	2
Czech Republic	0	0	0	1	0	0	1	0	0	0	0	2
Germany	0	1	0	0	1	0	0	0	1	0	0	3
Denmark	0	0	0	1	1	0	0	0	0	0	0	2
Spain	0	0	0	3	0	1	0	1	0	0	0	5
France	0	0	0	2	0	0	1	0	0	0	0	3
UK	0	0	1	1	0	1	0	1	0	0	0	4
Ireland	0	0	0	0	0	1	1	0	0	0	1	3
Italy	0	0	0	1	0	4	0	0	0	0	0	5
The Netherlands	0	0	0	1	0	0	0	0	0	0	0	1
Poland	0	0	0	2	0	0	0	1	0	0	0	3
Portugal	0	0	0	0	0	0	0	1	0	0	0	1
Romania	1	0	0	0	0	0	0	0	0	0	0	1
Slovakia	0	0	0	1	0	0	0	0	0	0	0	1
Sweden	0	0	0	0	0	1	0	0	1	1	0	3
Total	1	1	1	15	2	8	3	4	2	1	3	41

Table A2: Distribution of RTCs across first host and home countries.

First host countries (from which RTCs take place)	**Home countries of the companies undertaking RTCs**												
	Austria	Belgium	Switzerland	Germany	Spain	Finland	France	UK	Italy	The Netherlands	Norway	Sweden	Total
Austria	0	0	1	2	0	0	0	1	0	0	0	0	4
Belgium	0	0	0	2	0	0	2	0	0	0	0	0	4
Bulgaria	0	0	0	0	0	0	0	0	0	0	0	1	1
Czech Republic	0	0	0	1	0	0	0	2	0	0	0	0	3
Germany	0	0	0	0	0	3	0	3	0	0	0	1	7
Denmark	0	0	0	0	0	1	0	0	0	0	0	0	1
Spain	0	0	0	1	0	0	0	0	0	0	0	1	2
Finland	0	0	0	0	0	2	0	0	3	0	0	1	6
France	0	3	0	3	1	0	0	2	0	0	0	2	11
UK	0	0	0	3	0	0	0	0	1	1	1	0	6
Hungary	0	0	0	3	0	0	1	1	0	0	0	0	5
Ireland	0	0	0	0	0	0	2	0	0	0	0	1	3
Italy	0	0	0	4	0	0	4	0	0	0	0	4	12
The Netherlands	0	1	1	1	0	0	0	2	0	0	0	0	5
Portugal	0	0	0	0	0	0	0	0	1	0	0	0	1
Romania	1	0	0	0	0	0	0	0	0	0	0	0	1
Slovenia	0	0	0	1	0	0	0	0	0	0	0	0	1
Sweden	0	0	0	0	0	3	1	0	0	0	0	0	4
Total	1	4	2	21	1	9	10	11	5	1	1	11	77

Table A3: Distribution of RTCs across first and second host countries.

	Second host countries (towards which RTCs occur)																	
First host countries (from which RTCs take place)	Austria	Belgium	Czech Republic	Germany	Denmark	Spain	France	UK	Greece	Hungary	Ireland	The Netherlands	Poland	Romania	Russia	Slovakia	Slovenia	Sweden	Total
Austria	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2	0	0	4
Belgium	0	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	4
Bulgaria	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Czech Republic	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	3
Germany	0	0	0	0	0	0	0	0	0	1	0	0	4	2	0	0	0	0	7
Denmark	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Spain	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2
Finland	0	0	1	1	1	0	0	0	0	0	0	0	2	0	1	0	0	0	6
France	0	1	3	0	0	0	0	0	0	0	1	2	3	1	0	0	0	0	11
UK	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	1	0	1	6
Hungary	1	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	5
Ireland	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
Italy	2	1	1	1	0	1	1	1	0	0	0	0	2	1	0	0	1	0	12
The Netherlands	0	0	0	1	0	0	0	0	0	2	0	0	1	0	1	0	0	0	5
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Sweden	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	4
Total	3	2	9	6	1	1	2	2	1	6	1	2	22	9	2	4	2	2	77

[i] In line with Gereffi & Lee (2012), we assume Global Supply Chains and Global Value Chains as synonymous and we define them as "a governance arrangement that utilizes, within a single structure, multiple governance modes for distinct, geographically dispersed and finely sliced parts of the value chain" (Kano et al., 2020).

[ii] Germany has been the first and most important country adopting Industry 4.0 policies with the "Industrie 4.0" (Source: European Commission, Digital Transformation monitor [https://ec.europa.eu/growth/tools-databases/dem/monitor/content/germany-industrie-40]) initiative launched in 2011 by the *Bundesministerium für Wirtschaft und Energie* (BMWi, German Federal Ministry for Economic Affairs and Energy), which has been, for the whole European continent, the beginning of a renewed period of attention towards the adoption of industrial innovations. "Industrie 4.0" is an initiative that, in the original intentions of the German policymakers, will secure and develop Germany's leading position in the industrial manufacturing over a period of 10-15 years, by promoting a structural change towards a digital framework in manufacturing. The general areas of competence of the programme are the implementation of the Cyber-Physical Systems and the Internet of Things, which are expected to foster the growth of industrial production and, consequently, of the whole economy. The second European country to launch a national Industry 4.0 programme was the United Kingdom (UK), with the HVM Catapult (Source: European Commission, Digital Transformation monitor[https://ec.europa.eu/growth/tools-databases/dem/monitor/content/united-kingdom-hvm-catapult]), started in 2012. The aim was to enable innovation by means of a bold program of public-private financing and a series of collaborations with manufacturers, covering the development of 27 different technological areas. After Germany and the UK, other European countries adopted their own Industry 4.0 initiatives, choosing among different funding schemes (private, public or mixed public-private) and differentiating their initiatives according to the needs and the economic situation of the country itself. Some notable examples are the "Industrie du Futur" in France and "Piano Nazionale Industria 4.0" in Italy.

[iii] Please note: the transfer of jobs from the first host country can also be partial, meaning that the plant in the first host country is not always shut down.

[iv] Although the sample of firms might appear rather small, this is explained both by our accuracy in the sampling procedure (especially as regards the focus on European firms and on the selection of those data that could be clearly identified as RHC or RTC, as described in the methodological steps of our data collection) and by the current huge difficulties in tracking manufacturing processes that have been moved to other host countries or reshored, due to lack of data in official statistical sources and to the 'confidential' nature of these strategies

[v] The document is available here: https://ec.europa.eu/transparency/documents-register/detail?ref=COM(2016)180&lang=en

[vi] We considered the difference between the home and the host country since the higher the unit labour cost of the former with respect to the latter, the higher the cost-saving location advantage of the latter with respect to the former.

[vii] In this case, we considered the difference between the host and the home country since the higher the delta in the GDP per employee, the higher the productivity-enhancing location advantage of the former with respect to the latter.

[viii] The items are Power Distance, Uncertainty Avoidance, Individualism and Masculinity (Source: https://www.hofstede-insights.com/product/compare-countries/)

[ix] We had to drop those dummies that predict perfectly either the RTC (i.e., industries 13, 16, 17 and 32) or RHC (i.e., industry 32). All the other industries reported in Table 2 have been included through single dummies.

[x] We have not employed this specification as the main regression due to the high correlations among the control variables, which could give rise to multicollinearity problems, considering also that after computing the Variance Inflation Factors, one of the values turned out to be above the conventional threshold of 10. We decided, however, to display these results in the robustness check section since we believe that they are still useful to provide confirmation of our main results, given that a very recent publication by Lindner et al. (2020) suggests that "(i) multicollinearity does not introduce bias, meaning that it is not an econometric problem in the sense that it would violate assumptions necessary for regression models to work; (ii) coefficient instability is not a consequence of multicollinearity; (iii) in the presence of a higher partial correlation between the variables, it can paradoxically become more problematic to omit one of these variables; (iv) ignoring clusters in data can lead to spurious results" (p. 283).

[xi] In this case, we had to remove the variables reflecting both the location advantages of the first host over the home country and the characteristics of the second host country, since the variables capturing the location advantage of the second over the first host country are a linear combination of the variables accounting for the second host and for the first host country, and also of the variables concerning the home country when considering the RHC (in these cases the second host being equal to the home country). We did not include other stand-alone country-level variables to avoid the multicollinearity problems that are present in Table 8.

[xii] Again, we could not include other country-level variables in this specification to avoid the multicollinearity problems of Table 7.