CHALLENGING THE HOST COUNTRIES' LOCATION ADVANTAGES: THE ROLE OF INDUSTRY 4.0 IN FOSTERING THE RESHORING OF EFFICIENCY-SEEKING FIRMS

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ABSTRACT

The cross-border investments of efficiency-seeking firms are driven by the continuous search for better host-country location advantages in terms of either lower production costs or higher productivity. This is confirmed by recent evidence showing that these firms prefer to relocate to third countries when undertaking relocation of second degrees (RSDs), i.e. when modifying a prior location decision.

We claim that Industry 4.0 factors, with their widely acknowledged potential for decreasing costs and increasing productivity, may indeed alter this localization pattern and favor the relocation of efficiency-seeking firms to their home country (RHC). Our results confirm that efficiency-seeking firms tend to implement a RHC when they have the opportunity to take advantage of Industry 4.0 factors. More specifically, our findings reveal a specular role of technology intensity and policies, with the former influencing the return decisions of cost-saving firms, and the latter being relevant on those of firms that seek productivity enhancements. These results not only shed fresh light on the relationship between Industry 4.0 factors and firms' RSD decisions, but also raise a debate on how Industry 4.0 may alter the relevance of firm-level and country-level advantages for the location choice of efficiency-seeking firms.

Keywords: Location advantage and location choice; Efficiency-Seeking firms; Industry 4.0; Technology Intensity; Policies; Reshoring; Relocations of second degree.

INTRODUCTION

Over the past decades, firms have delocalized manufacturing activities and less-value added activities to low-cost countries offering inexpensive labour and cheaper raw materials (Kedia & Mukherjee, 2009; Mudambi, 2008). Cost reductions were the primary reasons for offshoring of US firms towards Mexico and other emerging countries (Lewin & Couto, 2007) and for the vast transfer of manufacturing activities by Western European firms to Eastern Europe countries (Fratocchi et al., 2015; Kinkel & Maloca, 2009). As a result, more fragmented and geographically dispersed global supply chains (GVCs) have started to emerge (Gereffi & Lee, 2012). This process was even accelerated by the diffusion of information and communication technologies (ICTs), which allowed to increase the connectivity across countries, between firms and within the network of subsidiaries (Chen & Kamal, 2016). In particular, international business (IB) scholars predicted, at the beginning of the twenty-first century, that the rise of the Information Age would have widened the geographic dispersion of international business networks (de La Torre & Moxon, 2001; Zaheer & Manrakhan, 2001).

Nevertheless, while this trend is not over, in the 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 of cost factors among countries, which modifies their relative attractiveness (Ellram, Tate, & Petersen, 2013). Companies' intentions to change manufacturing source is increasingly shifting from "offshore" being the predominant option, to "move between low cost countries" and "reshore" (i.e., return to the home country) being viable alternatives to offshore (The Economist, 2013) .

Recently, Barbieri, Elia, Fratocchi, & Golini (2019) have labelled the further movements of previously offshored manufacturing activities as "Relocations of Second Degree" (RSD), which they have been characterized as either Relocations to the Home Country (i.e., RHC) or "Relocations to a Third Country" (RTC) – the latter assuming a movement towards a second host country, different from home. The RHC option, in particular, has attracted significant attention by scholars, managers, and policy-makers (Barbieri et al., 2019; Stentoft, Olhager, Heikkilä, & Thoms, 2016; Wiesmann, Snoei, Hilletofth, & Eriksson, 2017), although it is recognized that the phenomenon is not mass trend (Ancarani, Di Mauro, Fratocchi, Orzes, & Sartor, 2015). One limit of this literature is that, with few exceptions (e.g., Albertoni, Elia, Massini, & Piscitello, 2017; Baraldi, Ciabuschi, Lindahl, & Fratocchi, 2018; Gray, Esenduran, Rungtusanatham, & Skowronski, 2017; Johansson & Olhager, 2018; Johansson, Olhager, Heikkilä, & Stentoft, 2019) it did not account for the rationale of the prior offshoring decision, thus preventing a clearer understanding of the firm's "sequential" internationalization pattern. When the RTC alternative has been considered while studying RSDs, evidence is found that it can indeed be a preferred option for efficiency-seeking firms (Barbieri et al., 2019; Manning, 2014) – suggesting that for these companies, manufacturing activities continue to flow from one low cost country to another, in a relentless search of location advantages that help to minimize costs.

Yet, cost considerations have been found to drive this choice in a number of cases (Fratocchi et al., 2016; Zhai, Sun, & Zhang, 2016), although quality issues and the need for higher market responsiveness have emerged as other two main reasons for RHC (Barbieri & Stentoft, 2016; Kinkel, 2014; Moradlou, Backhouse, & Ranganathan, 2017). In this respect, cost reduction is widely recognized as the strategic priority of efficiency-seeking firms; more specifically, it may be addressed either through the reduction of production costs (e.g., producing in countries characterized by low labour costs) or through the increase of productivity (e.g., implement investments in production automation). As a consequence, one may argue that RHC can apply to these firms either, to the extent that specific contingencies have intervened, able to (a) decrease the firm's dependence on the cost (e.g., low wages) or productivity (e.g., skilled labour) factors of foreign locations, or (b) increase the home country attractiveness in terms, again, of its cost or productivity factors.

Building on the most recent IB literature exploring the evolution of internationalization in the information age (e. g., Alcácer, Cantwell, & Piscitello, 2016), we claim that the so-called Fourth Industrial Revolution, better known as Industry 4.0, can play a role in explaining why some efficiency-seeking firms may decide to undertake a RHC, thus reconfiguring their value chain. 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, Dalenogare, & Ayala, 2019; Strange & Zucchella, 2017). Particularly, access to the heavily automated, highly productive manufacturing technology of Industry 4.0 – that is increasingly allowed 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, Di Mauro, & Mascali, 2019; Dachs, Kinkel, & Jäger, 2017; Strange & Zucchella, 2017) as long as this technology will ensure equally low production costs in high-income countries as well. This is made possible both through a process of labour substitution and through the consolidation of some intermediate products, the reduction of the production stages and the integration of the product architecture (Laplume, Petersen, & Pearce, 2016; Rezk, Singh Srai, & Williamson, 2016). As a consequence, firms can switch from complex and multi-tired to integrated and short-tired value chains that can be concentrated in one (or fewer) location, including the home economy. Meanwhile, many Governments start to look at Industry 4.0 not only as an opportunity to reinforce their manufacturing sectors, but also as a way to promote the return of previously offshored activities (Davies, 2015). Thus, policies supporting investments in Industry 4.0 technologies are increasingly adopted in various countries (Deloitte, 2018; Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014; Schlaepfer, Koch, & Merkofer, 2015), and could eventually increase the attractiveness of them in terms of their cost factors.

Despite the growing interests towards the effects of Industry 4.0 on GVCs reconfigurations and relocation decisions both in IB (e.g., Alcácer et al., 2016; Ancarani, Di Mauro, & Mascali, 2019; Laplume et al., 2016; Rezk et al., 2016; Strange & Zucchella, 2017) and in the Supply Chain and Operations Management literatures (e.g., Ancarani et al., 2019; Engström, Sollander, Hilletofth, & Eriksson, 2018; Fratocchi et al., 2016; Strange & Zucchella, 2017), the specific mechanisms through which this process occurs (i.e., the substitution of location advantages) and the direction in which occurs (i.e. towards either the home or the host countries) are still unclear, and the empirical studies on the topic are still scanty. Against these backdrops, this paper aims to disentangle the role of Industry 4.0 factors - in terms of firm-level technology intensity and home-country supporting policies – in fostering the efficiency-seeking firms’ decision to undertake a RHC by exploiting the new technologies to substitute for the host-country location advantages. We specifically focus on these firms, because we expect them to be deeply affected by the impact of Industry 4.0 on their manufacturing systems, in terms of higher productivity and/or lower costs. This is consistent also with the recent suggestion included as one of the progresses of international business research to investigate how “increases of productivity thanks to Industry 4.0 influence the choice regarding the international configuration of production or open new spaces for the phenomenon of reshoring and backshoring" (Chiarvesio & Romanello, 2018, 375-376).

In order to do so, we elaborate on the extant literature on the RSD of efficiency-seeking firms, which suggests that they are in general more likely to select a RTC (Barbieri et al., 2019). We claim that Industry 4.0 technologies can substitute for some host-country location advantages (i.e. low-cost of labour and higher productivity) that drive the initial internationalization and the subsequent relocation decisions of efficiency-seeking firms. Specifically, we advance and empirically test that, for efficiency-seeking firms, the likelihood to undertake a RTC decreases (in favour of a RHC) i) if these firms have developed strong Industry 4.0 technology intensity, or ii) if their home country has developed an industry 4.0 policy-based location advantage. In this respect, in our paper technology intensity is captured by the number of Industry 4.0 patents owned by the firm, while the Industry 4.0 policy-based location advantage characterizes a scenario under which a supporting policy is implemented in the home country but not in the host one.

We tested our hypotheses on data retrieved from the European Restructuring Monitor (ERM) database, which provides, among others, information about the relocation announcements involving firm's subsidiaries across the EU28 Member States (plus Norway). Our results show that, on average, efficiency-seeking firms are more likely to undertake RTC. However, firms located abroad to exploit cost-saving differentials are less likely to undertake RTC (in favour of RHC) when developing industry 4.0 technologies, while firms located abroad to exploit productivity-enhancing differentials are less likely to undertake RTC (in favour of RHC) when their home country adopt Industry 4.0 policies. In other words, our results show that, on the one hand, the firms increasing their Industry 4.0 technology intensity are able to develop a competitive advantage that allows decreasing production costs, thus compensating for the comparative advantage of the host country typically arising from the low labour cost. On the other hand, home countries adopting Industry 4.0 policies are able to offset the technological and competitive gap with respect to host countries offering productivity-enhancing location advantages, thus reducing the probability that productivity-seeking firms choose a RTC when undertaking a RSD. These results contribute, hence, to the recent stream of the IB literature that is inquiring how the traditional internationalization theories, such as the OLI paradigm, evolve in the era of digital revolution

(Alcácer et al., 2016; Banalieva & Dhanaraj, 2019), by showing that Industry 4.0 factors can weaken the importance of some host-country location advantages at least for efficiency-seeking firms.

The reminder of the paper is organized as follows. Section two introduces the theoretical background and develops the main hypotheses of the paper. Section three describes data and variables and offers some descriptive statistics. Finally, section four describes the econometric outcome, while section five provides the interpretation and the implications of our results.

THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

Location advantages and relocations of second degree of efficiency-*seeking firms*

The "location advantages" arise form differences in factor endowments between countries, which are traditionally considered as a main trigger of firms' location decisions. More specifically, location advantages are relevant complementary assets outside the boundaries of the MNE, which are location-bound and which are, in principle, accessible equally to all firms that are physically or legally established in that location (Narula, 2014a; Narula & Santangelo, 2009).

In analysing the raise of offshoring, Doh (2005) stresses the persistent prominent role of location in the motivations of the phenomenon. Assuming that companies' internationalisation is purposeful and goal-oriented, firms are likely to choose a destination based on the features that make it comparatively more attractive than others from the firm's standpoint (Benito, 2015). Undoubtedly, Dunning's so called "eclectic paradigm" offers one of the most comprehensive characterizations of the "location advantages" (1979, 1993, 1998). It distinguishes among four main motives of internationalization – namely: (i) market seeking, (ii) asset-seeking, (iii) efficiency-seeking, and (iv) natural resource-seeking – and it assumes that depending on the particular motive, the firm will select a location offering favourable conditions to the pursuit of its objective.

Specifically, efficiency-seeking advantages reflect opportunities for cost reduction (Buckley, Clegg, Cross, Liu, Voss, & Zheng, 2007). They arise when a host country offers the firm favourable conditions to compete on prices, by reducing costs and/or by increasing productivity. As such, it seems particularly relevant for offshoring decisions, which has been recognized as being primarily driven by a cost minimization priority (Bailey & De Propris, 2014; Canham & T. Hamilton, 2013; Contractor, Kumar, Kundu, & Pedersen, 2010). Among the various factors influencing efficiency-seeking investments (Dunning, 1998), human-capital specific advantages (Kedia & Mukherjee, 2009) affecting labour cost or productivity are found to be quite relevant in motivating the internationalization initiatives of manufacturing companies (Di Mauro, Fratocchi, Orzes, & Sartor, 2018).

The exploitation of the location advantages in the internationalization process has been studied mainly as part of the locational choice strategy designed when moving from the home to a host (foreign) country (e.g., Lewin, Massini, & Peeters, 2009). Yet, in recent years, there has been increasing interest towards the reconfiguration – rather the mere expansion – of the firm's international activities. Such broader focus of analysis stems from the recognition that firms may decide to modify their prior location decisions (Albertoni et al., 2017; Ancarani et al., 2015; Brennan et al., 2015; Fratocchi, Di Mauro, Barbieri, Nassimbeni, & Zanoni, 2014; Wiesmann et al., 2017). As mentioned above, these "relocations of second degree" (RSDs) have been typically characterized as either a return to the home country (RHC) or a relocation to a third (i.e., a "second host") country (RTC) different from both the home and the first host ones (Barbieri et al., 2019).

In studying RSDs, scholars typically apply the general internationalization frameworks to interpret the last change in location observed (Barbieri, Ciabuschi, Fratocchi, & Vignoli, 2018; Ellram et al., 2013; Fratocchi et al., 2016; Martinez-Mora & Merino, 2014). However, this perspective is someway narrow in nature, since it does not account for the rationale behind the previous location decision, thus preventing any understanding of the linkages between the latter and the RSD, as well as any meaningful characterization of the internationalization path of the firm based on the kind of location advantage it seeks. Gray, Skowronski, Esenduran, & Johnny Rungtusanatham, (2013) and Stentoft, Mikkelsen, Jensen, & Rajkumar (2018) recommend to enquire the reasons of offshoring while studying those of back-reshoring (i.e., RHC). In practice, to date only few empirical studies have analysed RSDs with this approach (e.g., Albertoni et al., 2017; Baraldi et al., 2018; Barbieri et al., 2019; Di Mauro et al., 2018; Gray et al., 2017; Johansson & Olhager, 2018; Johansson et al., 2019), which, however, have started to offer some interesting insights, particularly for efficiency-seeking firms. Gray et al. (2017), (Di Mauro et al. (2018) and Baraldi et al. (2018) studied RHCs that followed a cost-reduction offshoring decision. They found that, in these cases, RHCs represent, respectively, corrections to poor cost assessments of offshoring (Gray et al., 2017), or strategic shifts in the firms' competitive strategy (Baraldi et al., 2018; Di Mauro et al., 2018). Reductions in cost differentials between the home and the host countries have been identified, in general, as one motivation for RHC (Fratocchi et al., 2016; Martinez-Mora & Merino, 2014; Stentoft et al., 2016): as such, it could be applied to the case of efficiency-seeking firms too, which might reverse their location decision attracted by new, and more favourable cost conditions in their domestic countries.

Nevertheless, Barbieri et al. (2019) showed that, when the broader spectrum of RSD alternatives is considered, RTC tends to be the option preferred by efficiency-seeking firms. In similar vein, Manning (2014) found that firms pursuing a strategic imperative of cost reductions adopt RTC (rather than a RHC) in response to external challenges that led to cost increases on which the company has little control – again, this plays in favour of the RTC, if cost-efficiency is the goal. Even from a theoretical point of view, Ferdows (2008) suggests that, especially when firms lack distinctiveness in their products or production processes, they should prefer a "footloose" approach aimed at cost minimization through the relentless search, and exploitation, of efficiency-seeking location advantages in various parts of the world. In sum, up to date the literature considering the broader spectrum of RSD hints that efficiency-seeking firms may more likely choose a RTC (rather than a RHC), seemingly to maintain their strategic focus on cost minimization.

We claim that to gain more insights on the contingencies under which efficiency-seeking firms may decide to undertake a RHC rather than a RTC, it is necessary to understand the mechanisms through which these firms can either decrease costs or increase productivity. In this respect, Industry 4.0 offers a unique opportunity to pursue both these objectives, meaning that it can play a crucial role in affecting the RSD decisions of efficiency-seeking firms.

Industry 4.0

The full integration of information and communication technologies (ICT) in the context of manufacturing and applications is paving the way towards a new industrial stage frequently termed "Fourth Industrial Revolution" or "Industry 4.0" (Meniere, Rudyk, & Valdes, 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, Helbig, Hellinger, & Wahlster, 2013, 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 impact on.

Industry 4.0 integrates a set of emerging and convergent technologies adding value to the *whole product lifecycle* (Dalenogare, Benitez, Ayala, & Frank, 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 of 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, Orzes, & Sartor (2018) identify four clusters of enabling technologies – characterized by different share of hardware or software components, and varied connectivity extension – which deliver specific types of functions. 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, Bagheri, & Kao, 2015). "Network technologies" (e.g., cloud computing) support a device's functionalities through resources it can access from remote. "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 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 exists, and drive their simultaneous adoption in several Industry 4.0 applications (Culot et al., 2018; Lee et al., 2015).

Industry 4.0 Technology intensity, Location Advantages and RSDs of Efficiency-Seeking Firms

Technology – and in particular Information and Communication Technologies (ICTs) – has been recognized as a factor affecting the firm's internationalization process (Alcácer et al., 2016; Nachum & Zaheer, 2005). ICTs allow for remote coordination, extending the span of control and reducing its cost (Chen & Kamal, 2016; Leamer & Storper, 2001). Moreover, 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). Since Industry 4.0 technologies are embedded in ICTs, it is therefore not surprising that scholars have been recently started to investigate the Industry 4.0 phenomenon also to analyse whether and how it affects the firm's manufacturing location decisions, and the reconfiguration of global value chains (Strange & Zucchella, 2017). Chen & Kamal (2016), for instance, show that internet-enabled technologies affect the decision to re-organize production across national borders, by reducing both internal and external coordination costs, thus increasing the likelihood of in-house production as measured by intra-firm trade.

Nevertheless, the impact of Industry 4.0 technologies on the reorganization of the GVC in terms of re-location choice following the initial internationalization (i.e. the relocations of second degrees) has not been disentangled yet (Chiarvesio & Romanello, 2018; Galati & Bigliardi, 2019). While we are not aware of any study investigating the relationship between Industry 4.0 and RTC, some attention has been paid to that relating Industry 4.0 to RHC. Specifically, Dachs et al. (2017) found a positive relationship between Industry 4.0 “readiness” (measured through an index that captures the number as well as the complexity of the technologies adopted) and RHC. Instead, Müller, Dotzauer, & Voigt (2017) found weak support for that, with managers attributing relatively low importance, on average, to Industry 4.0 factors when bringing back production. Studies that generally investigated the RHC drivers – with no specific focus on the Industry 4.0 topic – also led to mixed findings about the role of specific Industry 4.0 technologies such as production automation. On the one hand, research conducted in Nordic countries clearly show that production automation may induce companies to repatriate earlier offshored production activities – or at least is an enabling factor (Engström, Hilletofth, Eriksson, & Sollander, 2018; Engström, Sollander, et al., 2018; Heikkilä, Martinsuo, & Nenonen, 2018; Heikkilä, Nenonen, Olhager, & Stentoft, 2018). On the other hand, Fratocchi et al. (2016) did not find evidence for that in the 377 European reshoring cases they analyzed. In spite of the someway contrasting results, common across these studies is the assumption that the possible impact Industry 4.0 can have on the firm’s relocation choice is due to the its strong potential impact on the manufacturing systems, in terms of increased productivity and/or reduction of production costs.

Therefore, we study the RSDs pattern of the efficiency-seeking firms, and on how their degree of Industry 4.0 technology intensity can influence their relocation pattern. In effect, several recent contributions have highlighted how the development of industry 4.0 technologies offers several advantages in terms of cost reduction (Alcácer & Cruz-Machado, 2019; Dalenogare et al., 2018; Lu, 2017) and productivity and flexibility increase (Brynjolfsson & McAfee, 2014; Fratocchi, 2018; Kagermann et al., 2013; Laplume et al., 2016; Moradlou et al., 2017; Moradlou & Tate, 2018; Rezk et al., 2016). To illustrate a few, automation and robotics, which are increasingly accessible also to SME due to their constantly decreasing costs (Strange & Zucchella, 2017), increase productivity as they make the production process faster and more reliable (Frank et al., 2019). Besides, they decrease the necessary labour component, thus reducing the relevance of wage gaps between high- and low-income countries (Bals, Kirchoff, & Foerstl, 2016). For certain applications – such as small batch production or the manufacturing of complex shapes, in addition to prototyping – additive manufacturing too can contribute to reduce costs (Blanchet, Rinn, Von Thaden, & De Thieulloy, 2014; Fratocchi, 2018;

Moradlou & Tate, 2018). Similarly, 3-D printing technologies and computerized manufacturing allow to save on costs by lowering the density and the span of the GVCs through the consolidation of some intermediate products (Laplume et al., 2016), the reduction of the production stages and the integration of the product architecture (Rezk et al., 2016), thus reducing the need for geographic dispersion and fragmentation. Analytics and Big Data have been reported to contribute to improvements in productivity (McAfee, Brynjolfsson, Davenport, Patil, & Barton, 2012) as they support better resource deployment (e.g., capacity utilization) as well as predictive maintenance. Finally, smart supply chain can contribute to overall cost reduction through increased coordination with suppliers in mass production, and more effective collaboration in product development (Frank et al., 2019).

As a consequence, the development of Industry 4.0 technologies by the firm may weaken (if not eliminate) location advantages of low cost and high productive countries and – at the same time – allow companies to be more responsive to clients' needs, or offer them customized products (Moradlou et al., 2017; Moradlou & Tate, 2018). As discussed in previous paragraph, for efficiency-seeking firms, localization of manufacturing in countries where production costs are lower, or productivity is higher is of crucial importance. This is why they have increasingly established their production activities in countries with low cost or high productivity advantages over the past decades, despite the higher vulnerability, longer lead times, and frequent quality issues experienced within their globally extended supply chains (Brennan et al., 2015). The development of Industry 4.0 technologies can offer a valuable opportunity to reduce production costs or increase productivity at home rather than by means of exploitation of the host-country location advantages. In other words, Industry 4.0 technologies are expected to reduce - in the case of efficiency-seeking firms – the need for internationalization. This opens the possibility to go back to the home countries in order to avoid all the burdens that come with offshoring (i.e. coordination and transaction costs, cultural and institutional distance, currency exchange volatility etc.).

A very preliminary evidence supporting this relationship has been offered also by Ancarani & Di Mauro (2018), who provide one of the first attempts to link Industry 4.0 to the motives of the location decision. After distinguishing among different types of RHC, namely, "cost-oriented", flexibility-oriented", and "quality-oriented", the authors recognize that cost-oriented RHC typically follows the same cost reduction aims that had motivated the offshore decision, by showing that 13.7% of the RHC decisions explicitly cite Industry 4.0 technologies (mainly automation and/or additive manufacturing) as a driver. Among such companies, firms aiming to reduce costs are slightly higher than those boosted by quality-motives.

Overall, this discussion leads us to support the idea that the development of a high degree of Industry 4.0 technology intensity, allowing cost reductions or productivity enhancements at home and, hence, substitution of the host-country location advantages, increases the propensity of efficiency-seeking firms to undertake a RHC. Thus, we forward that:

HP 1a: Firms investing abroad to exploit efficiency-seeking location advantages through cost reductions are less likely to undertake an RTC in favour of RHC when they have developed a strong Industry 4.0 technology intensity.

HP 1b: Firms investing abroad to exploit efficiency-seeking location advantages through productivity enhancing are less likely to undertake an RTC in favour of RHC when they have developed a strong Industry 4.0 technology intensity.

Industry 4.0 Home Country Policies and RSDs of Efficiency-seeking firms

With the term “Industry 4.0 policies” we refer to the programs launched by some national governments to encourage firms to adopt the newest technologies offered by the Fourth Industrial Revolution, such as cyber-physical systems, cloud computing, big data and augmented reality (Davies, 2015; Lasi et al., 2014). The basic concepts behind these initiatives are the technical assistance and the provision of tax cuts or direct financing to the firms investing in digital technologies. Additional supports provided by policymakers to firms adopting Industry 4.0 technologies consist of training and education programs for the development of qualified personnel, adoption of common technological standards, harmonization of the regulatory frameworks and design of long-term R&D policies. All these initiatives confirms the idea that Industry 4.0 “implies new interactions between public sector and organizations”, (Robinson & Mazzucato, 2019).

Germany has been the first and most important country adopting Industry 4.0 policies. This country pioneered for all the government-driven Industry 4.0 policies. The "Industrie 4.0"[i] initiative launched in 2011 by the *Bundesministerium für Wirtschaft und Energie* (BMWI, German Federal Ministry for Economic Affairs and Energy) 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 program 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 program was the United Kingdom (UK), with the HVM Catapult[ii], started in 2012. The aim was to enable the innovation by means of a bold program of public-private financing and a series of collaboration with the manufacturers, covering the development of 27 different technological areas. After Germany and 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.

The long-term aim of these Industry 4.0 policies is a deep transformation of the national industrial production, which is pursued by merging the conventional industry with digital technologies that are able to connect all the different parts of the value chain (i.e., suppliers, plants, distribution, customers and products). The expected effect of such policy-driven transformation is the increase of the firms' competitiveness through the reduction of their costs and the enhancement of their productivity. This should occur thanks to the possibility offered by digital technologies to increase production flexibility, to accelerate the time to market, to improve the product quality and to switch towards innovation- and customer-oriented business models (Davies, 2015). For instance, the European Commission has estimated that, by promoting the adoption of advanced analytics in predictive maintenance programmes, companies can avoid machine failures on the factory floor and cut downtime by an estimated 50%, thus increasing production by 20%. At the same time, policies supporting the application of sensors and the purchase of error-correcting machinery that can monitor every piece produced and adjust production processes in real time, could help the top 100 European manufacturers to save an estimated €160 billion in the costs of scrapping or reworking defective products (Davies, 2015).

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 affecting also 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). Furthermore, given the efforts of the national governments towards the implementation of advanced ICT systems, the relocating firms may benefit from more reliable and efficient distribution channels (Brettel, Friederichsen, Keller, & Rosenberg, 2014). The Industry 4.0 programs may result particularly attractive for efficiency-seeking relocating firms, which can take advantage of the incentives provided for the adoption of new technologies to reduce the overall production costs and/or to increase the productivity (Strange & Zucchella, 2017). The European Union has, indeed, explicitly mentioned the Industry 4.0 technologies as a concrete alternative to the decision to offshore manufacturing activities to distant countries with low cost of labour, and as a potential driver of the RHC decision (Davies, 2015). The correlation between Industry 4.0 policies and reshoring choices has been partially confirmed also by a recent survey undertaken by Müller et al. (2017) on 50 German firms. Among the drivers of the reshoring phenomenon, the interviewed companies indicated also the political incentives provided by the governments. In particular, firms' managers indicated Industry 4.0 policies as an incentive to bring back part of their previously offshored productive capacity to the home country, and to set up new production facility in their home economy.

This explains why 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, policy makers are strategically employing Industry 4.0 national programs to create a new type of "home-country Industry 4.0 location advantage", able to offset the low-cost or high-productivity location advantage of foreign countries and to stimulate those national companies that had invested abroad for efficiency-seeking reasons to bring production back home. 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 the quality of resources and networks a firm is able to access (Alcácer et al., 2016; Narula 2014b). Therefore, the implementation of an Industry 4.0 policy by the home country is expected to provide efficiency-seeking firms not only with the possibility of reducing costs and increasing productivity, but also with the unique opportunity to exploit the new institutional setting to upgrade their own capabilities. As a consequence, efficiency-seeking firms will have a further incentive to undertake a RHC when the home country adopts an Industry 4.0 policy, thus fully substituting the traditional host-country with the new home-country location advantages. Accordingly, we forward the following two hypotheses:

HP 2a: Firms investing abroad to exploit efficiency-seeking location advantages through cost reductions are less likely to undertake an RTC in favour of RHC when their home country has developed an industry 4.0 policy-based location advantage.

HP 2b: Firms investing abroad to exploit efficiency-seeking location advantages through productivity enhancing are less likely to undertake an RTC in favour of RHC when their home country has developed an industry 4.0 policy-based location advantage.

EMPIRICAL ANALYSIS

Dataset and descriptive statistics

To test our hypotheses, we collected data from the European Restructuring Monitor (ERM) database, which provides information about the relocation announcements involving firm's subsidiaries across European countries. Data are gathered from daily newspapers and business press in the EU28 Member States (plus Norway), and integrated by other sources such as company websites and social media. The task of data collection is assigned to a European network of experts in industrial relations, such as economists, sociologists or journalists.

The ERM database reports RSDs that (i) affect at least one European country; (ii) imply the reduction or the increase of at least 100 jobs, or (iii) involve at least 10% of the workforce in sites with more than 250 employees. Given that the focus of this paper is to study the choice between RHC and RTC, we considered the RSDs undertaken only 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 they violate the abovementioned condition (i). Hence, after dropping all the cases involving non-European firms or missing critical information, we ended up with a sample of 118 RSDs undertaken by European firms operating in manufacturing industries (from NACE Code 10 to NACE Code 33) between 2002 and 2015. Most of 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 1 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, likely due to the EU enlargements towards Transition Economies occurred in 2004 and 2007. At the same time, it is possible to observe a reduction in relocation initiatives since the year 2010 (with the exception of the year 2014), which might be ascribed to the economic crisis of the years 2008-2009.

- Insert Table 1 about here -

Shifting our attention to the geographic dimension, some interesting insights arise when comparing the home countries of the RSDs (i.e., the countries *of origin* of the firm undertaking the relocation) with the host countries (i.e., the countries *from* which relocations take place) and the final destination countries (i.e., the countries *towards* which relocations occur). Table 2 shows the distribution of RHC across host countries, home countries and final destination countries, being the two latter geographic units identical since RHC refer to back-reshoring initiatives. It turns out that most of RHCs took place within Western European countries. Indeed, Germany and France are the most represented home and final destination countries in table 2, being responsible for 15 and 8 RHCs, respectively. At the same time, Spain and Italy are the host countries that mostly suffered the RHC phenomenon, as they lost 5 subsidiaries each, especially from Germany (as regards Spain) and France (as regards Italy).

- Insert Table 2 about here -

Table 3 shows the distribution of RTC across host and home countries. Again. It appears that most of relocations have been undertaken by companies whose home country is in Western Europe, such as Germany (21 RTCs), UK (11 RTCs), Sweden (11 RTCs), France (10 RTCs) and Finland (9 RTCs). At the same time, the countries that are mostly suffering from the loss of firm due to RTC are still located in Western Europe, such as Italy (12 observations), France (11 observations), Germany (7 observations) UK and Finland (6 observations). Table 4 provides more insights on the final destinations of the RTCs: the countries that benefited are the Transition Economies, and in particular Poland, Romania, Czech Republic and Hungary, which were recipient of 22, 9, 9 and 6 RTCs, respectively. The only noticeable exception is Germany, which received 6 RTCs, thus being able to offset its losses as host country in table 3.

- Insert Tables 3 and 4 about here -

Variables

Dependent Variable.

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

Explanatory variables.

In order to capture the efficiency seeking location advantage of the host (with respect to the home) country, we employed two variables, i.e., *Host country cost-saving location advantage* and *Host country productivity-enhancing location advantage.* Both variables have been built by relying on Buckley et al. (2007) and Ellram et al. (2013) who suggest to employ macroeconomic indicators to account for the comparative advantage of a country (i.e., the host location) with respect to another country (i.e., the home location). To account for the cost-saving advantage, we employed as proxy the difference between the home and the host country in the unitary labor cost, by considering the average value of the last three years preceding the relocation announcement in order to smooth fluctuations[iii]. Data have been extracted from the OECD Compendium of Productivity Indicators, measured in the base year 2010=100. Conversely, to account for the productivity-enhancing location advantage, we used as proxy 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 in order to smooth the fluctuations[iv]. Data come from the World Bank database.

Moderating variables.

The first moderator is *Firm Industry 4.0 technology intensity*. 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. In order 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 the parameters for the definition of Industry 4.0 patents are described in the European Patent Office report, published in 2017 (Meniere et al., 2017).

The second moderator is *Home country Industry 4.0 policy-based location advantage.* This variable is a dummy taking value of 1 when the home country of the firm was able to develop an Industry 4.0 location advantage with respect to the host country where the firm is located, which occurs when an Industry 4.0 policy was in force in the former and not in the latter in the year before the relocation.

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. The first control variable is *Host country market-seeking location advantage,* which captures the extent to which a host country offers market opportunities with respect to the home country. Building on 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 variable is aimed at defining to what extent a country may result 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.

A second control variable is *Host country strategic asset-seeking location advantage*, 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.

A third control variable is *Post Crisis,* a dummy that assumes value 1 if the observation has an announcement year from 2009 onwards, and 0 otherwise. The aim is capturing the effect of the crisis on the relocation choices in the years following the rise of the crisis, which took place at the end of 2008. Another explicative variable is *Firm Size,* which is measured as the total assets of the company in thousands of US dollars (source: Orbis database, Bureau van Dijk database).

We also control for the *Cultural distance* between the host and the home country, by employing the Kogut & Singh index based on Hofstede's items (2001)[v]. Finally, we employed the *Industry Dummies* to account for the dynamics underlying each specific NACE-code (at two-digit level) of the firms involved in the relocations.

Table 5 shows the correlation matrix and the descriptive statistics of the dependent, explanatory and control variables of the model. In order 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 –

RESULTS

Given the dichotomy nature of our dependent variable, we employed a robust Probit model to estimate our results. To test the hypotheses, we implemented five different specifications, which are reported in Table 6. Following Meyer, Van Witteloostuijn, & Beugelsdijk (2017) we provide the specific p-value and we show the marginal effects in order to gain more insights on the magnitude of the estimated coefficients.

Column (i) displays the baseline results without any interaction. Both variables accounting for the efficiency-seeking location advantages (i.e., *Host country cost-saving location advantage* and *Host country productivity location advantage*), have a positive and significant (respectively p=0.002 and p=0.000) correlation with the dependent variable meaning that efficiency-seeking firms are more likely to implement RTC rather than RHC. More specifically, an increase of 10% of the cost-saving and productivity-enhancing location advantages increase the probability to undertake a RTC of 1.42% and 4.66%, respectively. As regards the moderators, only the variable *Firm Industry 4.0 technology intensity* exhibits a significant (p=0.019) coefficient with a positive sign, meaning that firms accumulating knowledge on Industry 4.0 technologies are more likely to undertake a RTC. The marginal effect shows that the corresponding increase is equal to 0.52% for a 10% increase of the variable accounting for the firm-level industry 40 technology intensity. Conversely, the variable *Home country Industry 4.0 policy-based location advantage* does not show any significant impact. As regards the control variables, *Host country market-seeking location advantage* displays a negative and significant (p=0.000) coefficient, thus suggesting that firms investing abroad for market-seeking reasons are more likely to return home (rather than to relocating to third country). The magnitude exhibited by the marginal effect shows that the probability to undertake a RTC decreases of 2.85% when the market-seeking driver increases of 10%. On the opposite side, the variable *Cultural distance* shows a positive and significant (p=0.024) coefficient, thus suggesting that firms investing in culturally distant countries are more likely to undertake a RTC, being the magnitude of the effect equal to 0.75% for an increase of 10% of the variable.

Column (ii) introduces the interaction between *Host country cost-saving location advantage* and *Firm Industry 4.0 technology intensity*, which displays a negative and significant (p=0.000) coefficient, meaning that firms investing abroad to save on costs are less likely to undertake a RTC when they cumulate intensive technology on Industry 4.0. This result provides confirmation that Hypothesis 1a is confirmed. Nevertheless, the variable *Firm Industry 4.0 technology intensity* does not exert any moderating effect on the other variable accounting for efficiency-seeking investments, i.e., *Host country* *productivity location advantage*, being the interaction term not significant in column (iii). Hence, hypothesis 1b is not confirmed. Finally, columns (iv) and (v) introduce the interactions between *Host country cost-saving location advantage* and *Home country Industry 4.0 policy-based location advantage* and between *Host country productivity location advantage* and *Home country Industry 4.0 location advantage,* respectively. While the former is not significant, the latter displays a negative and significant coefficient (p=0.028), thus showing that efficiency-seeking firms investing abroad to increase productivity are less likely to undertake a RTC when policies Industry 4.0 are in place in the home (but not in the present host) country. Hence, as regards hypotheses 2a and 2b, it turns out that only the latter is confirmed.

- Insert Tables 6 about here -

Given the non-linearity nature of the Probit model, we plotted the results of the two significant interaction terms in order to gain more insights on the negative sign of the moderation effect. Figure 1 clearly shows that firms investing abroad for cost-saving purposes are more likely to go back home after accumulating intensive knowledge on Industry 4.0 technologies. Conversely, figure 2 shows that the effect of the home country Industry 4.0 location advantages translates into a lower probability to undertake a RTC.

- Insert Figures 1 and 2 5 about here -

DISCUSSION AND CONCLUSIONS

After decades of efficiency-seeking investments undertaken by companies in search of cost-reduction or productivity-enhancing location advantages, a new disruptive phenomenon seems to have started inverting (at least partially) this trend. Industry 4.0, indeed, is providing firms with a unique opportunity to leverage valuable digital technologies that are able to offset the low-cost or high-productivity location advantages of some foreign countries, thus becoming a valid alternative to internationalization for efficiency-seeking firms.

More specifically, our results suggest that development of a firm-specific Industry 4.0 competitive advantage – based on the patenting of digital technologies – can invert the RTCs propensity of the cost-saving firms by pushing them to undertake RHCs (as shown by graph 1). Conversely, the development of a home-country location advantage – based on the adoption of Industry 4.0 policies – seems to have an impact on firms investing abroad to enhance their productivity, by reducing their probability to undertake a RTC (as shown by graph 2b).

A first possible explanation for these clear-cut results may reside both in the different business models underlying the two types of efficiency-seeking firms and in the different Industry 4.0 dimensions considered in this study. Firms investing abroad to save on costs are likely to exploit the lower cost of labour offered by some host locations. 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. This situation offers the extraordinary opportunity to switch from a host country-level comparative advantage based on cost differentials to a firm-level competitive advantage based on Industry 4.0 technology intensity, which is likely to increase the degree of freedom of the firm in the re-location 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 digital technologies, the firm can afford to undertake a RHC in order to exploit its new "Industry 4.0-based" competitive advantaged 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, firms investing abroad to enhance their productivity, while still pursuing conditions that can make them quite competitive on price, are likely to rely on different advantages with respect to the mere exploitation of the low cost of labour. In particular, the main mechanism through which firms can enhance their productivity via cross-border investment is to "learn-by-interacting" by gaining access to different international business networks, meaning that firm are exposed to different technological, managerial and organization capabilities that are available in the ecosystem of the foreign country (Alcácer et al., 2016; Bertrand & Capron, 2015). In other words, firms are able to enhance their productivity by sourcing knowledge, resources and know-how from the foreign production system by establishing economic relationships with the networks of suppliers, buyers, competitors, partners, associations and labour markets (Alcácer et al., 2016; Alcacer & Oxley, 2014; Johanson & Vahlne, 2009; Oxley & Sampson, 2004; Oxley & Wada, 2009; Pisano & Shih, 2009). This is possible when there is a technological and a competitive gap between the host and the home country, given that "there are more opportunities to benefit from knowledge and resources that do not exist in the home country when the acquirer invests in countries that are more advanced than its own" (Bertrand & Capron, 2015, p. 644). 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 a large number of 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 implement its learning-by-interacting strategy in the home country, thus reducing the probability to opt for a RTC when undertaking a RSD.

This might explain also why we did not found support for our hypothesis 1b. Indeed, on the one hand, the development of Industry 4.0 technologies by a single firm located abroad for cost-saving reasons is likely to reduce its dependency from the host country, thanks to the substitution of less-skilled and low-cost labour through digital technologies. This mechanism can trigger the RHC choice when undertaking a RSD. On the other hand, the same process does not apply to firm located abroad for productivity-enhancing reasons, since the increase of firm's Industry 4.0 technology intensity, despite being able to increase the productivity, cannot substitute for the network effects and for the learning-by-interacting opportunities offered by the productive ecosystem of the host country, which remains more competitive and technologically-advanced than the home country. At the same time, the implementation of Industry 4.0 policy is likely to be not so attractive for multinational firms located abroad to save on costs. Indeed, while these companies are focused on a short-term cost-cutting strategy, the Industry 4.0 policies have a long-term aim of increasing the productivity of the whole production system of the home country. Although higher productivity still implies lower costs, the productivity-enhancement is a longer process that requires investments in learning how to use new technologies to increase productivity and to reduce the costs. Therefore, cost-saving firms, which typically look for quick cost-reductions outcomes, are probably less attracted by Industry 4.0 policies, which require efforts and time, as well as a strategic switch from a short-term cost-oriented business model to a long-term productivity-oriented mind-set. In other words, Industry 4.0 policies provide companies with digital technologies that, although they can potentially increase their productivity, do not immediately affect the firm's cost structure nor reduce the labour cost in the home market. This might explain why hypothesis 2a is not verified. Rather, cost-saving firms will return back home only when they have already gone through the long-term process of digital learning, by developing their own Industry 4.0 technology intensity, as suggested by hypothesis 1a.

Another interesting result arising from our empirical analysis is the positive and significant relationship between the variable accounting for the Industry 4.0 technological intensity of the firm and the probability to undertake a RTC. This means that, with the exception of cost-saving firms that are more likely to return home when developing digital technologies for the reasons explained above, firms with a strong Industry 4.0 technology intensity are in general more willing to pursue their internationalization process by investing in a new host country. This result seems to suggest that the development of a portfolio of digital 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 one underlying the first internationalization described by the OLI paradigm, where firms invest abroad to exploit their technology-intensive ownership advantage. An alternative interpretation of our finding, which is more coherent with the most recent IB perspective concerning the conceptualization of innovative MNEs, is that firm 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 (Alcácer et al., 2016; Mudambi, Narula & Santangelo, 2018; Narula 2014a; Narula and Santangelo 2012). In other words, the positive correlation between Industry 4.0 technology intensity and RTC seems to reflect the attempt of MNEs to develop a new Industry 4.0 ownership advantages by integrating information and knowledge across countries, thus acting as orchestrators of international networks and pursuing a process of value creation that connect globally dispersed specialized knowledge (Dunning & Lundan, 2008; Nohria & Ghoshal, 1997).

In light of the findings discussed above, we believe that our paper can contribute to the International Business literature by taking part to the flourishing ongoing debate concerning the impact of new technologies on the internationalization patterns of the multinational firm in the information age (Alcácer et al., 2016; Banalieva & Dhanaraj, 2019). Specifically, our results seem to suggest that the development of an Industry 4.0 competitive 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 digital technologies are even more likely to re-invest in other countries to exploit or to develop further their Industry 4.0 competitive advantage. Nevertheless, de-internationalization seems to become a real option for those firms that are located abroad for cost-saving or productivity-enhancing reasons. In this case, the development of a firm-level Industry 4.0 competitive advantage or of a (home) country-level Industry 4.0 location advantage are able to offset the importance of the foreign countries' cost-saving and productivity-enhancing opportunities, respectively, thus weakening the role of the traditional host-country location advantage of the OLI paradigm for efficiency-seeking firms. Our results allow us to emphasize, as a policy implication, the crucial role of Industry 4.0 policies in re-attracting the productivity-seeking domestic firms that are located abroad, due to the opportunity to reduce the technological and competitive gap with the foreign locations. In this respect, it is worth noting that Pieri, Vecchi, & Venturini (2018) point out "that public incentives towards the adoption of intelligent technologies might spur productivity indirectly via inter-industry ICT spillovers" (Pieri et al., 2018, 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" (Pieri et al., 2018, 1843)

Our paper is not exempt from limitations, which, however, represent also the possibilities to develop other researches on this topic. First, future studies should try to investigate more in 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 digital 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 researches 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, in order to understand the geographic scope of the impact of Industry 4.0 technologies on RSDs. Forth, 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. Finally, it would be interesting to explore also the employment effects arising from RSDs that are fostered by Industry 4.0 technologies.

In spite of these limitations, we believe that our paper represents one of the first attempts to provide a theoretical insight and an empirical evidence on the relationship between the digital revolution and the location advantages, by shedding some lights on the internationalization and RSD patterns of multinational companies and of efficiency-seeking firms in particular.

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TABLES AND FIGURES

Table 1: Distribution of RHC, RTC and RSDs across 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
Total	**41**	**100.00**	**77**	**100.00**	**118**	**100.00**

Table 2: Distribution of RHCs across host and home countries.

Host countries	Home countries											
	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 3: Distribution of RTCs across host and home countries.

Host countries	Home countries												
	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 4: Distribution of RTCs across first and second host countries.

First host countries	**Second host countries**																		
	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

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)	*Host country cost-saving location advantage*	0.091	1.000								
3)	*Host country productivity-enhancing location advantage*	0.544	-0.127	1.000							
4)	*Firm Industry 4.0 technology intensity*	0.011	0.141	-0.005	1.000						
5)	*Home country Industry 4.0 policy-based location advantage*	-0.074	0.143	-0.044	0.154	1.000					
6)	*Host country market-seeking location advantage*	0.009	-0.228	0.504	-0.001	-0.031	1.000				
7)	*Host country strategic asset-seeking location advantage*	-0.045	-0.033	0.006	0.101	0.050	0.235	1.000			
8)	*Post Crisis*	-0.131	0.116	-0.171	0.039	0.270	-0.092	-0.124	1.000		
9)	*Firm Size*	-0.209	-0.039	-0.227	0.169	0.031	-0.027	0.001	-0.086	1.000	
10)	*Cultural distance*	0.144	0.036	0.101	-0.057	-0.151	0.006	0.079	-0.053	-0.095	1.000
	Observations	118	118	118	118	118	118	118	118	118	118
	Mean	0.653	-0.070	-0.135	0.064	0.051	0.270	-0.129	0.424	0.108	1.578
	Std. Dev.	0.478	0.873	1.000	1.213	0.221	0.626	1.096	0.496	1.277	1.543
	Min	0.000	-3.085	-2.541	-0.294	0.000	-1.783	-2.518	0.000	-0.545	0.000
	Max	1.000	1.641	2.026	6.391	1.000	1.766	3.827	1.000	7.890	8.993

Table 6: Results of the Robust Probit Models

Variables	Column (i)		Column (ii)		Column (iii)		Column (iv)		Column (v)	
	Coefficient	M.E.	Coefficient	M.E.	Coefficient	M.E.	Coefficient	M.E.	Coefficient	M.E.
Host country cost-saving location advantage	0.786	0.142	0.349	0.064	0.788	0.148	0.837	0.146	0.802	0.146
	(0.002)	(0.002)	(0.165)	(0.172)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Host country productivity-enhancing location advantage	2.577	0.466	2.613	0.480	2.580	0.485	2.637	0.459	2.619	0.478
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm Industry 4.0 technology intensity	0.285	0.052	0.731	0.134	0.121	0.023	0.292	0.051	0.284	0.052
	(0.019)	(0.026)	(0.007)	(0.002)	(0.492)	(0.478)	(0.016)	(0.024)	(0.021)	(0.028)
Home country Industry 4.0 location advantage	0.354	0.052	0.780	0.090	0.411	0.061	0.579	0.071	-0.991	-0.282
	(0.677)	(0.590)	(0.351)	(0.085)	(0.626)	(0.511)	(0.496)	(0.276)	(0.092)	(0.182)
Host country market-seeking location advantage	-1.577	-0.285	-1.545	-0.284	-1.618	-0.304	-1.645	-0.286	-1.603	-0.293
	(0.000)	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)
Host country strategic asset-seeking location advantage	-0.086	-0.015	-0.070	-0.013	-0.080	-0.015	-0.078	-0.014	-0.093	-0.017
	(0.654)	(0.647)	(0.714)	(0.710)	(0.679)	(0.673)	(0.687)	(0.683)	(0.631)	(0.624)
Post Crisis	-0.452	-0.086	-0.607	-0.119	-0.380	-0.074	-0.526	-0.097	-0.478	-0.092
	(0.269)	(0.279)	(0.159)	(0.189)	(0.365)	(0.371)	(0.198)	(0.208)	(0.240)	(0.249)
Firm Size	-0.213	-0.038	-0.161	-0.030	-0.226	-0.043	-0.215	-0.037	-0.221	-0.040
	(0.237)	(0.234)	(0.221)	(0.220)	(0.256)	(0.258)	(0.242)	(0.236)	(0.234)	(0.231)
Cultural distance	0.415	0.075	0.476	0.087	0.422	0.079	0.425	0.074	0.418	0.076
	(0.024)	(0.020)	(0.014)	(0.009)	(0.025)	(0.021)	(0.023)	(0.020)	(0.024)	(0.021)
Host *country cost-saving location advantage **			-1.823	-0.335						
Firm Industry 4.0 knowledge intensity			(0.000)	(0.000)						
*Host country productivity-enhancing location advantage **					-0.216	-0.041				
Firm Industry 4.0 knowledge intensity					(0.272)	(0.310)				

*Host country cost-saving location advantage * Home country Industry 4.0 location advantage*				-1.066 (0.213)	-0.185 (0.208)		
Host country productivity-enhancing location advantage Home country Industry 4.0 location advantage*						-2.446 (0.028)	-0.447 (0.012)
Industry dummies	yes	yes	yes	yes		yes	
Constant	2.068 (0.034)	2.211 (0.027)	1.999 (0.044)	2.177 (0.031)		2.116 (0.033)	
Observations	118	118	118	118		118	
Chi Square	71.138	81.671	69.532	68.822		75.209	

Please note: P-values between brackets

Figure 1: Plot of the interaction between *Host country cost-saving location advantage* and *Firm Industry 4.0 technology intensity*

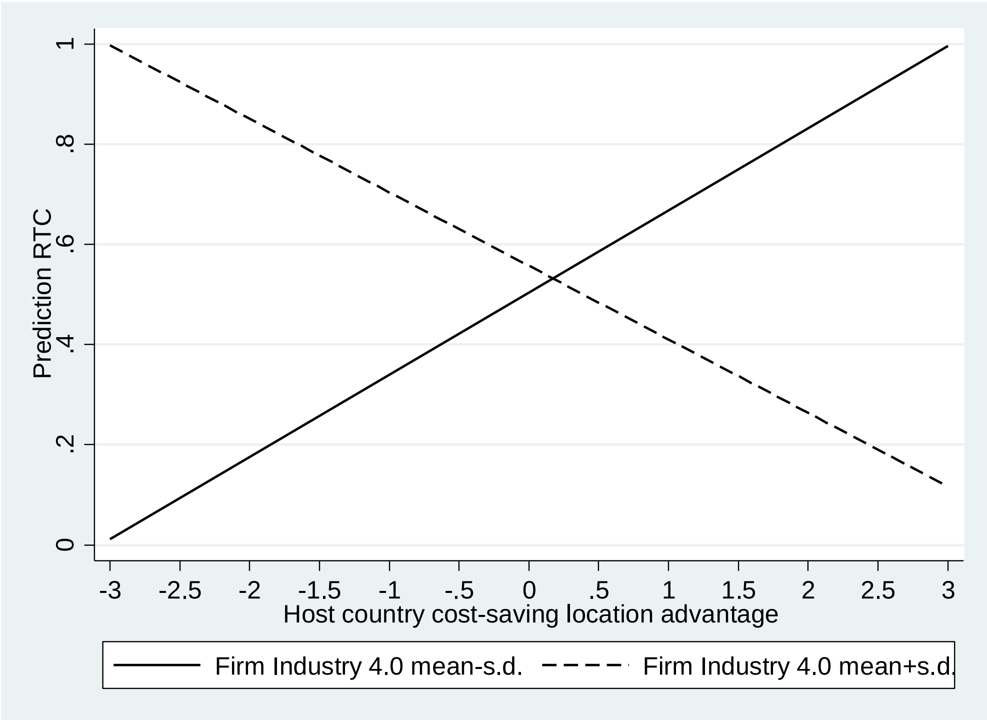
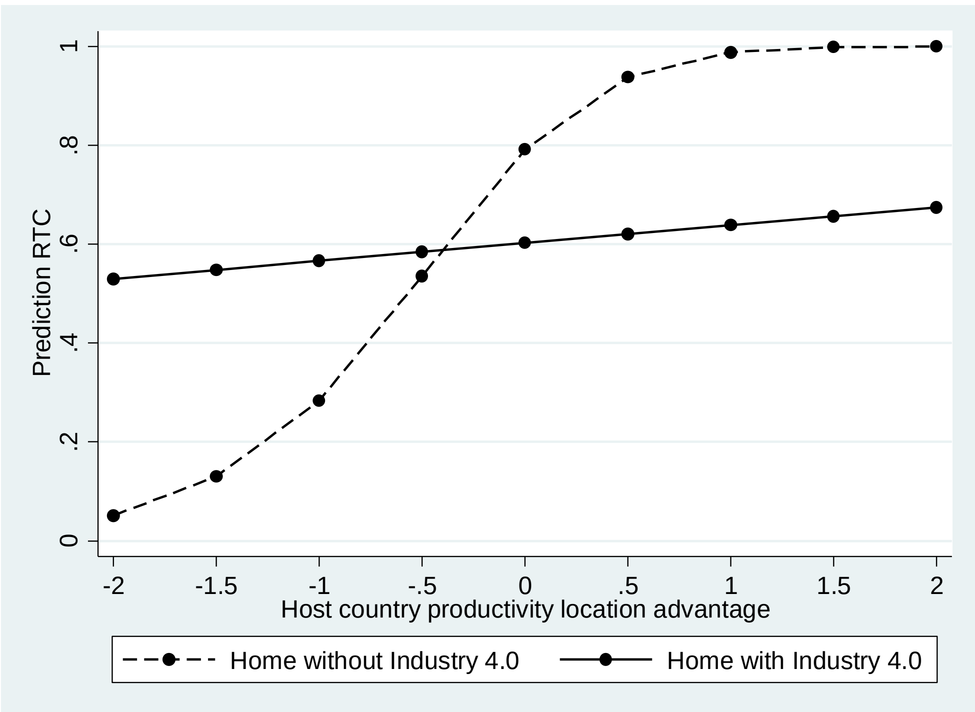


Figure 2: Plot of the interaction between *Host country productivity location advantage* and *Home country Industry 4.0 policy-based location advantage*



[i] Source: European Commission, Digital Transformation monitor [https://ec.europa.eu/growth/tools-databases/dem/monitor/content/germany-industrie-40]

[ii] Source: European Commission, Digital Transformation monitor [https://ec.europa.eu/growth/tools-databases/dem/monitor/content/united-kingdom-hvm-catapult]

[iii] 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.

[iv] 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.

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