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# EFFECTS OF INDUSTRY 4.0 ON RESHORING INVESTMENTS - HUNGARIAN EXPERIENCES

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# Effects of Industry 4.0 on reshoring investments – Hungarian experiences

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# Effects of Industry 4.0 on reshoring investments – Hungarian experiences[1]

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***Abstract***

After the 2008 crisis, the topic of reshoring previously outsourced production was raised in the EU and the USA, in parallel to reindustrialization and competitiveness discourses. This paper clarifies the definition of reshoring, backshoring and nearshoring, while enumerating the possible motivations for them (eg. higher-than-expected labour or transport costs, strategic decision-making, insufficient product quality). Automation and robotization (parts of the 'Industry 4.0' concept) can provide a push in the global production chain for various forms of 'shoring'. This can be highly relevant for CEE countries, given their high-levels of integration into global production chains. Advanced robotics increasingly allows the substitution of labour, thus a wave of reshoring can take place from low-cost labour-intensive countries to developed countries that previously exported capital and technology. This paper addresses reshoring impacting Hungary (backshoring from Hungary and nearshoring to Hungary from Far-Eastern countries). Apart from theoretical writings, little work has been done on the empirics of reshoring and its correlation with robotization. This paper summarises these empirical studies in a targeted literature review, while recent trends are mapped based on press information and interviews. The major conclusions are that backshoring from Hungary because of Industry 4.0 is practically non-existent, but examples of nearshoring to Hungary can be found. Certain country-specific characteristics (e.g. labour shortages, legal instability, tax policy) contribute to investment and automation decisions of foreign producers. Moreover, domestic SMEs are generally not prepared to the introduction of Industry 4.0 technologies in Hungary in comparison to the foreign affiliates.

***JEL :*** F23, F6, M11, M15, O33

***Keywords:*** Reshoring, Industry 4.0, Hungary, automation, nearshoring

## Introduction, definitions

With the widespread fragmentation of production and increasing globalisation, offshoring became a popular company strategy in the nineties. In the last decade, however, a reverse trend has been experienced, more and more companies that had previously offshored tasks, started bringing production back to their home countries

[1] The paper was prepared in the framework of the research project no. NKM 2019-76 titled "Hungary and Estonia - Strongly Connected to Global Value Chains"

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(Kinkel, 2012). This reshoring phenomenon can be further divided from a geographical point of view: backshoring is the relocation back to the home country of the firm, and nearshoring (Bals et al., 2016) is the relocation to a closer (neighbouring) country (Di Mauro et al., 2018a). This paper discusses these two aspects of reshoring detecting the effects on Hungary.

The concepts of reshoring, backshoring as well as nearshoring refer all to the reverse of offshoring. There has always been some movement of activities back to the home country typically because of disappointing experiences with production abroad (de Backer, et al., 2016), but the literature suggests a growing importance of reshoring. According to the European Economic and Social Committee**,** reshoring may even be one basis of reindustrialization in the EU (Iozia and Leiriao, 2014). Reshoring does not necessarily mean the repatriation of all the previously offshored activities, hence it does not need to realise a total international divestment. Thus, reshoring does not necessarily result in de-globalisation or the decrease in global activities of the given company (de Backer, et al., 2016).

The term „Industry 4.0" stems from Germany (Hannover Fair opening speech 2011)[3] where the government's high-tech strategy was adopted to promote the utilisation of new technologies at the companies. (In the US the term „smart manufacturing" is used more often). According to Rüßmann et al., (2015) Industry 4.0 has nine pillars (big data, autonomous robots, simulation, horizontal and vertical system integration, industrial internet of things, cybersecurity, cloud, additive manufacturing and augmented reality). From 2015 the notion „Industry 5.0" is also in use (it has been firstly introduced in an article published in a social network[4]), which means the joint work of highly skilled workers and robots producing customised goods and services.[5] Industry 4.0 could end up restructuring human tasks in manufacturing in ways that benefit the workers. The greatest advances predicted of Industry 5.0 involve the interaction of human intelligence

[3]http://www.wolfgang-wahlster.de/wordpress/wp-content/uploads/Industrie_4_0_Mit_dem_Internet_der_Dinge_auf_dem_Weg_zur_vierten_industriellen_Revolution_2.pdf
[4] https://www.linkedin.com/pulse/industry-50-from-virtual-physical-michael-rada
[5] https://www.raconteur.net/technology/manufacturing-gets-personal-industry-5-0

and cognitive computing. Combined, humans and computerized machinery (eg. collaborative robots, cobots) can be more rapid and perfect[6].

The question of this paper is whether the application of Industry 4.0 or its elements enhances backshoring and nearshoring and what are the consequences for Hungary. There is a considerable literature on reshoring and on Industry 4.0 separately and much less literature on combining the two topics but there are hardly any research concerning the prospects of Central European economies in this respect. This research gap is to be filled by this paper. The topic is important also because automation and robotization is most intensively applied in the automotive and the electronics sector, where foreign investment and globally connected production is significant in Hungary (and Central Europe).

Apart from the relevant literature review, the paper applies the methodology of gathering domestic and international press information (similar method was used by Sass and Hunya, 2014) and analysing availabe statistics. Interviews with Hungarian policy agents and companies were also conducted to have some kind of overall view.

We found that backshoring from Hungary has not been a relevant phenomenon yet. There are however examples of nearshoring to Hungary (from Asia) in order to shorten the supply chain. Adaptation of Industry 4.0 features (robotization, automation, digitalization) is taking place in Hungary mostly by foreign investors. It seems that instead of backshoring they realize automation in Hungary, stimulated by the shortage of labour in the country. Favourable tax conditions still make the country attractive for new foreign investments or reinvestments. The major driver of reshoring is the reorganization of the global production chains within which Industry 4.0 can be an important aspect.

The structure of the paper is the following: first general reshoring motives are described, then survey and country-case evidences on reshoring are shown. The next section analyses the barriers and difficulties of automation and Industry 4.0 application.

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[6] https://blog.gesrepair.com/2017/11/16/industry-4-and-5/

The paper also mentions the possible effects of robotization on labour. The final parts discuss the maturity and experiences of Hungary regarding Industry 4.0 and some nearshoring evidences.

## Motives for reshoring in general

Several different backshoring motivations have been proposed in the literature. Some consider it as a *correction of managerial errors* like insufficient planning and knowledge on the offshore location (Kinkel and Maloca, 2009) Miscalculation or underestimation of full costs belong to here (cost of monitoring, communication, and coordination between distant affiliates and headquarters are high and can be greater than initially envisaged (de Backer, et al., 2016). Others point to *changes in the offshore or home country environment*, such as the rising costs in Asia, or the lower costs of energy in the West (Martínez-Mora and Merino, 2014; Simchi-Levi et al., 2012). Scholars also have argued that backshoring may follow from the inability of firms to solve complex challenges created by offshore production (Manning, 2014). Backshoring has also been associated with *consumers' pressures on companies*, stemming from perceived higher quality of western productions ("made in" effect). An important motive of reshoring is *flexibility, the proximity to the market and to R&D centers* (de Backer, et al., 2016). Thus the communication flow between departments is uninhibited, there is a potential to increase product innovation as the design teams and manufacturing are operating in the same facility without a linguistic, cultural or geographic gap (Brandon-Jones et al., 2017). The reshoring investment decision can also be the *product of a crisis*, shrinking profit and demands in the home country (see the US around the global economic crisis of 2009, Tate, 2014). *Political stimulating programs*, national sentiment have also induced reshoring, mainly to the US. A detailed enumeration and grouping of motives can be found in Di Mauro et al., (2018). According to another grouping host-country, home-country and international-technological factors can be mentioned as motives (Młody, 2016). Reshoring to Europe, however, is not always easy for the companies and can be risky. Iozia and Leiriao, (2014) mark the strong euro, low productivity, high social and energy costs as barriers to reshoring and call for incentives in taxation, revitalisation of

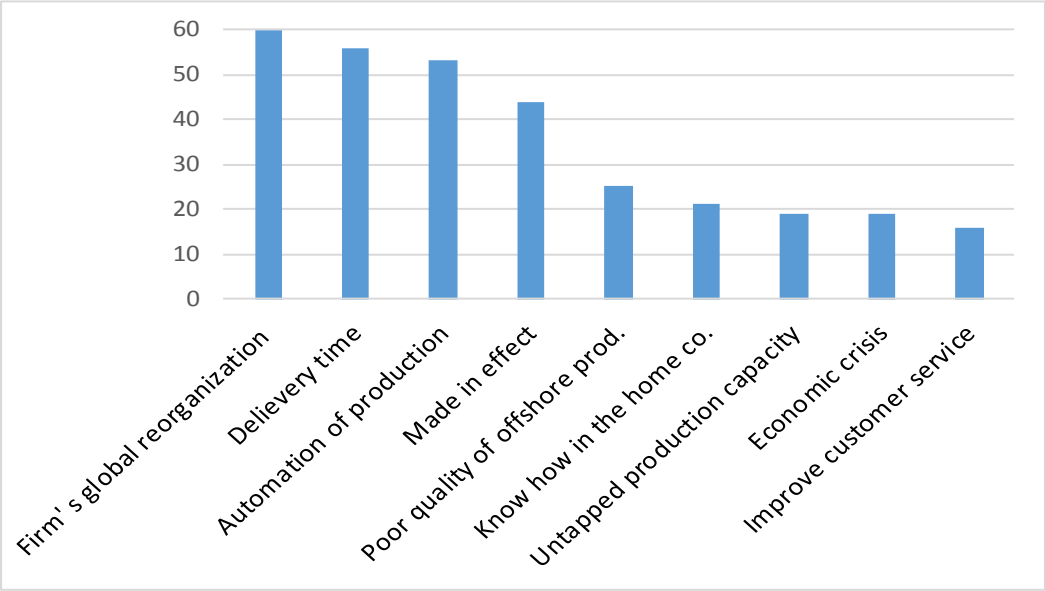
industrial districts and support to R&D among others. The mentioned backshoring motives are supported by survey evidences.[7]

Referring to the subject of this paper, a further important reshoring motivation has emerged in the past years: the *growing automation, digitalisation of manufacturing*. The internet of things, sensors, robots, data analytics and artificial intelligence (Industry 4.0) are transforming production. These may erode the labour cost advantage of emerging countries as labour costs will represent a smaller share of total costs in the production chain. Thus, it will not be worth offshoring for a company and reshoring can be favoured.

Figure 1 shows the most important motives declared by reshoring companies in the European Reshoring Monitor database. It can be seen that automation of production is among the leading three reasons.

[7] Concerning reshoring from China, Cohen et al., (2017) gathered data from 74 leading firms across manufacturing sectors. Respondents indicated how their production sourcing changed across regions over 2013-2015, and identified the important drivers behind these changes from a set of potential drivers. Using econometric analysis the authors found that the reasons for divestment from China are growing energy and labour costs, but there has been still much more investments than disinvestment. Similarly, Chen et al., (2015) survey 49 multinational companies with operations in China and find no significant trend to reshore production to developed economies. They also state that motives for investing and reshoring are complex, not only one or two-factor decisions.

Figure 1: Motives of reshoring




*Source:* European Reshoring Monitor (2014-2018)

There are some case study and survey evidence on the connection between reshoring and automation (see later) and there is also one econometric experiment. This latter was carried out by Krenz et al., (2018) who found evidence for an association between reshoring and automation (density of robots) within countries and within manufacturing sectors. An increase of robots (per 1000 workers) by one unit in the manufacturing is associated with an increase of the reshoring activity by 3.5 percent. (International Federation of Robotics provides information on industrial robots in countries and industries). Reshoring is measured here at a macroeconomic level by the growing difference between domestic and foreign inputs in production (taken by WIOD database). The reshoring measure shows by how much domestic inputs increased relative to foreign inputs compared to the previous year. Krenz et al., (2018) provide also evidence that reshoring improves wages and employment for high-skilled labor but not for low-skilled labor.

There are certainly various risks, barriers of reshoring (ranging from regulations, access to raw material, labour force) and can be grouped into global, home country-, host country- or firm-specific factors (see a collection of these in Engström et al, 2017). Among these barriers capacity extension as a consequence of backshoring can be a

difficult firm-specific factor, because although some companies may have introduced lean policies and automation, but further investment in new machinery can be necessary. This requires additional financial resources. Many companies that have failured offshoring consider it to be too late to change and reshore because the believe that the costs of reshoring are too high (Engström et al, 2017).

**Available data**

There is no worldwide database on reshoring. The European Union collects certain data and there are country-specific databases (in the USA and in Italy for example). Regarding the USA the "*reshoring initiative*" homepage[8] gathers published articles and collects interviews on the subject of reshoring to the USA. According to their 2017 report[9] reshoring job announcements steeply increased between 2015-2017 in manufacturing. (FDI and reshoring occurs mostly in the transport equipment, electrical equipment and textile branch). 62% of reshoring took place from China and 19% from Mexico between 2010 and 2017. As main positive domestic factors mainly government incentives, proximity to customers, skilled workforce availability were ranked and as main negative offshore factors quality, freight costs and total costs.

Regarding Italy, an inter-university database was formed (*Uni-Club MoRe Back-reshoring data* set) based on press information, academic papers and consulting companies' reports[10]. This project of five universities proved an increasing number of reshoring to Italy, mainly because of logistic costs, „made in" effect and quality considerations. Backshoring were apparent in several branches, but mainly in clothing-leather industry. Between 2007 and 2016 the database registered 121 reshoring decisions to Italy, mainly from China (33,9%), Eastern Europe, CIS (24%) other Asia (12,4%) [11].

[8] http://reshorenow.org/news/
[9] http://reshorenow.org/blog/reshoring-initiative-2017-data-report-reshoring-plus-fdi-job-announcements-up-2-800-since-2010/
[10] https://www.eesc.europa.eu/resources/docs/fratocchi.pdf
[11] https://www.este.it/images/Presentazioni-Relatori/2016/Presentazione_Zanoni_FabbricaFuturo_Bologna.pdf

The Italian database was widened to a European database, the mentioned *European Reshoring Monitor.* It collects information on individual reshoring cases from several sources (media, press, scientific literature) and maintains a regularly updated online database. Active data collection for the reshoring monitor began in February 2016 and some earlier reshoring cases (2014-15) have been identified from earlier data collection activities. The database is updated monthly. The monitor also contains an online database of reference material on reshoring (articles, reports). The database contains companies that reshore to their home country (within the EU) activities previously offshored to another country and companies that reshore to any EU country activities previously offshored to a non-EU country. In the description of each case there are some words also on the motives of reshoring.

Table 1 gives those European countries that most actively reshore (UK, Italy, France, Skandinavia and Germany) and also those countries from where production has come back. China is by far the most important country in this respect, but we also can find other Asian areas. There are some Eastern and European countries too but we can find Germany, UK, Italy also here. A part of reshoring is nearshoring, mosty to Central and East European (CEE) countries but most of it is backshoring.

Table 1: Geographical distribution of reshoring cases between 2014-2018

| **Reshored from** | | **Reshored to** | |
|---|---|---|---|
| China | 75 | UK | 44 |
| Poland | 15 | Italy | 40 |
| India | 15 | France | 36 |
| Germany | 14 | Norway | 20 |
| UK | 10 | Denmark | 17 |
| Sweden | 9 | Sweden | 15 |
| United States | 7 | Germany | 14 |
| Italy | 6 | Poland | 10 |
| Romania | 6 | Spain | 10 |
| Netherlands | 6 | Finland | 9 |
| Slovakia | 4 | Ireland | 4 |
| Czech Republic | 4 | Slovakia | 3 |
| Taiwan | 3 | Romania | 3 |
| Spain | 3 | Portugal | 3 |

| | | | |
|---|---|---|---|
| Australia | 3 | Belgium | 3 |
| Finland | 3 | Croatia | 2 |
| Bulgaria | 2 | Czech Republic | 1 |
| Vietnam | 2 | Austria | 1 |
| Belgium | 2 | Switzerland | 1 |
| Canada | 2 | Hungary | 1 |
| Estonia | 1 | | |
| Morocco | 1 | | |
| Norway | 1 | | |
| Cyprus | 1 | | |
| Singapore | 1 | (11 cases of nearshoring: PL,HU,RO,PT,IR,SK) | |
| UAE | 1 | | |
| Japan | 1 | | |

*Source:* European Reshoring Monitor

There is a „restructuring events" database of the *European Restructuring Monitor*[12](Eurofound). It contains data on major restructuring events reported in the principal national media in each EU member state since 2002. More than 24,000 restructuring events have been recorded. In order to be included in the database, an individual case must involve the announced loss or creation of at least 100 jobs, or employment effects affecting at least 10% of a workforce of more than 250 people. There are several types of restructuring including bankruptcy, closure, relocation, offshoring/delocalisation, outsourcing.

Barbieri et al., (2019) studied backshoring and relocation to a third country (RTC) based on the European Restructuring Monitor (ERM) relocation data between 2002 and 2015. Data show a peak in the relocation initiatives between 2005 and 2007, which is likely due to the EU enlargements. The worldwide financial crisis, which started in late 2008, caused a reduction in relocation initiatives between 2009 and 2010. The authors focused on location advantages underlying the previous offshoring decisions in manufacturing activities and their effects on later reshoring. According to their results, when a previous offshoring investment is driven by market-seeking location advantage, firms undertaking reshoring are more likely to opt for a backshoring, except during the economic crisis where market-seeking European firms seem to prefer RTCs. On the

[12] https://www.eurofound.europa.eu/observatories/emcc/erm/factsheets

other hand, RTC is a preferred choice when the location advantage is of efficiency-seeking type.

Dima (2018) analyses ERM relocation data between 2002 and 2015 and shows that Poland figures as an important destination for reshoring, and all the operations related with the country are of nearshoring type. Among other such frequent destinations are Romania, Hungary, Czech Republic and Slovakia. Germany is a relevant destination for reshoring events and here backshoring is also frequent.

A narrower database is the *European Manufacturing Survey* (EMS) 2015 that includes 2,120 manufacturing firms from Austria, Germany and Switzerland with at least 20 employees. The EMS measures backshoring with a question if the firm has relocated production activities from own affiliates or from suppliers back to the home country during 2013 and 2014. Thus backshoring is not just disinvestment but also relates to activities which have been contracted out to third parties. The paper of Dachs et al., (2017) is based on this Survey and directly addresses the question of reshoring as a consequence of Industry 4.0. Based on several questions the authors create an index of I4.0 readiness with six values (from 0-5). Overall, the paper finds a very small share of manufacturing firms which have backshored production activities. The most important reasons for backshoring are the lack of flexibility at the offshoring location and a low quality of the goods produced. I4.0 readiness is highest among the largest firms, which also have the second-highest backshoring propensity. At the sectoral level, there are very low values of the I4.0 readiness index in low-technology sectors such as food and beverages, textiles and clothing and wood, paper and printing, while the highest values can be found in electrical, electronics and among the manufacturers of vehicles. There is a significantly higher I4.0 readiness value for firms which have backshored production activities compared to firms with have not backshored.

The mentioned databases can show mostly the quantity and trends of reshoring. Regarding the motives in detail we can rather rely on surveys, studies, interviews and press information. Based on these we can have certain “country case studies” illustrating the major reshoring economies.

## Country examples

In the past years reshoring has become a popular topic in the *United States*. There are studies and statistics describing and measuring reshoring waves, and there are also surveys of firms. Ellram et al., (2013) surveyed a US sample of 319 firms regarding their motivation for production location. They found that the drivers for offshoring or reshoring location decisions change over time and by region of the world. They conclude that companies in their sample put more emphasis on total factor cost, profitability, and customer value than pure labour costs. In an other study (Tate, 2014) documents a moderate trend of reshoring to the U.S. which varies in strength by industry. In a survey of the Boston Consulting Group (2015) increasing reshoring to the US between 2012-15 was proved and a connection was also made to automatization of production. 56% of the managers believe that the decrease of automation costs improved the competitiveness of their products and 71% thinks that new technologies enhance reshoring to the US. Those who reshored mentioned the shortening of the value chain, reducing shipping costs, better control over anufacturing process and doing business easier as main motives.

Concerning *Germany* backshoring is an important topic too. Kinkel and Maloca (2009) surveyed 1663 German companies. Using a regression model and statistics they revealed that production offshoring has lost momentum and reshoring appeared among these firms. Between 16 and 25 percent of all offshoring decisions were followed by a reshoring activity within four years. Reshoring activities seem to be driven mainly by flexibility and quality concerns. In a later work Kinkel et al.,(2017) describes the results of the European Manufacturing Survey of 2015 for Germany. Backshoring of production capacities has slightly risen compared to the 2012 survey results. From 2013 to mid-2015, about 3% of the German manufacturing companies have backshored parts of their foreign production capacities to Germany. At the same time, production offshoring activities stagnated or declined. The main source countries of backshoring were the EU 15 countries (32%), followed by (other than China) Asian countries (23%), North America (16%), China (13%), and the Middle and Eastern European EU 13 countries (10%). The most important reasons for backshoring activities of German manufacturing

companies were the lack of flexibility (56%) at the offshoring location and a low quality (52%) of the goods produced.

Kinkel et al.,(2017) also intended to detect relationship between backshoring of production activities and the use of Industry 4.0 technologies. The analysis is based on data of 1,282 German manufacturing companies as a representative sample. Three technology fields were defined: digital management systems, wireless human-machine communication and cyber-physical-systems. In a second step, an Industry 4.0 readiness index was constructed at three levels. Level 0 is a non-user, level 1 is a beginner (the firm has introduced at least one element from one of the three different technology fields. Level 2 is an active user (if the company has introduced technologies from at least two of the three different technology fields) and level 3 is an advanced user (introduced at least one technology from all three different technology fields). 33% of the German manufacturing industry belonged to the level 0 group in 2015, 21% belonged to level 1, 25% to level 2 and another 21% to level 3. A logistic regression model displayed a significant positive correlation between the use of digitization technologies in manufacturing and the backshoring propensity of German manufacturing companies. "Advanced users" (level 3) have significantly more often shifted foreign production activities back to the German location as "non-users" (level 0) of digitization technologies.

German companies are under scrutiny also in Müller et al., (2017). This study is based on a sample of 50 German firms and asks the question whether Industry 4.0 affects the reshoring activity of these firms. 13 firms indicated that Industry 4.0 will play a role for them when bringing back production to Germany or setting up new plant in Germany or switching to German suppliers. Except for political or governmental incentives and decreased communication and coordination costs, three out of five drivers for reshoring that are named by these 13 responses are related to innovation, testing of technologies and time to market. Industry 4.0 mainly remained a niche in context of reshoring, that is related mainly to innovation and research and development.

The example of the *United Kingdom* regarding reshoring was analysed for example by Bailey and De Propris (2016). The authors prepared several semi-structured interviews and meta-analysis of surveys until 2015. Based on these they find that indeed there is

evidence on reshoring to the UK. The most important motives in generally are quality, saving on (transport) costs, greater flexibility and supply chain security. Bailey and De Propris (2016) focus on the automotive industry where there has been a significant trend of reshoring. Because of this, the UK government over 2010-2015 developed a £245 million „Advanced Manufacturing Supply Chain Initiative" to help local suppliers mainly in the automotive branch. The fund could be used for capital expenditure, skills and training, and R&D projects. In January 2014, UK Trade & Investment Agency launched „Reshore UK", a one-stop-shop service to foster companies to bring production back to the UK through strengthening business environment[13]. A reshoring homepage was also set up to help companies to find partners and possibilities.[14] A crucial event of the UK economy is Brexit. Exiting the EU can have some inducing effects on reshoring, but not without policy incentives (Bailey and De Propris, 2017). Firms will probably be seeking to create a far shorter supply chain, given the cost and complication that tariffs and non-tariff barriers might bring after Brexit. (Import intensity is high in most cases, 50% of the value of parts in a British-built car are imported from the EU)[15].

The global economic crisis of 2008 accelerated the trend towards reshoring manufacturing back to the UK. The results of a survey of 262 UK manufacturing companies — conducted at the end of 2016 — show that 70% of companies have undertaken some form of shoring activity since 2008; 40% of companies offshored; 13% of companies undertook direct reshoring. However 52% had indirectly reshored — increasing capacity at home instead of abroad. 70% of respondents considered direct reshoring and 20% indirect reshoring in the following years.[16]

Robinson and Hsieh (2016) made a case study on UK high-end clothing branch and Burberry company. They point out a reshoring trend in response to a growing demand for British-made fashion. The brand 'Made in Britain' is a marker of authenticity, superior quality, and indicator of tradition in luxury fashion. Apart from that there has been a growing awareness of the importance of combining local and global sourcing to

[13] https://www.gov.uk/government/news/new-government-support-to-encourage-manufacturing-production-back-to-the-uk
[14] https://www.reshoringuk.co.uk
[15] https://home.kpmg/content/dam/kpmg/uk/pdf/2017/03/Brexit-and-reshoring.pdf
[16] https://warwick.ac.uk/fac/sci/wmg/research/scip/networking/26september/wmg_realities_of_reshoring_report.pdf

swiftly meet changing consumers' requirements. By backshoring, Burberry shortened its supply chain and could better control the production process.

*Italy* is one of the countries where the issue of reshoring has been popular in the past years. The relevant literature is based mainly on case studies and questionnaires analysing the strategies of Italian companies. Mignucci, (2017) mentions the effect of digitalisation on reshoring and includes two Italian case studies. Benetton backshored production from Croatia in 2016 and invested in an automatised plant in Italy and Five (producer of electric bicycles) moved part of its production from China to Bologna creating a new robotised factory. In both cases reducing lead time, quality and the „made in Italy" factor were important motives. The demand for good quality Italian luxury articles (clothes, shoes) has increased in the emergent markets. The image of these products has become more and more important also as a contribution to export (Talamo, 2016). The famous Italian firms reconsidered and backshored parts of their production because of brand quality reasons[17]. Chiarvesio and Romanello (2018) made interviews in 16 firms in 2017. These firms have invested in Industry 4.0 as a result of a long-term investment in technology, R&D and innovation, which started in the previous years. Not every technology may be interesting for all the companies, it depends on the product and production characteristics. Four companies had formerly invested in productive subsidiaries in East Europe. Two of them backshored some part of their production to Italy and none have implemented Industry 4.0 in foreign productive subsidiaries yet. The decision of where to adopt Industry 4.0 depends on the broader firm strategy influenced by several factors (among them industrial clusters). From another questionnaire survey (Fazio, 2018) we know that Italian small and medium-sized enterprises (SMEs) have not been active to implement Industry 4.0 elements. Most of them maintains manual, artisanal production of high quality. They have information but simply do not consider automation or other elements necessary.

Relocalizations augmented since around 2010 in *France* (Bost, 2015). We cannot speak, however about a massive phenomenon and there are failed reshoring cases too. Similarly to Italy, reshoring activities to France have also a motive of a kind of national

[17] https://www.repubblica.it/economia/affari-e-finanza/2018/04/23/news/benetton_prada_safilo_geox_tornano_le_fabbriche_fuggite_allest-194587710/

identity „made in France" mainly in the case of certain products (beauty, luxury, etc.). Apart from this, several firms have had negative experiences in Asia, they faced stealing of technology, late deliveries, too large distances among other factors. There is also a progress in robotization and automation in France with declining costs that can further boost reshoring. During the decade since 2008 only 92 enterprises backshored its production to France.[18] There are cases that can be bound to automation, for example Paraboot shoe company that in 2013 reshored its sneakers production in Portugal to France and largely automatized production[19]. (Paraboot has also production plants in Itay and Spain but these remained because items are hand-made and labour is more expensive in France). Another case, the ski producer Rossignol outsourced to Taiwan in 2007 but in 2010 repatriated the production of 60 000 pairs of ski into France. The reason was to gain more flexibility and reduce delays and transport costs[20]. Rossignol also invested in automatization in its French factory later.

Fel and Griette, (2016) analysed ten cases of reshoring from China and found the following motives for reshoring: error corrections, changes in financial terms with China and changes in companies' strategies (especially to move upmarket). As a result of a questionnaire survey the authors also have a sample of 215 companies that previously offshored to China. 48% of them reshored, mainly in the textile, retail and automotive industry. In is interesting that 62% of reshoring was a nearshoring to the CEE region and 30% was backshoring to France. As reshoring motivation changes in Chinese business conditions were the most important, followed by strategic aspects and mistake correction.

Analysing fourteen case studies of *Spanish* footwear manufacturers, (Martínez-Mora and Merino, 2014) found that ten companies that had offshored production during the 1990s later increased production at home too. Some companies have increased their production in Spain as a complementary strategy to offshoring part of their production, others have decided to reshore the production which was previously outsourced to Asia.

[18] https://theconversation.com/la-relocalisation-industrielle-en-france-un-retour-vers-le-futur-89472
[19] http://www.grenoble-ecobiz.biz/jcms/rec_325925/fr/paraboot-relocalise-en-isere
[20] https://lexpansion.lexpress.fr/entreprises/rossignol-persiste-et-signe-dans-la-relocalisation_1344329.html

They find that reshoring is not necessarily a corrective action but rather a reaction to changing or new factors in the environment. Some changes derived from the variation in the difference between man- ufacturing costs in Spain and China, increase in logistics costs, stronger Chinese currency, changes including higher taxes and social security payments in China. Other changes were generated by the economic crisis (high level of stock was costly and small orders in short time frames became frequent). Also the large distribution groups imposed new distribution and consumer patterns on the sector (instead of former two seasons for launching new products there are now four and this requires shorter delivery time).

There is a book of studies describing relocation tendencies in the *Nordic countries* (Danemark, Sweden, Finland) based on a sample of 847 companies (Heikkilä, 2017). 18,9% of them realised backshoring between 2010-15. The major regions of origin for backshoring to the Nordic countries were Western and Eastern Europe, other Nordic countries, and China. Backshoring movements from Western European countries were more common within the company's own plant network, but backshoring movements from Eastern European and Asian countries were more common from the external suppliers or the contract manufacturers. Relocation was more characteristic for large firms and the rate of backshoring was relatively high in industries such as the electrical equipment, basic metals, furniture and chemical industry. Quality, flexibility, lead time, access to skills and technology, proximity to research and development were the main drivers of backshoring. The business ecosystem (an integrated network of companies that combine their resources to create new products and innovations according to customers'needs) can also affect manufacturing location decisions. The locations of customer firms can drive focal companies in the network to move manufacturing closer to the customers.

Engström et al., (2017) present case studies of four Swedish companies that have reshored, mostly from other European area. There were drivers of reshoring identified by all four case companies: quality, distance, transportation and logistics, research and development, capacity, customer and centralization. The identified barriers of reshoring were capacity, calculation difficulties, access to competent labour, supplier partnership problems and ownership of product blueprint.

Gylling et al., (2015) in a single case study of a Finnish company found that the reshoring decision was of corrective nature, as quality issues and a wave of rationalization in the home plant made domestic production more attractive. However, reshoring also was induced by changes in the business environment, especially in currency exchange rates and customer demand. Kaivo-Oja et al., (2018) regard Finland as a nearshoring target based on some location advantages (a country with low political risk, well-established infrastructure, and efficient logistics). They argue that although Finland is considered a high-cost manufacturing country, reshoring motivations can be more complex than only labour costs. Robotisation decreases the importance of wage differentials and manufacturing firms might prefer to control the complete production process without any risks to intellectual property in faraway countries.

We can find studies on reshoring to *Norway* too. Hammer, (2018) finds evidence on backshoring in a Norwegian county but also for the whole Norway there are cases of backshoring and nearshoring. Certain companies (Kleven, IPHuse, Plasto[21]) cite advances in automation and robotization as main factors for taking production back from foreign countries. Technology also allows companies (like Ekornes ASA[22]) to keep production in-house instead of outsourcing. Aamlid, (2017) introduces three Norwegian case studies of reshoring bound to Industry 4.0. One is Neumann Aluminium Raufoss (producing aluminium suspension parts for cars) that is an example of inhouse reshoring. The company has an own plant in China, but they built a new 4.0 plant in Norway (operating from 2016) instead of investing into the Chinese plant. Lead time decreased, flexibility and quality control improved, cultural differences do not take place. The other case is Hunton Fiber AS, producing fibreboard products for the construction industry. The firm decided to backshore from Poland establishing a new robotised manufacturing facility in Norway producing from 2018. The reasons are better product development control, larger flexibility and environment friendly transportation. The third firm is Kleven Verft AS that backshored engine production from Poland in 2013. Kleven totally automated shipbuilding and by reshoring reduced

[21] Plastic goods production was backshored from China because of robotisation.
[22] The company produces furnitures (seats) and has developed a sewing robot that enables the firm to maintain production inhouse.

transport costs and increased control. Slyngstad, (2017) describes another Norwegian case, IP Huse company that withdraw production of winches for vessels from Eastern Europe to Norway. Regarding the motivation for backshoring she writes that several of the firm's outsourced products had become much more expensive than anticipated and many of the outsourced products had little development in terms of design, optimization and production methods. In addition, new technology allowed the firm to mechanize and robotize parts of their production, reducing wages and increasing their inhouse capacity.

## Challenges of Industry 4.0

Certainly, there are risks of introducing Industry 4.0 technologies for a company. As mentioned, Industry 4.0 refers mainly to the emergence and diffusion of new digital industrial technologies like the Internet of things or IoT (embedded sensors, so that devices can interact with each other); big data analytics (BDA, the collection and real-time evaluation of data to optimise production); robots with greater autonomy and flexibility; additive manufacturing (3-D printing, Strange and Zucchella, 2017)

In the case of IoT, products are assigned unique identifiers and provide information about their origin, use and destination. They coordinate and synchronise themselves and can reduce transaction costs within global value chains (GVCs) and can facilitate an ever-deeper international division of labour in the global factory. However, IoT raises the question of cybersecurity and risks, because each of the millions of embedded sensors and communications devices is a potential entry point for hackers (Strange and Zucchella, 2017)

With BDA firms will be able to monitor overseas markets without paying local marketing affiliates, and they will be able to optimise supply, production and distribution activities around the world. But for analyse and operationalise the big data a range of technical and governance capabilities will be necessary. Apart from that individuals' privacy will be threatened from widespread big data application.

Regarding robotic systems, their performance has improved in the past decade and costs are projected to fall further, making robotisation available for more and more SMEs. The automotive sector has led the way in terms of automation with, according to

some estimates, every second industrial robot sold working in the automotive sector and 80% of the work done in making a car carried out by machines (Knight, 2012.). Apart from the costs of machines, finding skilled workers to manipulate them can be a challenge for a smaller firm.

Additive manufacturing technologies (3D printing) have important advantages. Softwares can be used by anyone, every product may be customised to the user, production of complex products is easy and overall production time can be reduced and additive manufacturing generates little or no waste. Finally products can in principle be manufactured anywhere in the world where there is a compatible 3-D printer. However, the use of additive manufacturing technologies is currently limited. First, present additive technologies are relatively slow, not suitable for mass production as unit costs are substantially higher. Scond, there is a limited range of raw materials, colours and size that can be used for 3-D printing. Third, 3-D printing cannot yet match high levels of engineering precision in strength, lower resistance to heat and moisture and compromised colour stability (Strange and Zucchella, 2017)[23].

The achievements of Industry 4.0 still require significant capital investment, at least initially (Vaidya et al., 2018). Therefore, these are not yet widespread among SMEs. Smaller manufacturing firms, particularly those located in emerging economies, have serious problems grasping the overall idea of Industry 4.0 and its specific concepts. Regarding the implementation of Industry 4.0 in emerging economies, the government takes on a leading role (Horvat et al., 2018). In addition, there is an increasing demand of customization, being at the same time in a global competition. This trend, results in diminished lot sizes. A survey of 253 companies showed that companies see missing standards and lack of skilled workers as problems, these are major barriers to the

[23] A famous successful example of additive manufacturing technology utilisation is Adidas that has created the SpeedFactory (first in Bavaria than in Atlanta), making customised shoes using robots and 3D printing. Being in Germany allows the company to shorten the time it takes to supply a store from 6 to 8 weeks down to a week or less and significantly reduce production time of a pair of shoe (from 60 days in Asia to a few days). Quality control, planning and speed are the most important benefits of the new production system (Manthorpe, 2017). The machine-led fusion technique is more precise than manual labour. However, altogether 403 million pairs of shoes are produced by Adidas while the Ansbach and Atlanta plants are aiming to reach „only" one million pairs each by 2020, so yet the large majority of shoe-making remains in the traditional manufacturing.

implementation of Industry 4.0 technologies for them (Glass et al., 2018). Considering the overall effects of Industry 4.0 for example on productivity, we should place the issue in a complex socio-economic and regional context and be aware of conditionality (Kovacs, 2019). All in all, as Tjahjono et al., (2017) confirms, some technologies can result in both of opportunities and threats, because all the different areas are interconnected, with no clear boundaries between them, depending on where it was analyzed, it could have a positive or negative connotation.

## Effects on labour

In the past decade there is a growing literature concerning the effects of new technological changes (automation, robotisation, additive manufacturing) on the labour market. This phenomenon is sometimes called "automation anxiety[24]" The analyses, projections vary from the highly pessimistic ones to optimistic ones. Robots are indeed able to do more and more tasks (Ford, 2015; Brynjolfsson–McAfee, 2014). The most cited "pessimistic" estimation is that of Frey and Osborne (2013) who ranked around 700 job types in the USA according to their risk of getting replaced by a computer. They concluded that 47% of employees were working in occupations that could be performed by algorithms within the next twenty years. Other articles also followed this line. However, according to the critics and using alternative counting methods Arntz et al., (2016) argue that automation aims at certain tasks rather than whole occupations. Jobs consist of performing a bundle of tasks not all of which may be easily automatable. Thus, the potential for automating entire occupations and workplaces may be much lower than suggested by the above mentioned calculations. According to the estimation of Arntz et al.,(2016) only 9% of the US jobs are at risk of robotisation. They also calculate figures for other OECD countries giving the highest share for Germany and Austria (12%), while the lowest for South Korea and Estonia (6%). Similarly, a research of McKinsey analysed around 2000 tasks in the USA and concluded that automation will delete only a few jobs totally. Instead, changes can affect almost every type of occupations to certain extent, depending on their task content (Chui et al., 2016).

[24] https://blogs.wsj.com/cio/2017/09/01/as-automation-anxiety-grows-remember-weve-been-here before/

Labour effects of robotisation depend also on its speed and disruptiveness. McKinsey (2017) estimates that between 400 million and 800 million individuals could be displaced by automation and need to find new jobs by 2030 around the world, based on midpoint or earliest automation adoption scenarios. People will need to find their way into new jobs and learn new skills.

The type of skills is important. Jobs, tasks with a low-risk of computerisation usually require higher skill levels and require creativity and social intelligence. According to an OECD study there is large variation in the risk of automation across countries. In general, jobs in Anglo-Saxon, Nordic countries and the Netherlands are less automatable than jobs in Eastern European countries, South European countries, Germany, Chile and Japan. The study shows that the risk of automation declines with the level of education, measured skills (numeracy and literacy) and with the wage level across almost all countries, suggesting that this wave of automation is skill biased (Nedelkoska and Quintini, 2018).

Jobs in unpredictable environments (gardeners, plumbers, child- eldercare) will be less automated, because it is difficult technically and wages are often low, which makes automation less attractive. The tasks will require more social and emotional skills, and more advanced cognitive capabilities, such as logical reasoning and creativity (McKinsey, 2017). Makó et al., (2018) analyse the data of European Working Conditions Survey and select workers into three main clusters according to cognitive characteristics of work tasks. In the group of creative workers are those who have to use their cognitive abilities during work. At the other end the in the group of taylorian workers have tasks with minimum autonomy and creativity. Taylorian jobs are those that can be easily replaced by robots sooner or later. In between there is a third group of "constrained problem solvers" who do creative job but have small autonomy. Regarding Hungary, the share of creative workers decreased from 2010 to 2015 from 44% to 37% and the share of taylorian workers increased from 27% to 33%. Thus, among the Central- and South-East European countries Hungary has the largest share of replaceable jobs.

Table 2. Types of occupations in EU, 2005 2015

| | **2005** | | | **2015** | | |
|---|---|---|---|---|---|---|
| **Scandinavian** | CR | CPS | TAY | CR | CPS | TAY |
| Denmark | 74 | 13 | 13 | 77 | 14 | 9 |
| Finland | 67 | 20 | 13 | 73 | 18 | 9 |
| Sweden | 80 | 10 | 10 | 74 | 15 | 11 |
| **Continental** | | | | | | |
| Austria | 51 | 29 | 20 | 57 | 25 | 19 |
| Belgium | 56 | 20 | 23 | 59 | 19 | 21 |
| France | 59 | 19 | 21 | 62 | 24 | 14 |
| Netherlands | 71 | 16 | 13 | 63 | 16 | 21 |
| Luxembourg | 63 | 18 | 19 | 65 | 24 | 11 |
| Germany | 51 | 25 | 24 | 49 | 23 | 29 |
| **Mediterranean** | | | | | | |
| Greece | 40 | 32 | 28 | 28 | 32 | 40 |
| Italy | 40 | 28 | 33 | 45 | 16 | 38 |
| Portugal | 42 | 24 | 34 | 41 | 28 | 31 |
| Spain | 37 | 28 | 35 | 47 | 28 | 25 |
| **Anglo Saxon** | | | | | | |
| Ireland | 58 | 19 | 22 | 55 | 21 | 24 |
| UK | 50 | 20 | 30 | 59 | 21 | 20 |
| **NorthEastEu** | | | | | | |
| Estonia | 57 | 25 | 19 | 62 | 21 | 18 |
| Latvia | 52 | 19 | 29 | 35 | 17 | 48 |
| Lithuania | 39 | 30 | 31 | 45 | 28 | 27 |
| **Central Europe** | | | | | | |
| Czechia | 43 | 30 | 27 | 38 | 32 | 30 |
| Poland | 46 | 32 | 22 | 41 | 30 | 29 |
| Hungary | 44 | 29 | 27 | 37 | 30 | 33 |
| Slovakia | 37 | 32 | 31 | 35 | 35 | 31 |
| Slovenia | 52 | 24 | 24 | 55 | 26 | 19 |
| SouthEast EU | | | | | | |
| Bulgaria | 40 | 30 | 29 | 38 | 24 | 28 |
| Romania | 37 | 39 | 24 | 35 | 37 | 28 |
| EU 27 average | 50 | 24 | 26 | 52 | 24 | 24 |

*Source:* Makó et al., (2018) p.201, 203

Certainly, new jobs will be created that are non-existent today. The report of McKinsey, (2017) expects that 8 to 9 percent of 2030 labor demand will be in such new types of occupations. With sufficient economic growth, innovation, and investment, there can be enough new job creation to offset the impact of automation. However, by governmental additional investments will be necessary to reduce the risk of job

shortages and ensuring that workers have the skills and support needed to transition to new jobs. Countries that fail to manage this transition could see rising unemployment and depressed wages. Robotisation impacts employment in certain services and manufacturing mostly in the automotive, electronics, metal, and chemical product sectors.

Szalavetz, (2017) describes examples of Hungarian robotization and their effects on jobs. Her interviews made it clear that new relatively low-cost robots have indeed reduced demand for operators in the surveyed companies. Nevertheless, as emphasised by the executives interviewed, the impact of the new technological solutions on jobs is not straightforward. On the one hand, these robots help overcome labour shortages. On the other hand, the reduction of demand for operators related to specific activities has not resulted in overall job losses, the operators had been reassigned to other production activities. At the same time, some smart solutions are taking over white-collar tasks. For example, automated data extraction solutions, introduction of big data analytics have freed up engineers from preparing daily reports and scrutinizing production parameters. Sometimes engineers with skills are experiencing increasingly intensive intra-firm competition for their talents: they move to (regional or central) HQ premises. Assessing this phenomenon from a 'factory economy' perspective, this may jeopardise the perspectives of a subsidiary upgrading its operations – points out Szalavetz (2017).

## Backshoring and Industry 4.0 readiness in Hungary

Like other scholars, Cohen et al., (2017) points out that regarding Eastern Europe, labour costs and labour quality and availability proved to be significant motives for investing from the nineties. Any kind of political and economic risk can be deterring for investors. Divestment is not mentioned explicitely in this study but we can conclude that if labour factors deteriorate in the region, certain investors can be motivated to reshore or move to other regions from here. There are examples of replacing labour-intensive

and not automable funtions from Hungary to cheaper countries.[25] The case of Lear Corporation (Box 1) is similar but also connected with global production reorganization.

Box 1: Lear Corporation

The case of Lear Corporation is an example for moving labour-intensive production to lower cost countries from Hungary and automating at the same time in the US and Germany. Lear Corporation was founded in 1917-ben in Detroit. It produces car seats and electronic car parts in 37 countries. In 2017 Lear closed its production of seating covers for premium passenger cars in Mór, Hungary and layed off 800 workers. They took the production in Romania and Moldova (lower wages). In 2018 the company closed another factory and layed off 500 workers in Gyöngyös that produced electric wire harnesses for passenger cars. This process is very labour intensive, not worth to robotize, the company removed it to Ukraine, Romania, Serbia where wages are lower. Both plants functioned since two decades in Hungary. At the same time Lear Corporation opened an assembly plant in Flint, US in 2017. It supplies seats for the Flint General Motors Truck Assembly plant and employs 600 people[26]. Lear also automated its German affiliate with cobots to screw together automotive seat and frames with an end-of-arm screwdriver[27].

This paper focuses on the application of new technologies – as motivation for backshoring. No doubt, we can find examples of these. Dachs et al., (2017) describes the example of a producer of metal parts, where wage advantages were the main motive to offshore production and locate this production step in Hungary. The firm later automated this production step, and installed a robot for smoothening and polishing metal parts. The robot is faster and works 24/7 which increased productivity. This investment allowed the firm to move the production step back to Austria, it gives the firm more flexibility and spare on transport costs.

New technologies can of course be adopted not only at Western headquarters of investor firms but also at the firms functioning in Central and Eastern European region. As mentioned, backshoring has costs and barriers, so in the case of geographically close CEE countries local automation of affiliates can be a viable option. Agglomeration effects can also help this strategy, the Visegrád countries have become important clusters of the automotive industry due to the high concentration of production capacities here. Severe labour shortage in this region can also inspire local automatization (the president of the

[25] The Austrian-owned Prevent Premium closed down in 2017 in Hungary. The firm produced car seat carpits, 300 workers were layed off and production moved to Bosnia.
[26] https://www.assemblymag.com/articles/94451-auto-supplier-lear-opens-assembly-plant-in-flint
[27] https://www.equipment-news.com/human-robot-collaboration-to-drive-the-automotive-industry-part-ii/

association of Hungarian pharmaceutical manufacturers for example claimed that automatization is a solution for the growing labour shortage[28]). Similar conclusion was drawn in McKinsey, (2018) that suggests automation for Hungary to achieve long-term productivity improvements boosting competitiveness. The report argues that automation will reduce labor shortage that is creating a bottleneck to economic growth.

How is Hungary prepared for Industry 4.0? Roland Berger (2014) developed a macro level Industry 4.0 readiness index bundling production process sophistication, degree of automation, workforce readiness and innovation intensity into a category called "industrial excellence". Then factors like high value added, industry openness, innovation network and Internet sophistication were combined into a category labeled "value network". Each category was measured using a 5-point scale (5 is the best). The combination of these two categories determines a country's position in the RB 4.0 Readiness Index. The results were depicted in a chart where the vertical axis represented the extent of the index, while the horizontal axis represented the percentage share of manufacturing in GDP. This way European countries were grouped into four clusters. The clusters are the „frontrunners" (large industrial base, very modern business conditions and technologies (Sweden, Austria and Germany) „potentialists" (weakened industrial base but in the corporate sector indications of a modern and innovative mindset) „hesitators" (lacking a reliable industrial base, suffering from severe fiscal problems). The fourth group consists of the „traditionalists" mainly in CEE region, containing Hungary. They have sound industrial base, but few of them have thus far launched initiatives for industry 4.0.

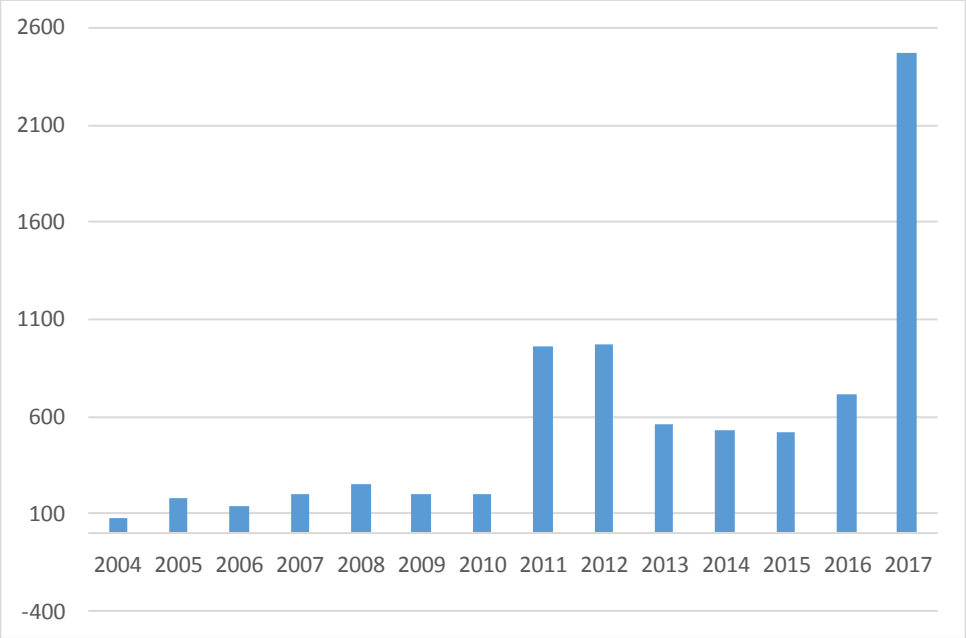
In the past two years there is a growing discussion on Industry 4.0 in the CEE countries, among them Hungary. Government officials, industrial organisations manifest themselves, several conferences are organised, Industry 4.0 Platform has been created such as sample smart factories too. SMEs are also targeted, but the companies that have money, capability and opportunity to implement new technologies are rather large, international firms. SMEs rather adopt technologies and solutions already developed

[28] Portfolio.hu (2018) "Automatizálással válaszolnak a kihívásokra a hazai gyógyszercégek (Interjú)" https://www.portfolio.hu/gazdasag/egeszseggazdasag/automatizalassal-valaszolnak-akihivasokra-a-hazai-gyogyszercegek--interju.298060.html

and tested. Self-motivation, personal attitude of the leader is very important here (Nagy, 2018). There are certainly contradictory factors too. Kruliš et al. (2018) conducted interviews with experts in the Visegrad countries who cited more weaknesses than strengths. As weakness high regulation, taxes, corruption, monopolies, stakeholder groups, inadequate education system, fear of change were enumerated. Political interference plays a key hindering factor in the adoption of new technologies.

Let us have a look what the data show on robotization. Figure 2 gives the number of industrial robots sold in Hungary. Until the economic crisis there is a kind of stagnation but later sales have increased.

Figure 2. Industrial robot sales, end of the year units, Hungary




*Source:* International Federation of Robotics

Figure 1 shows a jump of robot sales in 2011-12 and a huge jump in 2017. The former increase can be bound to the launch of the Mercedes factory. In 2017 the number of applied industrial robots grew by 244% and 71% of these robots functions in the automotive industry.[29] (A major player is Audi Hungaria that began production of

[29] http://www.digitalhungary.hu/e-volution/Magyarorszagon-is-elre-tor-az-ipari-robotika/7519/

electronic motors in 2018 applying high automation in its plant.[30] Suzuki also creates a completely „smart factory" for 2020.[31]) In general the robots sold are mostly handling robots and welding robots.[32]

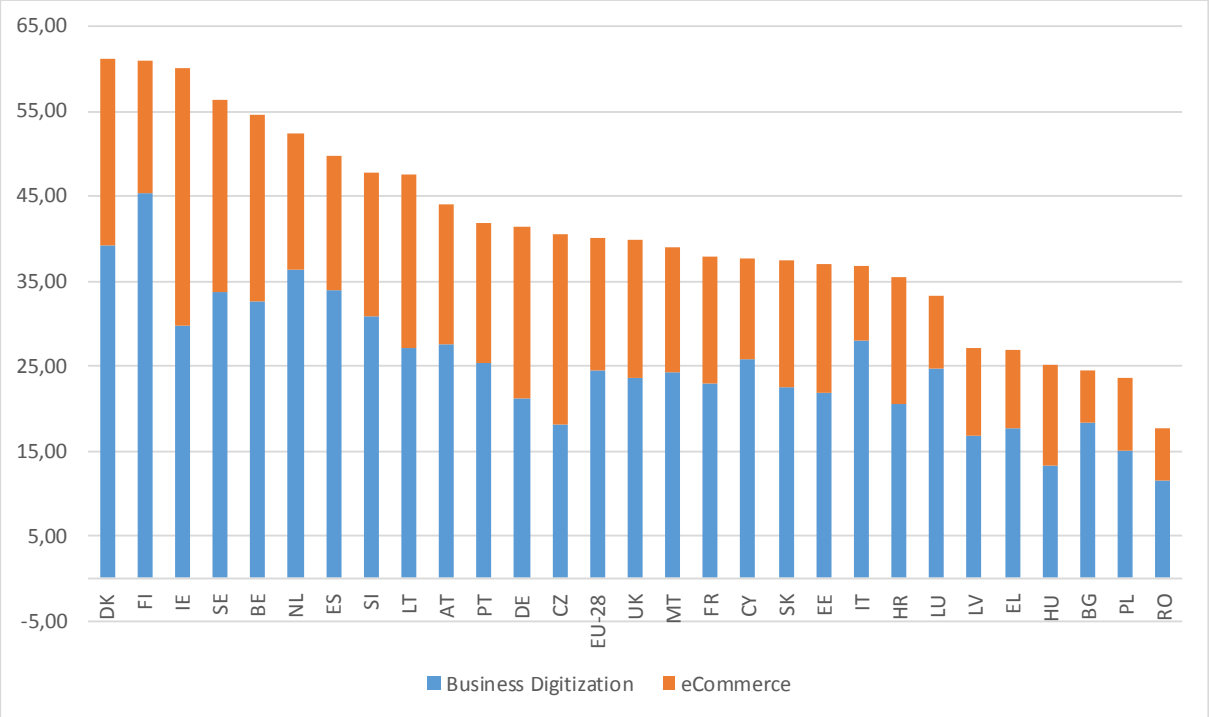
Robots are and have already been employed by multinational affiliates in the CEE region, most plants are already highly automated (Szalavetz, 2017). Therefore Industry 4.0 readiness in these countries has been and will be determined by foreign investors' decisions. We can gain insight to the experiences of large, foreign affiliates in automation from Szalavetz, (2017). The first finding of her interviews with Hungarian managers was the relatively high degree of preparedness, investment in the new technologies (automation solutions, use of sensors, traceability solutions) since more than a decade ago. Another finding was that even the advanced local users of Industry 4.0 applications lacked a systematic digital strategy. The companies face four basic types of challenges: 1. Shop-floor technological problems, 2. Shortages of skilled labour (together with the decreasing cost of industrial robots, this was an important driver for some of the surveyed companies to adopt industrial automation solutions), 3. Increased production complexity, 4. Increased customer requirements in terms of time, variety, costs and flexibility.

Advance in automation is rather different in the case of foreign affiliates than the general picture. Regarding the general attitude of people, Hungarians rather mistrust automation. According to a Eurobarometer survey (European Commission, 2017) 38 per cent of Hungarians have negative view of robots and artificial intelligence and this is one of the highest percentages in Europe. 73% agree with the statement that robots and AI steal people's jobs (with this share Hungary is just in the center of the EU countries).

[30] https://bcmagazin.hu/2018/12/17/elektromos-gyartasba-kezd-magyarorszagon-a-harom-nemet-autoipari-foszereplo/
[31] http://gyartastrend.hu/autoipar/cikk/okosgyarat_hoz_letre_a_suzuki
[32] https://www.vg.hu/vallalatok/elaraszthatjak-magyar-ipart-robotok-2-767161/

As a part of the Industry 4.0 implementation digitalization can also be mentioned. In this respect EU has built an index (DESI index) that can illustrate the position and development of certain countries. A part of this complex index is the „intergation of digital technology"combining e-commerce and business digitization. Figure 3 shows that Hungary performs rather poorly in EU comparison. Figure 4 shows that the increase of this index between 2014-18 was also rather moderate.

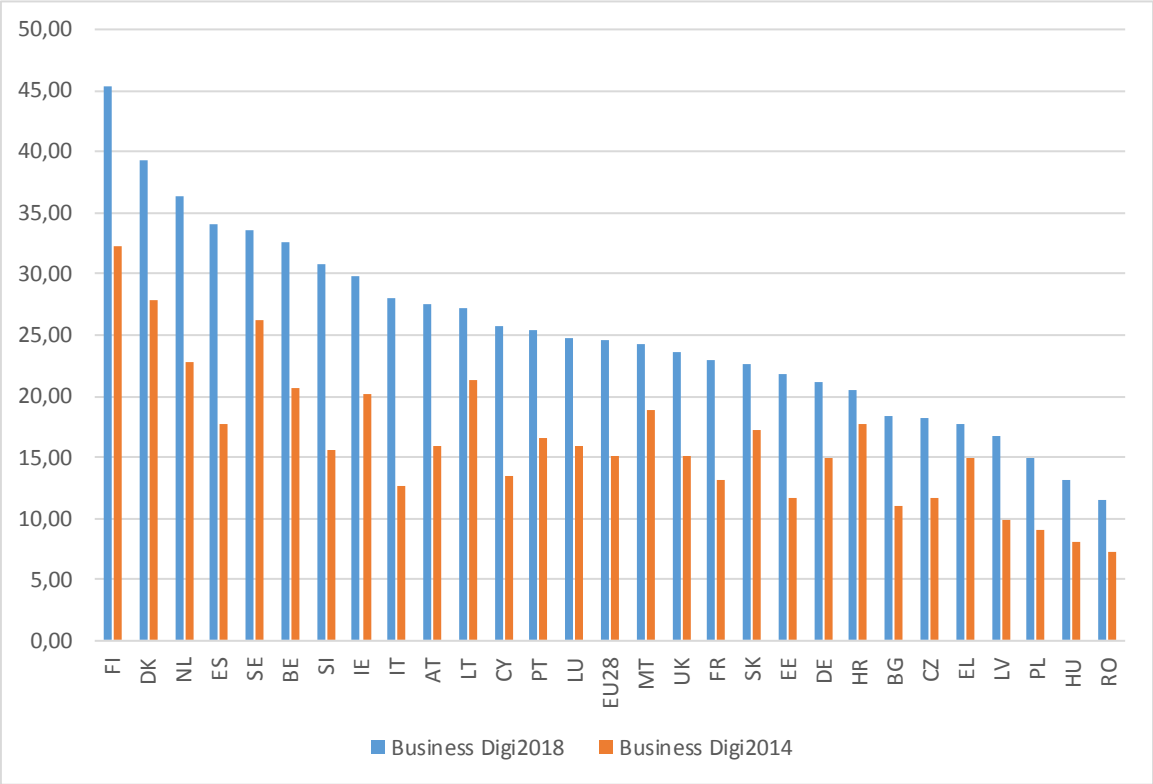
Figure 3. Integration of Digital Technology, 2018




*Source:* DESI Index database[33]

[33] https://ec.europa.eu/digital-single-market/en/desi

Figure 4. Development of Business Digitization 2014-18




*Source:* DESI Index database

***Note:*** DESI Business Digitisation sub-dimension calculated as the weighted average of the normalised indicators: Electronic Information Sharing (enterprises who have ERP software package to share information between different functional areas), RFID (Enterprises using Radio Frequency Identification technologies for after sales product identification or as part of the production and service delivery), Social Media (firms that use two or more types of social media), e Invoices (firms sending e-invoices suitable for automatic processing), Cloud (buy Cloud Computing services of medium-high sophistication).

SMEs and large companies work in a local economy, connected to its social and economic conditions, which is called an entrepreneurial ecosystem. Autio et al., (2018) constructed the European Index of Digital Entrepreneurship Systems (EIDES) to assess the digital entrepreneurial ecosystem. The authors state that digitalization creates new challenges for policy that should facilitate entrepreneurial ecosystems, instead of focusing on individual SMEs. In an ecosystems approach to entrepreneurship policy, the focus has to be on facilitating entrepreneurial experimentation and business model discovery. EIDES measures both physical and digital conditions for ventures in EU 28 countries. The overall EIDES index is the average of both General and Systemic

Framework Conditions. The four General Framework Conditions are: Culture and Informal Institutions, Formal Institutions, Regulation, and Taxation, Market Conditions, and Physical Infrastructure. The Systemic Framework Conditions are: Human Capital, Knowledge Creation and Dissemination, Finance, Networking and Support. The sub-indicators are constructed from several indices of international databases (WEF, Eurostat, Heritage Foundation, OECD, IMF). The index values show that Hungary is in the 24th place among the „laggards" of the EU28 countries.

On the other hand, the ability for local SMEs to exploit their comparative advantage depends on how well they are integrated into local and national networks (infrastructure education and links with other business). However, the high degree of centralisation in Hungary hampers this process. Development policies are determined and financed at the centre, local authorities focus on centrally-financed projects (OECD, 2019).

The results of a representative survey made by the T-Systems[34] among 800 managers reinforce these gloomy results. According to these, only 25% of Hungarian SMEs invested in informatical development in 2017-18 and half of them finds its present level adequate. However, digital invoices, online customer service are very rare and only every second SME has own website. Possible dangers in informatics are downgraded, only 19% of the SMEs considers it important.

There was a long questionnaire survey conducted by SZTAKI HAS in 2016[35]. This survey in a later period was analysed by Nick, (2018) with 169-232 respondents (depending on the filling out of questionnaire parts). 69% of the sample consisted of totally or majority Hungarian owned firms. 62% of the sample was SMEs. The most important results of this survey are the following: the digitization of production process do not exists at 61% of the firms, 74% does not apply robots. Altogether 82.3% of the companies consider important or essential the application of industry 4.0 elements but only 18.6% has applied any kind of implementation strategy (in the case of domestic companies 8.5%). Foreign owned and automotive industry firms perform usually better than others in this respect. Nick, (2018) concludes that Hungarian SMEs should renew

[34] https://ado.hu/cegvilag/a-kkv-k-felet-nem-erdekli-a-digitalizacio/
[35] https://www.i40platform.hu/sites/default/files/2018-03/Flyer_v6.0.pdf

their equipment for creating smart factories, and he finds that sectoral and value chain position influences the adoption of Industry 4.0 elements. Regarding the barriers of implementation firms confirmed lack of skilled labour, digital illiteracy, outdated production technologies, lack of support. Another conclusion based on a few deep interviews is that interpretation fo Industry 4.0 is subjective and firm-specific, based on available human resources. The product (its comlexity and mature) also determines Industry 4.0 readyness.

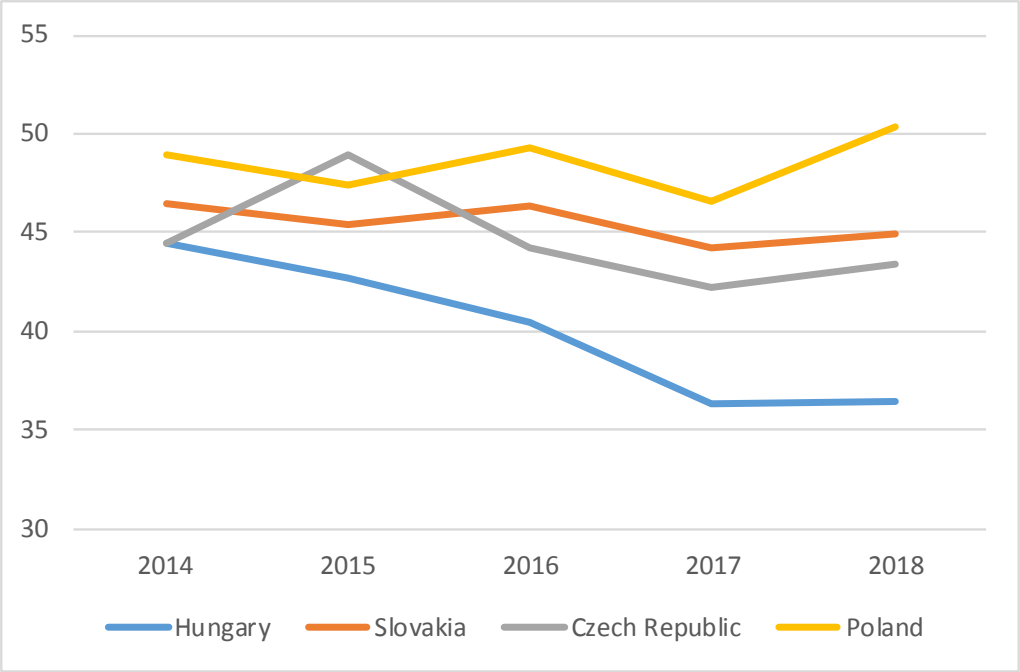
Box 2: Field experiences

I conducted an interview with an industry development counsellor, project leader at IFKA Industrial Development Nonprofit Ltd. This agency manages the EU supported „Industry 4.0 Sample Factory" project for manufacturing SMEs. Evaluation, counselling, sample smart factory visits are part of the project. The participant firms had to fill out a self-evaluating questionnaire in advance and these showed a more positive, favourable picture than the reality. The expert evaluation proved that management is usually the weakest element in Hungarian SMEs, basic capabilities, knowledge are lacking. Also, there is a complete lack of aims and stategy. If there are aims, these are of a very short run (e.g.next year more revenue). Managers do not feel it necessary to communicate aims to the workers and distribute tasks. Several times the manager himself does a lot of things (HR, logistics, purchase, etc) there is no middle-level leader or responsible person. Evaluation showed weakness in supply chain and quality management. Maintenance, logistics and IT infrastructure were, however, in relatively good shape. According to the field experiences of the agency, thus, the most important barrier for Industry 4.0 is the weak capability of the manager and the inadequate and ineffective basic process. Because of these, in certain firms it is not even worth introducing robots. Labour shortage is also an important barrier, such as constant wage-increases.

The experiences of Box 2 about general management problems are reinforced by a comparative indicator of general entrepreneur-preparedness. The Global Entrepreneurship Index[36] is a composite indicator of the entrepreneurship ecosystem in a given country. The GEI index has 14 components, it measures both the quality of entrepreneurship and the extent and depth of the supporting ecosystem. Figure 5 shows that from 2014 this index has been deteriorating in Hungary, on the contrary to the other three Visegrád countries.

[36] https://thegedi.org/global-entrepreneurship-and-development-index/ The GEI index contains data of more than half million individuals from the Global Enterpreneurship Monitor and also composed institutional data from 6-8 large databases (WEF, Unesco, OECD, UN, World Bank, etc).

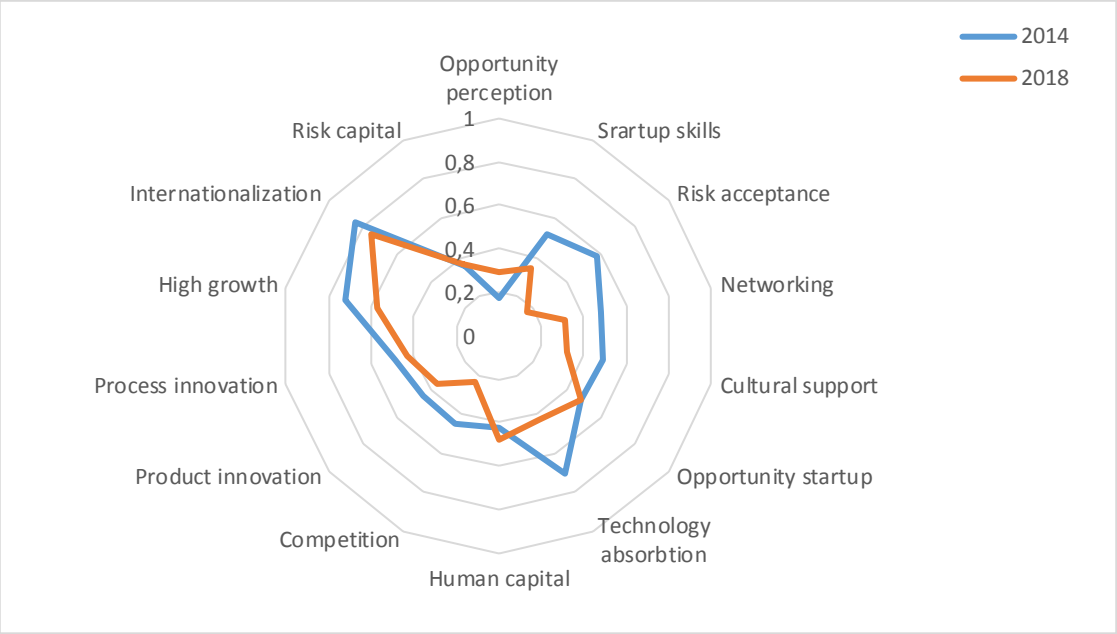
Figure 5: GEI index value




*Source:* Global Entrepreneurship index yearly reports

If we have a look at the sub-components of the index, it turns out that the deterioration is present almost everywhere, most severely at risk acceptance, networking and competition. Internationalization is the only well developed area. There seems to be a comlex problem in Hungary with the mentality, education of entrepreneurs and with the supporting institutional system.

Figure 6: GEI components in Hungary




*Source:* Global Entrepreneurship index yearly reports

We certainly can find a few positive examples of purely Hungarian-owned firms (see box 3) generally medium or large sized.

Box 3: The case of Simon company

The company Simon Manufacturer of Plastic Products was founded in 1985 as a one-person company and has been a 100% Hungarian owned family firm since then. It is presently directed by the son and daughter of the founder, Mr. István Simon. They have 400 workers, the headquarter location is on Kőszárhegy village. The firm became one of the country's leading plastic manufacturing companies. Simon MPP use lean production, modern technologies with automated molding, they produce 30 million automotive parts per month. 90% of the products are sold to the automotive industry. There is also a complete engineering service from 3D to serial production. the company participates in dual education with universities. Simon MPP focuses on constant development, innovation and machine acquisition, which has been supported by government and EU funds. Mr. István Simon told that automation is to a certain extent induced by labour shortage but much more importantly by quality reasons. He also pointed out that Hungarian firms struggle with the lack of sufficient capital. Regarding labour, he considers proper education essential, they organise factory visits for even primary school student groups.

Regarding Industry 4.0 technologies we can conclude that there is a dichotomy in Hungary, foreign MNE affiliates are much more capable and willing to introduce these than domestic SMEs. This is partly, because SMEs are different anyway from MNEs in several respects. Scholars even argue that the Industry 4.0 maturity models for SMEs should be different from large firms (Mittal et al., 2018). SMEs are financially constrained, they have informal organizational structure, they have scarce employee participation, less collaboration with R&Dand educational centers, etc. The very starting point for an SME on the road of automation is different (lower) from that of a large firm. The other reason of the duality in Hungary is the mentioned problems of the Hungarian management.

## Nearshoring to Hungary

Nearshoring is a term which describes outsourcing to the countries located near the country where the outsourcing company operates, often sharing a border with it. It combines the advantages of outsourcing and onshoring (hiring company from the same country). For instance for companies from the United States, a popular nearshoring destination is Mexico whereas Eastern European countries have become a service base for European developed countries (Germany). Regarding the IT sector for example, according to Deloitte Global outsourcing survey[37], 74 percent of companies are already outsourcing and 87 percent of responders are planning to outsource in 2018. Nearshoring is becoming more and more popular and countries such as Poland, Czech Republic or Romania are becoming targets of IT companies.

German companies are active in nearshoring. In the survey made in 2016 by Müller-Dauppert (2016) the sample consists of 71 firms. 54.9% of the respondent German companies already used nearshoring as location strategy for their production plants. 22.4% of the participants see nearshoring as future trend to a high or very high extent. Nearshoring is chosen on the basis of costs, but the delivery time and the availability of qualified employees play also an important role. Central-Europe proved to be the most relevant region for nearshoring.

[37] https://www2.deloitte.com/us/en/pages/operations/articles/global-outsourcing-survey.html

Lőrincz (2018) enumerates some reasons why the CEE region can be favourable area for nearshoring of West-European firms. These are for example geographical and cultural proximity, skilled labour, expertees, same time zone, lower costs. Placing business in a nearby country enables face to face meetings, that can ease problem solving and building mutual trust. Short distance also gives a chance to better identify the market and service provider before signing a contract. If the tasks to be outsourced require expert knowledge, Eastern European specialists may be more expensive than Indian ones, but it is compensated by fewer mistakes and misunderstandings at work. It is difficult to cooperate with people with poor English or a strong accent[38]. Box 4 provides examples of nearshoring to Hungary (although not for automation reasons).

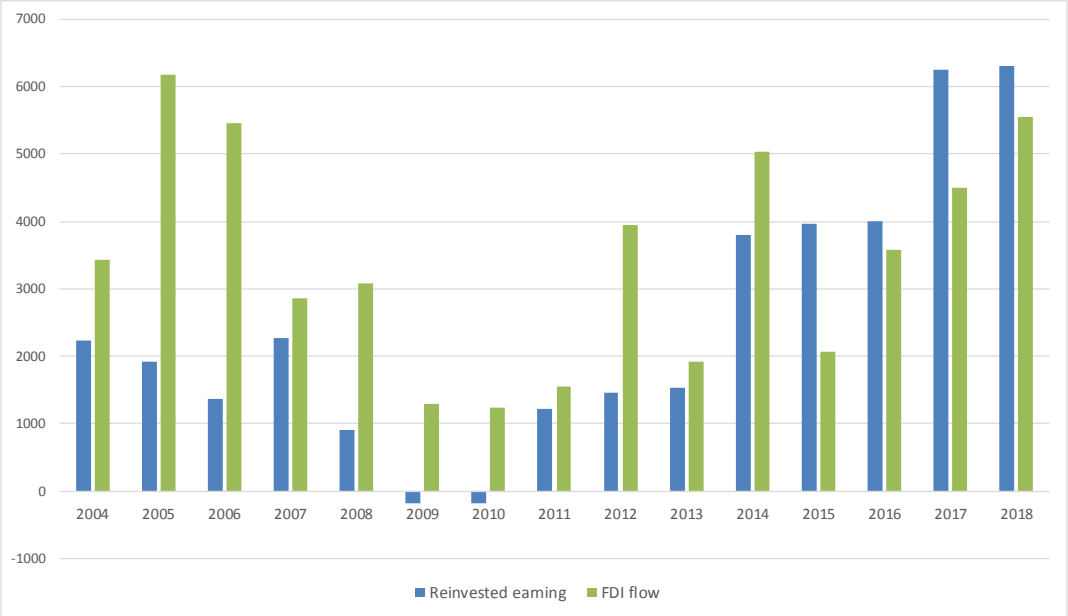
Box 4: Nearshoring cases in Hungary

Considering Hungary, we have a few evidences on nearshoring to the country (Sass and Hunya, 2014). *Josef Seibel*, a German shoe producing firm, transferred its production in 2011 from China, India and Moldova to Hungary and to Romania. It chose a Hungarian partner for that and located the Hungarian and the Romanian plants close to each other along the two sides of the common border[39]. The motive of this nearshoring was problems with discipline in meeting the deadlines and problems with quality in far-away locations.
Another case took place in the textile-clothing industry. The German company *J.H.Ziegler*, a producer of textiles for the car industry transferred back the production from North Africa, China and other Asian locations to Bábolna in Hungary. They had problems also with meeting deadlines and with quality. High transportation costs and diminishing Chinese wage advantage over CEE region also played a role. One new Hungarian plant was inaugurated in 2011[40].
*Märklin*, a producer of model trains in Germany was hit by the international crisis in 2009, but maintained its production in Győr, Hungary. A part of production of components had been outsourced to China, but because of quality problems the company decided to reshore and increase production in Hungary instead. Märklin bought land and invested in 2014 to build a new plant using also EU and Hungarian state funds[41].
The *Bosh Group* nearshored production of power tools from China to the Miskolc factory in Hungary (Robert Bosch Power Tool Kft, founded in 2001). The firm realised an investment of 3.9 bn HUF between 2012-15[42]. In 2016, Bosch created here also a regional service center, and the Hungarian power tool factory became the biggest one in Europe[43]. In February 2019 another member of Bosch Group, the Robert Bosch Energy and Body Systems announced an investment of 14 bn HUF in Hungary for the production of new generation components of body electrics[44].

[38] https://euvic.se/se/nyheter/nearshoring-is-gaining-popularity-why+&cd=1&hl=hu&ct=clnk&gl=hu
[39] https://index.hu/gazdasag/magyar/2011/05/20/egymilliardos_cipogyarbovites/
[40] http://ceauto.hu/news/a-jh-ziegler-uj-gyartocsarnokot-avatott-magyarorszagon
[41] http://nol.hu/gazdasag/kinabol_gyorbe_tolatott_vissza_a_m_rklin-1118381
[42] https://24.hu/fn/gazdasag/2015/03/04/3-9-milliard-forintos-beruhazas-miskolcon/
[43] https://magyaridok.hu/gazdasag/bosch-regionalis-szolgaltato-kozpontot-hozott-letre-miskolcon-1997167/
[44] https://www.napi.hu/nemzetkozi_vallalatok/bosch-beruhazas-autoipar.676619.html

There are certain economic policy elements that can enhance nearshoring to Hungary. The very low corporate income tax (CIT) rate is definitely one. With its 9% CIT rate Hungary is almost an offshore country within the EU and this is very attractive for investors. (It has been an issue lately in Italian press[45] that every day an Italian company comes to Hungary to establish a business. These are mostly micro and small enterprises who apart from the flat tax rate find here well functioning administration. Medium-sized and large Italian companies invest too and can benefit from further allowances if they carry out research and development activity. Similar trend has been observed from Slovakia, companies move headquarters to Hungary because of favourable tax[46]).

Figure 7: Development of FDI flows and reinvested earnings in Hungary, EUR mn




*Source:* Hungarian National Bank (MNB) statistics

Investors have considered Hungary a good location. FDI inflows have been fluctuating in the past decade (pumped up by one large automotive investment in some given years) as Figure 7 shows. In 2015-2017 there is a growing trend of FDI flow balances but these are surpassed by the yearly amount of reinvested earnings[47] stemming mainly from

[45] https://www.ilsole24ore.com/art/mondo/2019-02-25/la-flat-tax-orban-attira-ungheria-nuova-impresa-italiana-giorno-114922.shtml?uuid=ABpvwwXB&refresh_ce=1

[46] https://finweb.hnonline.sk/zahranicna-ekonomika/1920981-madarsko-laka-nase-firmy-na-nizke-dane

[47] Reinvested earnings are the portion of income due to the owners of equity in addition to distributed income (dividend). The difference between the positive or negative adjusted profit after tax and the dividend declared in the period concerned is reinvested earnings.

European investors. Favourable fiscal conditions thus promote investment and reinvestment of profits and also nearshoring.

Box 5: New foreign investments applying Industry 4.0

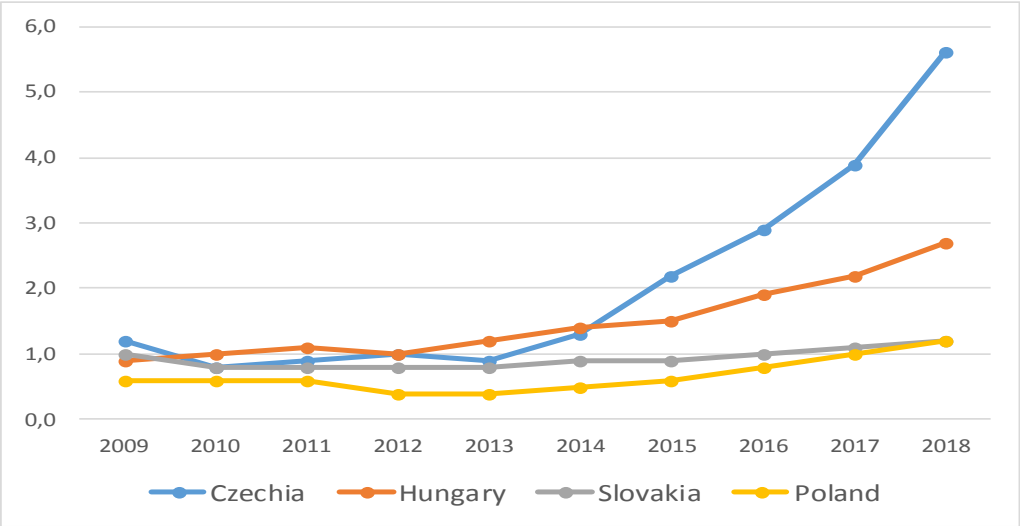
There are recently announced investments that create smart factories. New investments usually get also financial support from the government. *Hanon Systems*, the leading South-Korean automotive supplier is extending its current capacities in Székesfehérvár, and is establishing new plants in Rétság and Pécs. The key products of the company among others include automotive climate control and heating systems, blowers, compressors and sleeves, front modules, exhaust gas recirculation modules, electronic coolant pumps and valves and electronic choker valves. Their products are manufactured in 40 plants located in 20 countries worldwide, and development takes places in 18 engineering centres. Hanon Systems Hungary Kft. was established in 1990 and has been operating under its current name since 2015. The current extension results in a large-scale capacity increase of the Korean company in Europe and automation and Industry 4.0 solutions will play a major role during the realization of the investment. The manufacturing of non-compressor production product families will be relocated to a newly constructed plant in Pécs, and aluminium founding will appear as a new activity in Rétság[48]. The taiwanese owned bicycle producer *Giant Group* announced a three phases investment in Hungary with an estimated total sum of 48 million euro. The construction of the first phase of this production facility is expected to be completed in the second half of 2019. Initial production capacity is planned to be around 300,000 units and will focus on core European bicycle and e-bike models. Having a production facility located close to the market was important for the firm, Giant will distribute products to Eastern and Western Europe. This was one of the key factors in choosing Hungary as the base for the second production facility in Europe instead of expanding the existing factory in the Netherlands[49]. The *Continental Group* employs 8000 workers in Hungary and realised investments also in the past two years. In February 2019 they opened an artificial intelligence development center for self-driving cars in Budapest.[50] The Japanese *NIDEC* inaugurated its car-component factory in Northern Hungary in 2018 to manufacture 1 million oil pumps in an automated factory[51].

Examples given in Box 5 show that new plants are often automated or connected to the Industry 4.0 concept. As mentioned, the severe labour shortage in Hungary can be an incentive for automation of the production process and digialisation of services. A kind of indicator for labour shortage is the job vacancy rate. Eurostat registers job vacancies

[48] https://hipa.hu/hanon-systems-to-extend-capacity-and-establish-new-sites-across-hungary
[49] https://www.bike-eu.com/home/nieuws/2018/07/giant-starts-building-new-facility-in-hungary-10134125
[50] https://forbes.hu/uzlet/megnyitott-a-budapesti-kozpont-ahol-onvezeto-autokat-fognak-vezetni-tanitani-continental-mesterseges-intelligencia-fejleszto-kozpont-2019/
[51] https://autopro.hu/en/news/NIDEC-GPM-to-manufacture-1-million-oil-pumps-annually-in-Bercel-thanks-to-new-investment/27575/

and the job vacancy rate provides a comparative indicator for the Visegrád countries (see Figure 8).

Figure 8: Job vacancy rate

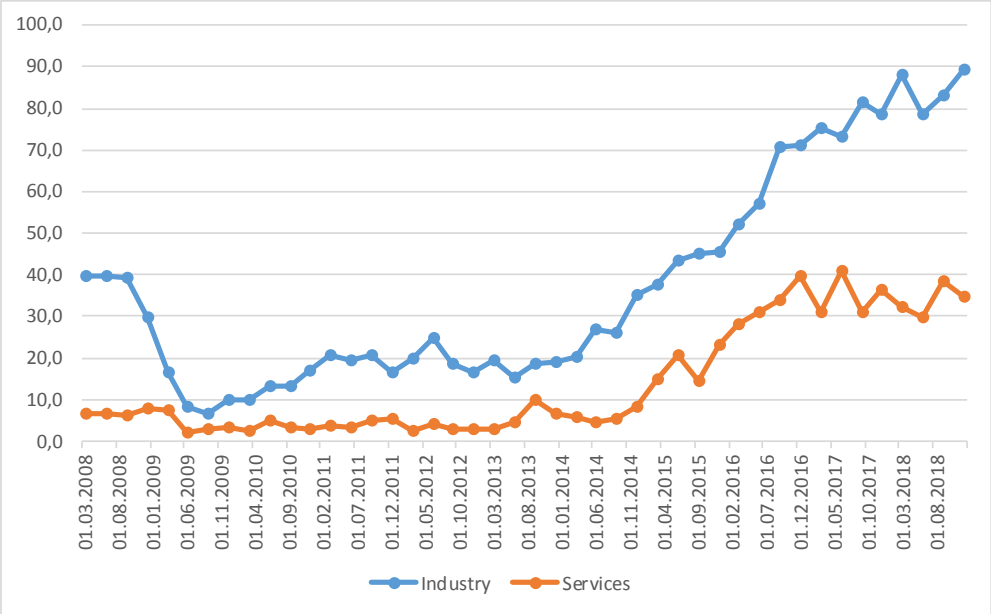



***Note:*** The job vacancy rate (JVR) is the number of job vacancies expresses as a percentage of the sum of the number of occupied posts and the number of job vacancies: JVR = number of job vacancies / (number of occupied posts + number of job vacancies) x100

Source: Eurostat

It is seen that job vacancies in the Czech Republic are the most acute and the second most serious case is Hungary. Labour shortage become more and more a barrier to proper business conduction as several company surveys show. Since 2013 recruiting adequate people is increasingly difficult (MKIK GVI 2017) and labour shortage hits industry the most (see Figure 9).

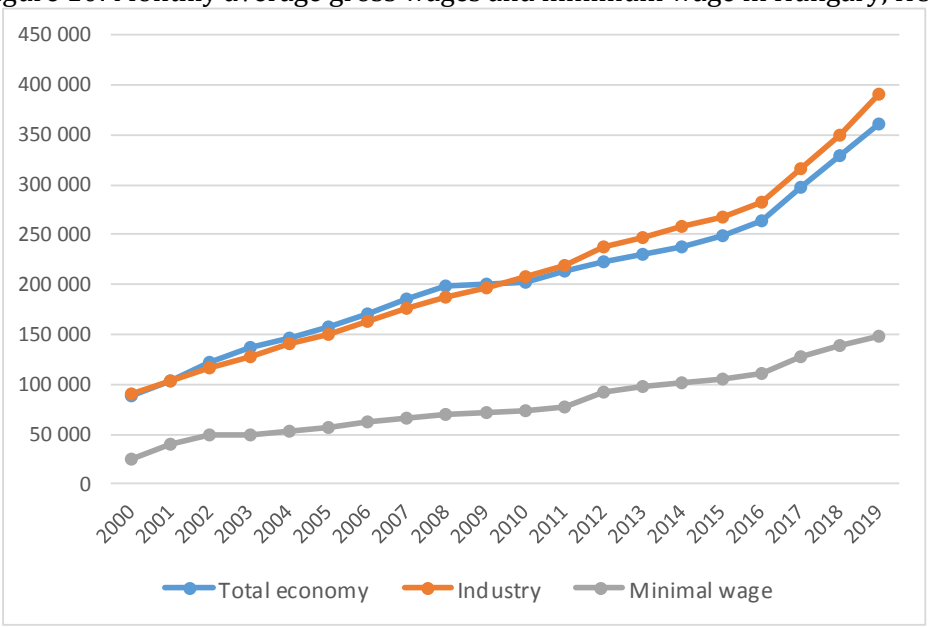
Figure 9: Labour shortage as a percentage of firms pointing to labour shortage as a factor limiting production by sector




*Source*: OECD, 2019 p. 27

The figure shows that since 2014 there is a steep increase of perception of labour shortage among firms. Labour shortage is a consequence of demographic changes and emmigration workers abroad. A direct consequence of labour shortage is wage increase that is constant and quite significant in Hungary (see Figure 10).

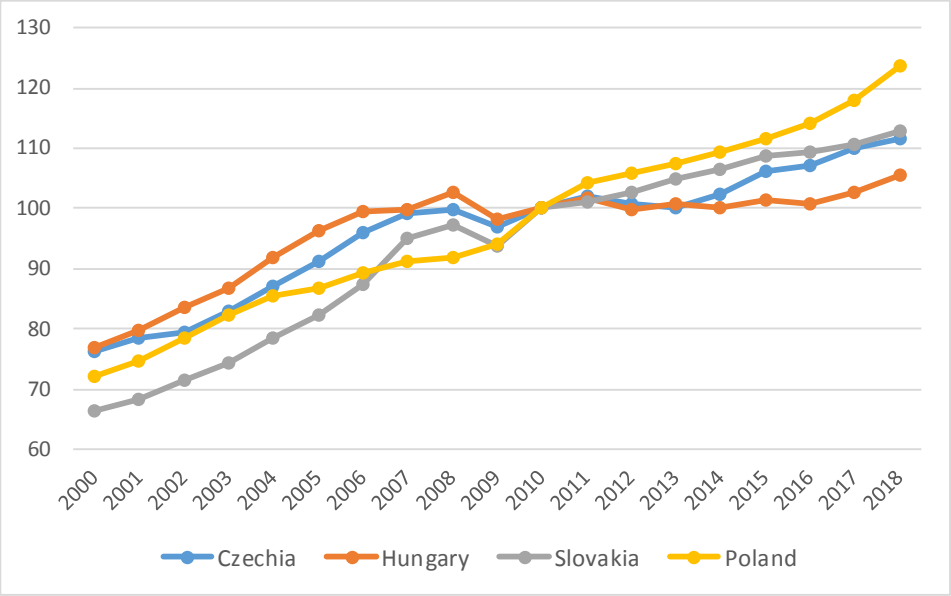
Figure 10: Monthly average gross wages and minimum wage in Hungary, HUF




*Source:* National Statistical Office

The wage increase, however, has not been followed by productivity increase. According to the data of Eurostat, productivity in Hungary stagnates since the crisis and outpaced by the productivity increase in the other three Visegrád countries (see Figure 11).

Figure 11: Real labour productivity per person employed




*Source:* Eurostat

Most of the companies in Hungary have not been prepared to the rapidly rising wages in the past two years. Automotive suppliers, GVC participants could not raise their sales prices, their profits decreased. In order to save costs several of them launched Industry 4.0 projects in 2017.[52]

## Conclusion

In the past decade reshoring became a relevant phenomenon. In several developed economies companies brought back previously offsored production partly or totally. Backshoring took place mainly from China or from other far distance areas. There are some sporadic examples of backhoring from the CEE region, but not from Hungary. Motivations for reshoring can be various, most importantly the need for more flexibility, control of the whole production process, prestige of the home country quality, etc.

[52] Based on firm-presentations and discussions at the Automotive Industry 2019 conference https://www.portfolio.hu/en/events/conference-economy/portfolio-mage-jarmuipar-2019/825/overview

Automation and robotization proved to be also a motive for backshoring in the past years.

There is no global database on reshoring cases but there are European and US sites to collect these. Having analysed these and domestic and international press I have not found backshoring capacities from Hungary since 2014. From a Hungarian point of view nearshoring to the country proved to be more important, because of certain location advantages and favourable tax policy. If foreign investors nearshore to Hungary, it seems better if they automatize their plants because of labour shortage and wage increase. Data and survey evidence show that the introduction of Industry 4.0 technologies can be bound mostly to foreign affiliates in Hungary. However, the question is to what point it is worth, because after a while (if eg. wages are already not significantly lower) it can be more advantageous to invest/robotize in the home country.

Szalavetz and Somosi (2019) mentions the example of a completely automated steel factory in Austria that produces 40% more than a similar one in Hungary. The Hungarian factory has 550 workers while the Austrian one has only 14. That hints to the fact that not only or not really backshoring from Hungary can be a danger but new Industry 4.0 production facilities in developed home countries that make investment in Hungary superfluous and old fashioned.

Hungarian SMEs – with a few exceptions - proved to be unprepaired for the application of Industry 4.0 technologies. This statement is supported by several global indices presented in this paper and also by surveys, personal experiences of experts. There are major problems in Hungarian SMEs like risk avoidance, the lack of strategy and proper management abilities. Therefore efforts to improve education and training is essential.

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