The Impact of Industry 4.0 on FDI, MNE, GVC, and developing countries: A conceptual note

Abstract

The fourth industrial revolution is redrawing our business landscape today. Industry 4.0 has the potential to seriously impact the future of Foreign Direct Investment (FDI) and Multinational Enterprises (MNEs). This paper aims to provide an assessment of how the widespread adoption of new digital technologies, such as the Internet of Things, big data and analytics, robotic systems and additive manufacturing might affect the location and organization of activities within global value chains (GVCs). In particular, the analysis will focus on how this new technology can affect the geographic span and density of GVCs. Potentially, wider adoption of new digital technologies has the potential to partially reverse the trend towards global specialization of production systems into elements that may be geographically dispersed and closer to the end users. It would do so by consolidating some intermediate product manufacturing and thereby eliminating some formerly separate upstream facilities, and yet by the same token it may increase the geographic dispersion of final stage production closer to end users or markets. This process of GVC restructuring could enhance renewed geographic concentration to offset some new drivers of dispersion. This leaves the question whether in some industries diffusion of new digital technologies may change the role of MNEs as coordinators of GVCs by engaging a wider variety of firms.

This paper gives an overview of the most relevant issues and effects that Industry 4.0 is expected to bring on to MNEs and GVCs to developed and especially to developing economies in the near future. On the basis of recent literature and studies, we identify some main possible impacts or scenario's and define some relevant questions for further research. The paper thereby analyzes the possible implications for international business practice and theory and also looks into the wider repercussions on employment and development.

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1. Introduction and definitions

The term "Industry 4.0", originated in Germany, is commonly used to refer to the 4th industrial revolution (4IR). Although the concept lacks a thorough understanding and a proper definition, most visions and approaches do however indicate that Industry 4.0 revolves around leveraging digit(al)ization to the benefit of optimization and integration of production processes of goods and services. Similar to other industrial revolutions, it is a result of (disruptive) innovation, in this specific case driven by an empowered and more connected usage of technologies within production ecosystems. As such, the current advancements and progress that are taking place in both the service and manufacturing industries have been generally coined 'the 4th industrial revolution' (4IR) or 'Industry 4.0' (Schwab, 2016).

Although still in its infancy, Industry 4.0 is shaping our world in a breadth and depth, never seen before (Schwab, 2016). Due to the i) rise and popularity of mobile internet, ii) smaller, more powerful and cheaper sensors, iii) ability of accessing and using a massive continuous data stream, the world's physical and virtual systems will become interlinked and allow global interactions in a flexible way (Schwab, 2016). This new way of digitalization is shaping both the demand and supply side of business. On the demand side, expectations are being shifted from product-centered to more customer-centered approaches. On the supply side, we see a focus shift from reducing costs to offering products in a more innovative way with new and more added value (Schwab, 2016). These focus shifts mean that companies, especially multinationals with global value chains need to rethink and reshape their business models to prepare for this disruption (Strange, Roger, and Zuchella, 2017).

The utilization and development of these technologies is currently only at an early stage, definitely if one considers the full theoretical potential that these technologies can have once fully deployed. As Amara's law indicates, we tend to overestimate the impact of a new technology in the short run, but we underestimate it in the long run (Kietzmann, Pitt, & Berthon, 2015).

Nevertheless, it is hard to underestimate the future impact of Industry 4.0 which will range from the way that individual organizations are organized (e.g. supply chain setup) over macro-economic challenges (e.g., investment attraction, taxation systems, social concertation etc.) to private life (e. g. consumption behaviour, employment, lifelong learning etc.). Therefore, all stakeholders will need to prepare themselves to cope with the challenges of Industry 4.0 in order to grab its full potential benefits.

This paper is structured as follows: After explaining the main technologies that affect Industry 4.0 and illustrating their possible impacts, the paper will focus on the overall impact that Industry 4.0 might have on international business and more specifically Foreign Direct Investments (FDI), Multinational Enterprises (MNEs) and Global Value Chains (GVCs) in developed and developing economies, in particular.

2. The main Industry 4.0 technologies with an application to chocolate production

Although the number of new technologies abound, we can identify four major groups in Industry 4.0: Internet of Things (IoT), Big Data and Analytics (BDA), Robotics, and Additive Manufacturing (Strange, Roger, and Zuchella, 2017). Some of these include other advances such as Artificial Intelligence (AI) or block chain, but we will focus on the initial four. Each of these constitute in a different way to Industry 4.0 but it is their simultaneous deployment that allows firms to proactively take part in the revolution. Data and connectivity are central concepts at all levels. These new technologies allow firms to create factories of the future where autonomous smart objects serve as a self-organized IoT industry network. At the center, some of the identified core objectives relate to efficiency gains, cost reductions as well as enhanced data analytics and communication improvements. Hereafter we explain the four main Industry 4.0 technologies and their possible impacts with an illustration / application to the chocolate industry. We have chosen this example to illustrate that Industry 4.0 is also going to have a major impact on traditional industries, not just technology-intensive industries.

Internet of Things (IoT)

Schwab (2016) describes IoT as the relationship between things and people that is made possible by connected technologies and various platforms. In the case of GVCs, placing sensors that could provide real-time data inter alia, would allow better capacity planning, assessment of the usage and functionality of products, and wear and tear monitoring (Bughin et al., 2015a). This will result in a greater integration of data between firms, suppliers and customers, and in a reduction in the need for intermediaries (Porter and Heppelman, 2014). Moreover, and more importantly, IoT will fundamentally change management of geographically dispersed value chains (Strange, Roger, and Zuchella, 2017). Products will be monitored in a linked information flow instead of separate flows of information.

In the case of cacao production for example, this is extremely relevant for sourcing and tracing the origin of the cacao beans' region and variety. By applying for instance, e-payments in the supply chain of the cacao and chocolate industry, a chocolate producer can improve the tracing of the origin of the specific cacao beans and provide more information about the product to the customer (e.g. taste, aroma, sustainability). A digital money platform that combines financial and non-financial services such as information about farm planning, weather, inputs, production, post-harvest activities and market prices, will allow the firm to continuously monitor its raw material and adapt its strategy accordingly. Based on the information obtained through the platform, it can wisely choose in which country or even which farming community to invest. On the other side, a host country might want to attract new innovative players into the cacao field and therefore create a more competitive environment (Ginsburg, 2018).

Big Data Analytics

Data nowadays, can be generated from a diversity of sources, including sensor-generated data from smart products, publicly available data from search engines and social media sites (e.g. Google, Facebook, Weibo, WeChat), and new gene sequencing methods. This provides MNEs with new sources of potentially very valuable information (Davenport et al., 2012; Mayer-Schönberger and Cukier, 2013; George et al., 2014). For MNEs, this implies the ability to i) monitor emerging trends and opportunities in overseas market without the need to make substantial resource commitment, and ii) optimize more effectively their supply, production and distribution activities around the world.

When we refer to our example of the chocolate industry, estimates predict that the market for chocolate in China will grow to a value of 40 billion yuan (5.3 billion euros) by 2020. As the chocolate consumption of cacao per capita is still less than 1 kilogram a year, a mere tenth of the European consumption, there is still room for growth (Ren, 2017). Therefore, some European chocolate producers are now firmly set on expanding their production to China. Disposing of detailed data on specific flavor preferences of the Chinese consumers through (social) media monitoring and knowing more about the specific taste of a type of cacao bean through genome sequencing methods, producers will be capable to offer the right product to the right customer. This has important implications for investment decisions in the cacao industry (e.g. specific region), and for the go-to-market strategy e.g. value proposition, marketing and sales.

Robotics

The use of industrial robotics is in a rise due to three major factors (Strange, Roger, and Zuchella, 2017). First, the costs of both hardware and software has fallen by 20% in the last decade, while performance increased annually by 5% (Sirkin et al., 2015a). Consequently, the costs of robotics might be equal compared to human labour cost in a couple of years. This could impact MNEs in the decision where to locate manufacturing activities. For instance, reshoring manufacturing activities to advanced and skilled economies instead of offshoring to low labour costs economies might be a consequence. Second, the technical capabilities have become more versatile and mobile and thus able to perform more complex/delicate tasks. The more advanced robotic systems are even more intelligent due to AI and machine learning and thus provide and receive feedback from other parts of the production system through IoT (Strange, Roger, and Zuchella, 2017). Third, the improvements in costs, performance and functionality have permitted small-and-medium sized companies to adopt these technologies.

Robotics could help chocolate companies to improve some production steps and thus lower their costs. For instance, the sorting of good and bad cacao beans is still done manually today. A US based company, bext360, developed a robot that through machine learning and computer vision, knows how to sort good beans from bad beans. In 3 minutes, it is able to process 18000 beans. Moreover, the robot provides analysis to the farmer about the quality of their harvest. Combined with the platform discussed in the IoT section, this would give chocolate firms valuable information about the different beans and their quality, which can be in turn applied to their investment and go-to-market strategy.

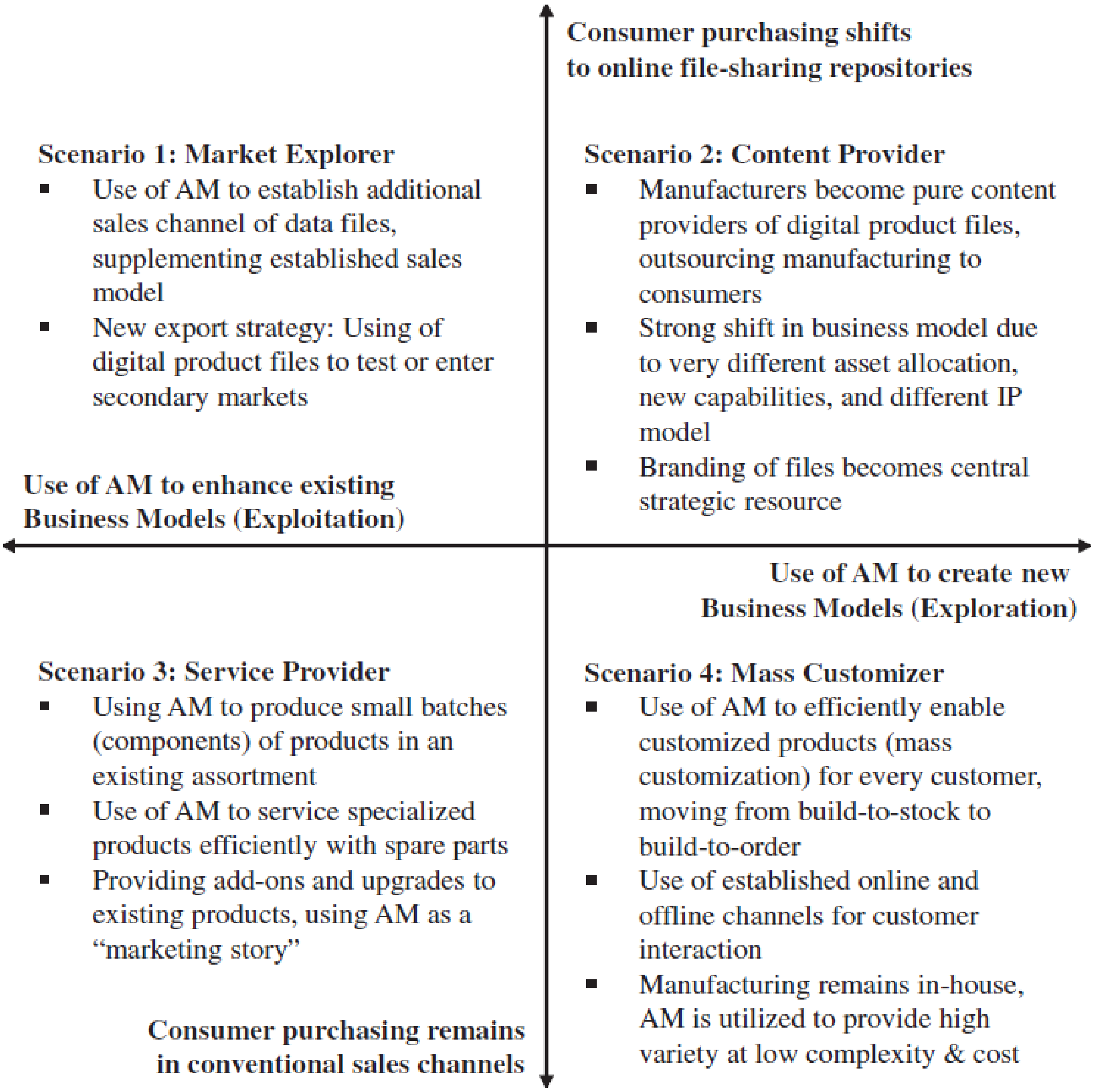
Additive manufacturing

Finally, additive manufacturing creates products by building up successive layers of materials. The greatest advantage in terms of GVCs, is that the manufacturing process can be located anywhere in the world if there is a compatible 3D printer. Therefore, manufacturing does not need to be centralized, but can take place close to the end-users, resulting in lower delivery times, transportation costs and supply chain risks. Currently some chocolate producers are working with 3D chocolate printers to support chocolatiers in their craft.

Although the minimum efficient technical scales vary considerably across industries, traditional manufacturing and price competition require large production series for manufactured goods. However, it is possible that the minimum efficient technical scale for additive manufacturing is significantly lower than for traditional production (Laplume, Petersen, & Pearce, 2016). In that case, scale economies, which are on par with factor-cost differentials as an important antecedent of global value chains, would no longer constitute a pivotal cost advantage in manufacturing. As such, the wider adoption of additive manufacturing has the potential to partially reverse the trend toward fragmented, specialized, and globally dispersed supply chains. It would do so by consolidating some intermediate product manufacturing and thereby eliminating some formerly separate upstream facilities, and yet by the same token it may increase the geographic dispersion of final stage production closer to the end users or markets (Alcacer, Cantwell, & Piscitello, 2016). So the process of GVC restructuring would have some aspects of renewed geographic concentration to offset some new drivers of dispersion. Rezk, Srai, and Williamson (2016) highlight the trade-off concerning the impact on the geographic dispersion of production activities of computerized manufacturing technologies. On the one hand, these technologies open up new options for firms to fragment and disperse their activities, and hence move from collocating activities locally to dispersing the value chain; yet, on the other hand, these technologies allow fewer production stages and a more integral product architecture, which requires production activities and tasks to be closely coupled. Accordingly, they claim that the latter tendency will transform some products that have been delivered through complex, multi-tiered value chains into relatively short tiered, integrated chains, depending again on product characteristics and their associated knowledge attributes.

Jiang, Kleer, & Piller (2017) constructed on the basis of their qualitative study, four extreme scenarios for additive manufacturing and future implications of 3D printing by selecting the following two projections : the impact of additive manufacturing on firm's business models and on consumer distribution channels

Figure 1 : Four controversial extreme scenarios how additive manufacturing affects consumer purchasing models.



Source: Jiang, Kleer, & Piller (2017)

The horizontal axis shows that for some experts, additive manufacturing can be regarded as just another production technology requiring novel knowledge and skills, but mainly improving the operational excellence of a company. While some operations may change drastically, the operating model of the company will remain the same. For those rejecting this projection, however, established business models will be disrupted by additive manufacturing, demanding incumbents to make radical changes. These two extremes resemble the established debate on exploitation versus exploration in the innovation management literature (March, 1991).

The vertical axis covers one of the most frequently debated implications of additive manufacturing (Rayna and Striukova, 2016, West and Kuk, 2016). The experts believing in this projection foresee a strong change in consumer behavior: Instead of acquiring physical products, consumers will utilize online databases to download product designs for self-printing, either purchasing the file (similar to downloading a music file in an online music store) or using a sharing model with open-source designs. Experts rejecting this projection, however, expect that also in 2030, products produced via additive manufacturing will be purchased as physical objects via established online or offline channels.

Combining these two axes, Jiang, Kleer, & Piller (2017) derive four possible scenarios. The extreme Scenario 1 combines the exploitation model with a new distribution model. Here, a company uses the efficiency of selling online files instead of exporting products to test new foreign markets, but also to cover niches of demand in established regions. Once a market is established, however, the products will be sold via a conventional business model (moving to Scenario 3). Scenario 2 combines the two extreme positions of an exploration strategy with a distribution model via online file-sharing. In this model, the business model of the company shifts fundamentally. A former manufacturer becomes a pure "designer" (providing the digital print files only). The core job of the company here is to guarantee the "3D printability" of the files. For its revenue model, it has to utilize new forms of intellectual property protection to allow for value capture.

Scenario 3 is the most conservative setup where additive manufacturing is mainly used to support an established business. Another option is to utilize additive manufacturing for the manufacture of niche products which are not economically feasible with conventional manufacturing models. Finally, Scenario 4 builds on the idea of mass customization, i.e. providing an individual product for every consumer, but with mass production efficiency. The business model of the company, hence, shifts drastically. Instead of forecasting product demand and producing it on stock, all operational activities are purely reactive, staring with the individual demand of each single customer.

3. The impact of Industry 4.0 on MNEs

Under the umbrella concept "Industry 4.0" it is clear that the global economy is undergoing a major transformation. Industry 4.0 is fundamentally disrupting traditional industries and labor markets and fundamentally changing the global economy. We are experiencing a digital revolution that is transforming the world as we know it. To companies, this means opportunities as well as challenges for new or changed business models, spanning from R&D and production to marketing, logistics and sales. Traditional business models and value chains are challenged as digitally performed activities allow for increased availability, shorter lead times, faster time-to-market and lower transaction costs.

These new evolutions require new business models. According to Bogers et al. (2016, p. 225) we will move from i) centralized to decentralized supply chains, ii) product-centred to customer-centred, iii) cost-based business models to innovation-based models. These shifts will challenge current conceptions of international business and MNEs. Current working strategies need to adapt to, and incorporate aspects of the Industry 4.0 based on their business, stake-holders and competition if they want to survive.

To compound the pressures on existing firms, this revolution also entails the advent of new industries and new players. As companies now have the ability to diversify or even change the focus of their business, so can competitors. Moreover, market structure is now more dynamic and key boundaries that used to exist tend to progressively disappear (e.g. consumers are becoming producers, niche market is becoming attractive to large players, not just to small ones) (Rayna & Striukova, 2016).

The advent of the digital economy also witnessed the advent of new industries and new types of companies, such as iBusiness companies that use the internet and computer based information systems to provide an internet-based platform, which allows users and customers to interact with each other (Brouthers, Geisser, & Rothlauf, 2016). For instance, we have witnessed the arrival of firms like Google and Facebook, which now cater to billions of users. Their innovative business models provide different conceptions of international business and the MNE, and Industry 4.0 will likewise lead to the rise of new organizations which leverage the new digital technologies but are not constrained by a need to adapt pre-existing models, routines and capabilities. This translates into opportunities for lower overall costs, allowing for smaller companies to compete with well-established companies and brands. Simultaneously, customer expectations mount with increased transparency, and competition increases across sectors. The further growth of digital platforms for the distribution of products (e.g. Amazon, Alibaba) should also make it easier for small firms to enter global markets. As such, not only big but also smaller enterprises will benefit from Industry 4.0, as it will allow them to (more easily) offer their products or services on an international level thanks to the availability of global (e-commerce) platforms. However, it remains to be seen whether smaller firms will be able to jump on the bandwagon as there is likely to be a discrepancy between the 4IR readiness between smaller and bigger firms in favor of the latter.

Industry 4.0 has the potential to strengthen the linkages in global value chains yet poses serious challenges to existing business models to create extra added value. This extra added value will be obtained by optimizing costs and increasing potential revenues. An example of cost optimization is the fact that via emerging technologies such as rapid prototyping the time to market, and hence its costs, during an R&D-process can become significantly lower. These benefits can be maximized by deploying these technologies on a global level. The supply chain system, for example, can become more decentralized (e.g., thanks to 3D printing) requiring less logistic efforts and/or costs and decreasing its environmental footprint. Other connecting technologies such as block chain or the IoT will make the roles of intermediate parties less relevant again decreasing its related costs, increasing operational efficiency and overcoming (national) trade barriers.

However, others see possibilities for production centers to be outsourced and centralized. Currently, the largest 3D printing companies are few and far between, although this industry is only getting started. Most companies still outsource their production given the prototyping nature of the types of products on offer. MNEs will need to adapt themselves to fully make use of those new production techniques. They will have to reconsider their strategic decisions, for example, regarding their manufacturing setup (i.e. owning vs. only using manufacturing equipment) or their revenue model (e.g., traditional sale of products vs. offering products on a pay per use).

Currently, major 3D printer manufacturers are geographically concentrated in the United States and Europe. Four of the top five manufacturers are U.S. firms (3D Systems, Stratasys, ExOne, Optomec). The others hail from Europe, in particular, Germany (EnvisionTEC, EOS, microTEC), Belgium (Layerwise and Materialize), and Sweden (ARCAM). Many firms are entering, exiting and merging into this hypercompetitive and volatile market all the time. Up!, a Chinese manufacturer, has 3D printers that are gaining ground in Asia and the Dutch firm, Ultimaker, was just founded a few years ago (Gress & Kalafsky, 2015).

For MNEs, Industry 4.0 could significantly alter the existing production mode, shifting from a vertical integration (with ERP systems for example), to horizontal integration where every unit is connected to the network, able to interact directly with every other unit. Thanks to Industry 4.0, managers will be able to make better use of resources, better schedule maintenance and avoid delays. From customers' orders to delivery, Industry 4.0 can contribute its part with for example checking the availability of raw materials, analyzing orders, queuing orders and tracking the whole process (Boucher-Genesse, 2016).

Simultaneously, customer expectations mount with increased transparency, and competition increases across sectors. Digital channels and tools allow for customer segments in new markets to be reached at lower costs compared to traditional set-ups. New methods for brand-building, marketing and sales are enabled, as well as better insights into customer behaviour and demand. Digitalization allows for wider reach, sales at higher speed, increased precision and lower costs, but also increased complexity and competition.

Of course Industry 4.0 could also bring along risks for multinational companies. As processes are easier and easier to align, product standardization becomes more attractive, possibly causing the development of products which lack market relevance in different geographic areas.

Despite the unmistakable potential benefits that Industry 4.0 could bring to companies, many business leaders experience a 'heightened level of anxiety' regarding business, economic and societal threats confronting their organizations (Digital Journal, 2018). In the near future it will be very important for organizations to dispose of the right people, who are familiar with cloud technology, data analytics or robotics. As 62% of the current business leaders indicate that they do not have enough digital skills among their workforce today, this could prove to be a serious challenge. Offering apprenticeships or internships to grow the workforces' digital knowledge can help in this process (Digital Journal, 2018).

Another concern is data security (Kagermann, Anderl, Gausemeier, Schuh, & Wahlster, 2016). This growing interconnectivity of machines, products, parts, and humans will also require new international standards that define the interaction of these elements in the digital factory of the future. Big data is becoming increasingly important, making big data analytics (BDA) an essential part of the future of industry. Efforts to develop data standards, for instance, for the Internet of Things (IoT) are in their infancy but are being driven by traditional standardization bodies and emerging consortia. New data protection laws and/or stronger industry self-regulation will need to be formulated to safeguard the privacy of individuals, and to put limits on what data can be accessed, stored and transmitted both nationally and across borders (Weber, 2010; Weber, 2013; Rose et al., 2015). This raises questions such as : who will have legal title over, and who will bear legal responsibility for, products which involve consumer-generated intellectual property (Berthon et al., 2015; Kietzmann et al., 2015).

In general, Industry 4.0 will allow multinational enterprises to increase their efficiency by making better use of resources, aligning their production process more directly, increasing production speed and eventually delivering more value to the customer. Yet, 4IR is requiring major changes in the business model and the various steps of their value chain.

4. The impact of Industry 4.0 on GVCs

The above mentioned changes also have major repercussions on the location and organization of global value chains (GVCs). Industry 4.0 technologies are expected to impact on the re-organization of production networks, the spatial organization of innovation and the location of the different business functions of value chains (R&D, logistics and planning, production, administrative and supportive functions).

Integrated real-time communications through GVCs will reduce the need for work-in-progress inventory. The enhanced machine-to-machine and machine-to-human interaction will allow greater product customization. Distribution will be effected by unmanned logistic vehicles and drones, at least once the considerable safety issues have been resolved. Labor productivity should rise and labor costs should fall in the medium-term, and firms will base their production location decisions less on production costs and more on proximity to customers. According to Bogers et al. (2016) a move from centralized to decentralized supply chains is envisioned, where consumer goods manufacturers can implement a "hybrid" approach with a focus on localization and accessibility or develop a fully personalized model where the consumer effectively takes over the productive activities of the manufacturer.

Finally, the inevitable reconfiguration of GVCs and the changing power relationships between the participants will lead to ever-greater confusion about where products are made, where value is generated, who benefits, and thus, where taxes and customs duties should be levied (Groth et al., 2014). Echoing the policy debate (Reich, 1990; Reich, 1991; Tyson, 1991) in the 1990s about who is "us" and who is "them", governmental attitudes towards trade and investment promotion/regulation will need to adapt to this new reality.

With Industry 4.0 firms can increase their efficiency through automation of individual processes, connection of various steps in the production process and registration of enterprise data, giving the various levels of management more possibilities to analyze and optimize the whole process (Boucher-Genesse, 2016). Industry 4.0, with its new service activities like Big Data and the Internet of Things, also increases the value of after-sales and knowledge intensive services (Gereffi, 2017). This will also involve a greater integration of data between firms and can reduce the need for intermediaries (Sasson & Johnson, 2016). The need to coordinate product and information flows will then decrease, bringing on benefits in production and distribution efficiency, particularly when cross-border flows within GVC's are involved.

After all, as the Internet of Things allows to reduce the transactions costs associated with international production, this facilitates an ever-deeper international division of labor within global factories (Strange & Zuchella, 2017). But maybe the most important impact of global value chains, as mentioned earlier, can be the relocation of manufacturing activities to the traditional advanced economies. This tackles an important question that requires further and deeper research.

5. The impact of Industry 4.0 on FDI

Finally, this 4th technological revolution will also have a major impact on the depth and breadth of Foreign Direct Investments (FDI). Industry 4.0 will have its impact on the location as well as the extent of FDI as the need for global flows of FDI as well as the FDI location characteristics are likely to change. For instance, the use of online technologies perhaps requires less marketing and sales investments, with each firm putting boots on the ground as online content providers take over much of the data gathering and provision. But also production might become more centralized and localized near the customers rather than dispersed in fragmented global value chains.

Individual businesses will need to reconsider their criteria used in their decision process relating to investing in foreign countries. The way in which foreign investors choose locations for FDI will change, as other indicators for investment decisions will become more relevant.

Industry 4.0 can blur the distinction between developing and developed countries and might consequently make the benefits of inexpensive labor in developing countries less relevant (FDI Intelligence, 2018). If a European company is looking for a country to make an investment to manufacture a product, and this product can be made via automation instead of labor, this company is more likely to prefer producing close to home in developed countries. If artificial intelligence (AI) replaces employees in a given industry, this produces an excess supply of labor and consequently minimizes the leverage and negotiation power of labor.

The digital aspect will remain a central concept within this field which raises the question as to how investors should assess projects when engaging in FDI that evolves around industry 4.0. In the scope of the technological improvements and restructuring firms, the high-skilled human capital will become more important and maybe even a driving factor in FDI. Greater automation will displace lower-skilled labour, but increase demand for higher-skilled labour (e.g. software specialists, engineers, data analysts). Low-skilled workers will be substituted or cancelled out by automated tasks. However, high-skilled labor will become more important as they will monitor and drive further innovation.

Therefore, low labor cost may become less important from an FDI perspective. As technological improvements have the potential to cut costs even more and increase efficiencies based on the local and in-house technological capabilities, FDI may increase in those locations with a higher agglomeration of technological capabilities. The traditional focus on the availability of cheap labour, for example, might shift towards a focus on the availability of a technology-savvy workforce. Similarly, also governments will need to adapt their policies to secure that they apply investor-friendly regulations. The level of labour costs might become less important compared to the openness of the economy, stimuli for innovation, availability of adequate telecom infrastructure etc.

6. The impact of Industry 4.0 on developing countries

Much of the discussion on the economic effects of industry 4.0 has concentrated on the effects in developed countries. However, these changes also have major repercussions on development and developing and emerging countries.

Optimists state that any adverse effects will be short-lived and that digitalization may help overcome slowdowns in productivity growth and increase worker income and well-being. Pessimists point to the rapid pace and increasing scope of new technological breakthroughs, and state that robots may require only a small number of better skilled workers for their operation, rather than the requirement for large numbers of low-skilled workers that complemented earlier technological breakthroughs. The result may be enduring adverse employment and distributional effects. Both narratives and arguments are coherent and may actually occur simultaneously, with benefits accruing in productivity growth for better-skilled workers and the owners of robots, while low-skilled workers risk being impoverished.

The increased automation in developed countries risks eroding the traditional labour cost advantage of developing countries. If robots are considered a form of capital that is a close substitute for low-skilled workers, then their growing use reduces the share of human labour in total production costs. This is why experts argue that Industry 4.0 favors providers of capital over labor (FDI Intelligence, 2018).

Adverse effects for developing countries may be significant. According to some estimates, for developing countries as a group, the "share of occupations that could experience significant automation is actually higher in developing countries than in more advanced ones, where many of these jobs have already disappeared", and this concerns about two thirds of all jobs (World Bank, 2016). Reshoring economic activities to developed countries is one mechanism that could lead to shrinking output and employment in the manufacturing sector of developing countries. Developed countries may aim to reshore in order to regain international competitiveness in manufacturing and stem the decline in manufacturing employment and the polarization of income that is to the detriment of middleclass workers. Reshoring could turn global value chains on their head, and lead to their decline as a potential industrialization strategy for developing countries (De Backer et al., 2016).

To the extent that relative factor endowments determine the international division of labour, the use of robots could alter the location of manufacturing of particular sorts of goods and services by altering their relative factor intensities. Assuming that low-skilled human labour and the use of robots are close substitutes and that robots controlled by high-skilled workers could perform, for example, clothing production and electronics assembly more efficiently than low-skilled workers, then these activities become relatively more skill-intensive. Deploying more robots than others would allow countries to increase their relative supplies of effective low-skilled labour (including both low-skilled human workers and robots). Doing so would allow countries with a low ratio of low-skilled to high-skilled workers to reduce their labour cost disadvantage and make labour-intensive manufacturing more competitive. Accordingly, such activities could shift from countries with a relatively high ratio of low-skilled to high-skilled workers to countries with a relatively low ratio. The result would be a shift in the latter country's sectoral structure of output and export towards a larger share of manufactures (Kozul-Wright, 2016; Rodrik, 2016).

It is not clear whether such shifts in activity in entire sectors may be expected to occur. Drawing on insights from more recent trade theory, which stresses the importance of firms and their heterogeneity in terms of productivity even within economic sectors, offers different results. Productivity differences may arise because some firms choose to produce in more technology-intensive ways, for example by deploying more robots than other firms. This may make them sufficiently competitive to exporting. Such effects may be reinforced by combining robotization with other new automation technologies, such as additive printing. The latter lowers the costs of prototyping and small-volume production, and could facilitate the initiation of manufacturing of new products, whose large-scale production could become economically feasible through the deployment of robots. Imitation by other manufacturers ready to undertake fixed-cost investments in robots and other automation technologies could boost a country's industrialization level generally and ignite a gradual increase in the share of manufacturing in its output and export structure. Another effect of deploying robots may be that this type of technology upgrading helps firms at initially lower productivity levels avoid being driven out of the market through import competition, and this could help stem deindustrialization. Therefore, according to the study of Kozul-Wright (2016), intra-industry reallocations of market shares and productive resources between firms are likely to be much more pronounced than sector-wide inter-industry reallocations that would require factor-intensity changes of a much wider range.

The 4IR brings both golden opportunities and challenges to developing countries and India in particular. Overall, there is an optimistic view, affirming that developing countries possess the foundation to seize the opportunities from 4IR. Especially, developing countries' young and growing population structure is best suited to take advantage of the next technological revolution, as it is still in its incipient stage. Additionally, due to the historical context, most developing countries missed the chance with the previous industrial revolutions. Developing countries should be ready to seize the opportunity provided by 4IR to "get straight to new industries", "utilize new technologies" and thereby "enhance the industrialization and modernization process" and "shorten the development gap with developed countries". Given India's current state of digital skills, they are likely to benefit relatively more than some other developing countries.

However, the challenges from 4IR in developing countries are also recognized as job displacement due to further automation, which threatens developing countries' core industries with intensive labor skills like garments, leather and footwear. The explanation for this is that cheap labor is not a factor generating competitive advantage. With modern technology, 4IR would use machines to be replaced humans in the whole process of manufacture. Or replace the production process entirely, as 3D printed shoes might illustrate. Who needs shoe materials and production equipment if they are to be printed in the store? Therefore, instead of holding an advantage of cheap labor force, developing countries will find it increasingly difficult to catch up to the developed world. Moreover, although most developing countries possess a young labor force, skills of labor force are mostly relatively low (Van Hiel, et al., 2018; Vivarelli, 2014).

In enterprise's perspective, the actual available information reveals that between SMEs and larger corporations there is a gap in terms of awareness and preparation regarding 4IR. SMEs appear to show limited interest in 4IR, and devote minimal attention to developing a game plan to deal with the trend. While further investigation into how prepared SMEs are for 4IRs is needed to have a more accurate snapshot of the current situation, it is understandable how smaller companies do not actually find 4IR relevant to their businesses, as the concept is still new, and they would be the least likely to afford to transition to more advanced technologies. Larger corporations may not have financial shortcomings, and are better informed regarding 4IR, at least in the cases of the business leaders, and hence presumably these corporations are better prepared strategically to cope with 4IR. However, further and deeper investigation is required into the effects of 4IR for large corporations versus SMEs and specially for the developing economies.

7. Conclusion

The emergence of the new Industry 4.0 clearly raises many major questions. In this paper we tried to give an overview of the most relevant issues and effects that Industry 4.0 is expected to bring on to MNEs and GVCs as well as to developed and developing economies in the near future. On the basis of recent literature and studies, we tried to identify some main possible impacts or scenarios and to define some relevant questions for further research. Many questions remain unanswered today and deserve deeper research. What will constitute important ownership (firm-specific) advantages under Industry 4.0? Which value chain activities will MNEs need to control, and which isolating mechanisms will they need to possess (Rumelt, 1984; Rumelt, 1987; Lawson et al., 2012) for them to capture the rents earned in GVCs? If manufacturing activities are carried out by a combination of publicly available robotic systems and independent 3-D printing super-centers, then will the ownership of production capacity allow effective value capture, or can such activities be outsourced? Will it become more important for MNEs to control the design and distribution stages of GVCs? But 3-D printing will potentially allow customers to have greater input in the design of their products, and control over where and when it is manufactured. Or will Big Data Analytics adoption allow large firms to anticipate market trends and to offer customer benefits that are hard for competitors to imitate? Will formal property rights allocated by the State (e.g. patents, trademarks, licenses) or brand names and/or corporate reputations be effective isolating mechanisms in a world of product customization and dispersed manufacturing?

What will be the nature of location advantages under Industry 4.0 for (a country like) India? International business is based on a concept of geography that may be partially challenged in an Industry 4.0 scenario (Gress and Kalafsky, 2015). Clearly, greater use of robotic systems will minimize the cost economies that are realized from locating manufacturing activities in low labour-cost countries, such as India. But will this mean that such activities are reshored to traditional (advanced economy) locations? If so, what will be the impact upon employment opportunities (Frey and Osborne, 2017) given the capital-intensive nature of the manufacturing process? Or will manufacturing activities increasingly be located closer to the final customers? Certainly this would be the logical conclusion from the widespread adoption of 3-D printing. These developments will have significant impacts upon what products are traded, what is exported from where and imported to where, and where jobs are sustained. The spread of additive manufacturing would reduce trade in finished goods, and local availability of the necessary raw materials would also reduce trade in intermediate goods. How will host- and home-country governments react, and what policies will they enact to promote or restrict trade and FDI?

Finally we wonder what internalization advantages will be critical under Industry 4.0 for a country such as India? Are there advantages to being vertically-integrated in the face of the technological changes identified above (Afuah, 2001; Langlois, 2003) and, if so, what should be internalized and what should be externalized? Should knowledge (including big data) be increasingly internalized within MNEs, whilst operations are increasingly externalized? Certainly it appears that the key capabilities that will guide firm performance in the future will be those that address, on the one hand, the need to anticipate and shape future customer demands and, on the other hand, the need to bring about greater efficiencies in the distribution of final goods. These capabilities are inextricably linked to the deployment of BDA and the IoT, and it will be firms that can afford to invest in these nascent digital technologies and employ the associated high-skilled labour that will flourish. This seems the future of the MNE in the coming decades of the twenty-first century. The question also remains whether a country like India is up to the task in addressing these opportunities.

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