Doctoral School of International Relations and Political Science

Thesis Summary

Gurály Roland Ferenc

Evolution of FDI Hosting Economies in the Context of the Rapid Worldwide Diffusion of Robotics Technologies

Analysing the Manufacturing Sector of the V4 Countries

PhD dissertation

Supervisor:

Dr. István Magas

Prof. Emeritus

Budapest, 2024

Department of World Economy

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1. INTRODUCTION

1.1. Research Target

1.1.1. Study focus

The high-level question on the geographic effect of automation is very complex, and a full elaboration of it is unworkable within the limits of the current study. In this research, therefore, I narrow down the investigated subject where the effects are better demonstratable. The focus is on the different dimensions: the independent variable, the dependent variable, and the level of the application in terms of geography and sector.

The independent variable, in my case, is the current technology revolution. It has many linked terms, like Industry 4.0, digital revolution, etc. Here, I focus on automation in the original sense and deal with physical robots working in the manufacturing industry, which I refer to as robotisation. Under robotisation, I mean physical robots in the broader sense (not only humanoids), whose tasks are to execute physical actions automatically. Making the investigated area even narrower, I analyse only on robotisation in the manufacturing industry.

The dependent variables support the measurement of the economic impact of robotisation.

First, robotisation impacts labour. While the impact of automation on jobs is a global issue, the level of impact differs geographically, depending on the characteristics of a certain country or region.

The second chosen indicator is foreign direct investment (FDI). The changes in both the volume and nature of FDI stock are relevant in this context. FDI has become a valuable tool in the international economy; FDI-based growth is a tool for many less developed countries to try to catch up with the leading ones.

Third, robotisation tendencies generally accompany technological upgrading. This means that a certain country or region develops its innovation and industrial capabilities faster than the average country.

Fourth, upgrading can be measured as positions within global value chains as GVCs have growing significance in the global economy. Accordingly, the position of the investigated countries in the GVCs will be analysed.

In terms of applying the research, the geographical focus is the Visegrad Four countries (the Czech Republic, Hungary, Poland, and Slovakia). The reasoning is that these countries have achieved remarkable results in terms of the FDI inflow. FDI was a dominant tool for them to catch up since the system change in 1989 (Sass, 2021). The second argument is their development status. As mentioned earlier, the mainstream thinking is that there is a negative effect on production outsourcing from leading industrial countries to developing countries. However, the impact on so-called “catching-up” countries,

which are somewhere in between the two categories[1], is less explored, and the Visegrad Four (V4) economies are in this category[2]. Third, they are considered vulnerable as they depend on IFDI (Nölke, 2009), and the subsidiaries of multinational companies are dominant players in many aspects within these countries (Sass, 2020).

Based on the problem setting and the focus areas, the ultimate question[3] to study is the following:

How do FDI hosting catching-up countries, like the V4, develop during the era of swift robotisation?

1.2. Research Objectives

1.2.1. Research questions and hypotheses

1.2.2.1. Research Question 1 and the related hypothesis

The assumption is that the investment in the manufacturing industries of V4 countries is impacted by the ongoing automation process in the home factories of the large multinational companies in leading industrial countries. Thus, the increasing robotisation in the leading FDI-sending countries might decrease the volume of investments in the V4 and can even lead to the backshoring of production from the V4 to the headquarters factories. Consequently, the first research question in the V4 context is:

Research Question 1. *How does the increasing robotisation in advanced economies affect the volume of foreign direct investments in the manufacturing sector of the V4 countries?*

The hypothesis is that there is an effect of robotisation on investments in the V4 countries:

Hypothesis 1: Robotisation-related growth in the leading industrial countries has a negative impact on the foreign direct investments from the leading multinational companies in the manufacturing sector of the V4 countries.

1.2.2.2. Research Question 2 and the related hypothesis

My presumption is that the V4 countries benefit from the current industrial revolution, and there is a technological upgrading in progress in the V4 countries. Accordingly, the second research question is:

Research Question 2: *Is there a technological upgrading towards the leading industrial countries in progress in the V4 region?*

The concerning hypothesis is the following:

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[1] The V4 countries are developed economies, but as it is introduced later, in terms of their position in FDI flow and upgrading in GVCs they show similarities to some developing economies.

[2] The catching-up status is underlined by the fact that the Central Eastern European economies have been growing at a larger rate than the average of the European Union since 1990 (Molterer et al., 2022).

[3] This high-level question is not equivalent to the research questions, which are formed later.

Hypothesis 2: The global technological advancement supports the technological upgrade in the V4 countries, mainly through the subsidiaries of large multinational companies.

1.2.2.3. Research Question 3 and the related hypothesis

The consideration is that the technological development in the V4-located subsidiaries of large multinational companies also fosters upgrading in GVCs. The related research question is as follows:

Research Question 3: *Does the technological development in the subsidiaries of large multinational companies in the V4 stimulate upgrading the subsidiaries in the global value chains?*

My hypothesis is that these developments support the V4 subsidiaries to establish better positions in GVCs:

Hypothesis 3: The technological development in the subsidiaries of the large multinational companies in the V4 promotes upgrading these units in the global value chains.

1.2.2.1. Research Question 4 and the related hypothesis

Forecasts say that the number and type of jobs will shrink due to automation; some researchers find that this process is already ongoing (e.g. Ford, 2015). Besides, there is an assumption that robotisation will benefit skilled workers at the expense of unskilled ones. As the manufacturing sector of the V4 countries is embedded into GVCs, the expectation is that the job market of these countries is affected e.g., there is less need for manual workers due to the increasing robotisation level.

Research Question 4: Does the increasing robotisation in manufacturing sites of multinational companies in the V4 decrease the need for manual workers in the V4 subsidiaries?

Hypothesis 4: The hypothesis is that the increase in the level of robotisation in the manufacturing sites of multinational companies in the V4 region impacts the number and type of workers employed.

1.3. Methodology

Understanding the impact of robotisation on the economies of catching-up countries like the V4 is a complex task, therefore, an adequate and complex methodology should be invented. Consequently, my research uses quantitative and qualitative approaches, both applied at macro and micro levels.

The following table (2. Table) shows a high-level summary of the tailor-made methodology framework:

	Quantitative	Qualitative
Macro-level	• relation of robotisation rate growth rate and the outward FDI stock to the manufacturing industry • analysing the employment-related statistics in the V4 • trade in value-added indicators tendencies • investigating other development-related indicators	• Scrutinising the FDI, backshoring, employment, technology and GVC-upgrading related trends in the leading developed countries and the V4 countries, based on interviews with experts and desk research on the relevant literature
Micro-level	• comparison of annual report information for global companies and their subsidiaries in the V4 focusing on employment-related differences	• Interviews with local (V4) managers of selected multinationals from the main FDI-source countries, discussing issues such as automation tendencies, employment possibilities, signs of backshoring, upgrading in GVCs, catching up to leading Western economies, etc.

The methodology matrix

2. THEORETICAL FRAMEWORK

2.1. Literature review

This section covers the literature relevant to the three research questions, e.g. it includes the assessment of articles and studies in the field of:

- employment,
- foreign direct investment,
- technological upgrading,
- upgrading in global value chains.

Although I try to analyse the most essential writings in each category, the focus is on research that includes the considerations of automation[4] and/or robotisation.

2.1.1. Employment

Growth theories are the most relevant to employment. Growth is related to external variables in the exogenous models. The production function is the main theory related to it. The latter is important for

[4] As mentioned earlier, the focus is the thesis is rather robotisation than automation, but as there are more studies available on the later one, articles on both terms are analysed in the literature review.

my research in terms of representing the two main substituting factors in capitalism: capital and labour (Solow, 1957). A related finding is that robots can also be considered a form of capital (Battisti et al., 2022).

Regarding the sectoral impacts, those research studies are interesting for my thesis which focus on the manufacturing industry. A report from PwC (Hawksworth et al., 2018) explains that automation will affect different sectors unalike. In terms of potential job loss, the manufacturing sector is the second after transportation and storage. According to their calculations, in the manufacturing industry during the 20s, approximately 20% of the jobs can be lost and during the first half of the 30s, another 20% (Hawksworth et al., 2018). Impacts on the manufacturing sector are not foreseen only in the future; they are present, according to a recent empirical study (Compagnucci et al., 2019). De Backer and his co-authors also find this relation: "manufacturing industries in which labour costs account for a large(r) share in total production costs are more likely to invest in robotics because robots allow to save on labour and thus costs" (De Backer et al., 2018)

Fernández-Macías and his co-authors (Fernández-Macías et al., 2021) augment the understanding of industrial robotisation in Europe with a new perspective. They discovered that:

- There is only incremental development in robotisation technology, and the recent European robots are just updates on earlier solutions. They observed no disruptive element in the current robotisation tendencies.
- Robotisation is very concentrated. In terms of industrial sectors, there are only three where the robotisation rate is significant: automotive, plastic, and metal products. With regard to geographical concentration, they calculated that nearly half of the industrial robots are employed in Germany.
- The sectors where the increase in robotisation was higher are those where the share of routine tasks is high and there is a relatively lower share of highly educated workers, but at the same time, the wages and labour union membership are higher.

Due to these findings, they state that "These robots are more likely to replace less sophisticated robots than human workers" (Fernández-Macías et al., 2021). However, it should be noted that the period investigated was from 1995 to 2016, and significant progress has been made during the last years in the field. They also mention that the emergence of artificial intelligence might change the "non-disruptive" nature of robotisation.

2.1.2. Foreign Direct Investment

There are micro-level (e.g. firm) and macro-level (usually country) theories related to foreign direct investment (FDI). One of the most important in the first group is the OLI paradigm[5] (Dunning, 1980).

[5] Also called as the "Eclectic paradigm".

The OLI paradigm categorises the factors that impact firms' decision-making into ownership, location, and internalisation advantages. From this list, location-specific advantages are particularly relevant, as differences among locations can cause additional benefits. The "push" and "pull" factors are also related to the location advantages. Push factors are the internal or domestic factors that enable and force the organisation to seek investment outside its home country; pull factors make a particular firm/location/country attractive to the investor (Dunning 2004).

A gravity model complemented for FDI shows that investments are indirectly proportional to distance costs (Paniagua, 2015), meaning that nearshoring[6] can be economically advantageous. The article also finds that the role of re-investors was neglected in FDI-related literature. Another study observed that FDI positively correlated with GDP and negatively with distance (Dorakh, A., 2020). The author also declared that EU membership resulted in 23% higher FDI inflows for newer member states between 1991 and 2017.

Automation tendencies and technology development, in general, have an impact on foreign direct investment-related policies as well. The new manufacturing technologies influence leading MNE[7]s to reconsider their investment strategies, and they might choose the scenarios of "retention", "selection", and "reconfiguration" (Szalavetz, 2017).

Scientists tend to agree that automation-related developments will be uneven geographically, e.g., that developed economies, especially the higher industrial ones, will benefit more than most of the developing ones. Spence and his co-authors argue that the developed world will be the ultimate winner of the current changes. "All these trends play to the strengths of developed countries, where skilled work forces, large quantities of capital, huge customer bases, and dense clusters of high-tech companies combine to power modern economies." (Lund et al., 2019). This finding aligns with the thoughts of automation experts (Atkinson, 2019). Accordingly, it is also noted that "the rapid development of the robotization and artificial intelligence in the last decade have helped the redirection of FDI flow from low-wage countries to higher-wage and more developed countries" (Kalotay et al., 2022). Robots also play a role in this process: more developed economies benefit more from automation tendencies as they already have a higher robot density and a higher stock of complementary traditional capital (Alonso et al., 2020).

However empirical studies do not support the above-mentioned theory. According to an OECD working paper, the strength of robotisation seems to be limited at the moment: it is enough to keep some production in highly developed economies but not strong enough to take production outsourced earlier to developing economies back to developed countries (De Backer et al., 2018). Automation is also

[6] Nearshoring means relocation of investments to the home region and backshoring means the relocation of the offshored investments to the home country (Merino, et al, 2021). Backshoring is also often called reshoring.

[7] Multinational Enterprise

present in emerging countries, where production costs are lower. In this respect, nearshoring is a more realistic scenario than reshoring (Butollo, 2021).

The results show that the link is mainly positive (especially in middle-income countries), and in most cases, the stock of robots per 1,000 employees in developed countries increased together with the growth in IFDI[8] in developing countries (from the developed ones). At the same time, the authors paid attention to the early warning signs as continued robotisation beyond a threshold level resulted in a slower-growing FDI in developing countries (Hallward-Driemeier et al., 2019).

2.1.3. Technological upgrading

Innovation-related investments support the development of a particular company, industry or country. Robotisation is one of the manifestations of innovation-related activities in production processes. Therefore, the pace of robotisation alone can be seen as an indicator of development or, in other words, technological upgrading. This is underlined by the fact that robots are one of the critical drivers of productivity increase in developed countries (Atkinson, 2019).

A key organisation in the field of robotisation is the International Federation of Robotics (IFR). The IFR publishes annual statistics on the number of industrial and service robots[9] used at the country level what I utilised during my analysis.

Robotisation is not only important from a quantitative perspective. As reported by a study (DeStefano et al., 2021) robotisation in developing countries had a positive implication, namely upgrading in quality as the authors recognised that robots can enhance export quality. Robots upgrade the quality especially in products where the quality was initially low. As these kind of products are more dominant in developing countries, "results suggest that developing countries may have greater potential for quality catch-up through automating their production" (DeStefano et al., 2021).

Decisions on deploying new technologies, like robots, are also affected by geographical factors. Analysing the effects in a sectoral and regional comparison, Krzywdzinski observed different labour-use strategies that firms deploy in highly automated plants. The location of the plan and the probability of having a lead role in implementing new technologies are strongly correlated (Krzywdzinski, 2017).

2.1.4. Upgrading in Global Value Chains

A crucial GVC-related foundation by Baldwin is the "smile curve" (Baldwin, 2013). He discovered that offshoring of production started during the second unbundling of globalisation. The value-added content decreased in the offshored stages. The smile curve asserts that fabrication – especially final assembly – involves less value creation today than it did before the second unbundling – the smile deepened.."

[8] inward foreign direct investment

[9] Although service robots are important for the overall performance of a certain economy, in this research I rely on industrial robots only to keep the study focused on manufacturing.

(Baldwin, 2013). Baldwin classifies the investors as “headquarter economies” and the recipients as “factory economies”.

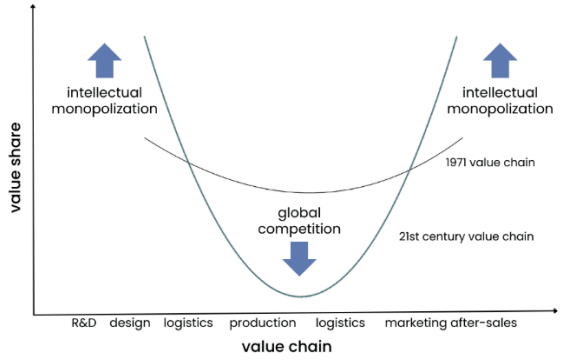

Figure: The smile curve: good and bad stages in the value chain

Own creation on the basis of Baldwin, 2013

During recent decades, it can be observed that there has been an ongoing offshoring process from developed countries to developing ones. The large MNEs relocate their production-focused functions to less developed countries, while they maintain control of higher value -added activities in their home countries (Neilson et al., 2014).

The examination of the effects of robotisation within the GVC framework is particularly interesting for my research. It was found that higher robotisation increases both employment growth and the value added in the particular industry. However, it is only beneficial for some participants; the advantages and disadvantages depend on which type of value-added component the certain industry is focusing on (Ghodsi et al., 2020).

Analysing the same issue at the country level, a study (De Backer et al., 2018) indicates that robot usage affects the upgrading possibilities of countries within GVCs. A higher level of robotisation might increase the efficiency and quality of production, which in turn might increase GVC participation.

3. DISCUSSION AND RESULTS

3.1. Analysing the Impact of Robotisation on Foreign Direct Investment

My initial assumptions were the following:

- robotisation in the leading industrial countries negatively affects their foreign direct investment in the manufacturing sectors of less developed countries,
- the above-mentioned theory is valid for the V4 countries as well.

By building on the findings of the literature and my quantitative and qualitative analysis, I cannot find an unambiguous general negative link between robotisation in the leading industrial countries and the investments from these countries to the manufacturing sector of less developed[10] countries. The question arises as to why the related prophecies (e.g. Lund et al., 2019) are not yet materialising.

Part of the answer was given by one of the senior managers of a car manufacturer: he emphasised the complexity of the decision-making process for investment. For every investment-related decision,[11] there is a checklist to go over in the headquarters, and this list includes approximately sixty-eight factors. These factors include the market environment, the existence/non-existence of customs, the availability of an educated workforce, the supply chain situation, the role of trade unions, logistical, political, and demographic aspects, etc. As a result, the level of automation/robotisation in the headquarters factory and the derived implications alone are not the decisive factors in the future of a subsidiary.

Also, the statistics show an increase in inward foreign direct investment in manufacturing in the Visegrad Four. This growth was visible both in absolute and relative values. The absolute growth means that MIFDI[12] stock increased throughout the examined period. The relative growth is derived from the ratio of MIFDI stock versus IFDI[13] stock within the particular V4 countries. In a simplified formula:

$$\Delta\text{MIFDI stock}^{\mathbf{V4}}/\Delta\text{IFDI stock}^{\mathbf{V4}} > 1$$

1. Equation: MIFDI/IFDI-related changes in the V4

Where,

ΔMIFDI: is the annual growth rate of the inward foreign direct investment stock in manufacturing in the V4 countries in the observed period,

ΔIFDI is the annual growth rate of the total inward foreign direct investment stock in the V4 countries in the observed period.

Besides the investment volume, I also analysed the potential that a subsidiary factory was closed due to increased robotisation in large multinational companies' headquarters' factory. Consequently, I tried to answer whether backshoring from the manufacturing industry in the V4 has taken place during the last decade. As it was found both based on the literature and the field research, there is no evidence for significant backshoring.

[10] The „less developed" does not mean developing, it contains all the countries which are not leading industrial countries (e.g. Germany, Japan, the USA, etc.) including developed ones (e.g. the V4).

[11] It also includes the decision whether to sustain an earlier investment.

[12] As introduced earlier, MIFDI stands for inward foreign direct investment in manufacturing.

[13] IFDI means inward foreign direct investment.

Following the literature on push and pull factors for an investment decision (Dunning, 2004; Szunomár, 2020), I explore how these factors justify the lack of backshoring from the V4.

On the one hand, there are some adverse developments on the "push" side for investments, as robotisation in the headquarters of large multinationals probably has a decreasing "force" on efficiency-seeking investments, which is often the case in the manufacturing sector of the V4. Besides, as explored in the empirical analysis section, production costs have increased in the V4, which is a decrease in the "pull" forces for investments.

However, on the other hand, the production is still much more cost-efficient in the V4; according to a manager, Hungary, for example, is still considered a "low-cost country" and has substantial benefits when considering an investment decision. This means that although efficiency-seeking is still a critical factor in investment motivations, the relative decrease in related efficiency does not cause inefficiency in absolute terms. Additionally, as mentioned earlier, the factor mix for an investment decision is quite complex; it cannot be narrowed down to the cost of robotisation in the headquarters versus the cost of the workforce at the subsidiary.

The finding about the nexus of developed leading countries and the V4 during the last decade can be summarised in the formula below:

$$\mathbf{\Delta PushHQ^{R}+\Delta Pull\ Sub^{L+Lc} \ll PushHQ^{Fo} + Pull\ Sub^{Fo}}$$

2. Equation: The relation of push and pull factors in the V4 in the context of the study

Where:

$\Delta PushHQ^{R}$ is the new, changed value (usually a decreased one) in the push factors at the headquarters due to the changes in the robotisation rate (usually an increase creating a decrease in production costs) in the headquarter factories, and

$\Delta Pull\ Sub^{L+Lc}$ is the new, changed value in the pull factors (usually a decreased one) in the local subsidiary due to the changes in the availability (usually a decrease) and cost of labour (usually an increase creating an increase in production costs).

Fo[14] means other investment-related decision-making factors both in the headquarters economy (in our case[15], usually in Germany), ranging from the overall market forces on the company (e.g. a drive to lower production costs) to the high salary cost of employees in the headquarters factories and also in the

[14] Simplifying the problem, the other factors are presented as static ones, as the focus of this paper is the changes of two factors: robotisation and labour related ones.

[15] According to the interviewed organisations.

countries where the subsidiary is located (in our case in the V4), measuring the utilisation opportunities for already established facilities and the good logistics possibilities, etc.

The formula shows that the sum of the decreased values of both the robotisation-related push factor and the labour availability and labour cost-related pull factors are still substantially smaller than the aggregated value[16] of all the other push and pull factors. In other words, robotisation and the changes in the local labour market probably had a negative impact on the attractiveness of the V4 manufacturing sector. However, due to the stability or even increase of other factors, the manufacturing industries of the V4 region are still attractive destinations for investments.

When investigating what the other factors are that make the V4 still an attractive destination for investors, the answer to the question is probably the gravity model.

As shown in the literature review (Paniagua, 2015 and Dorakh, A., 2020), there is a negative correlation between FDI flow and distance. It was also found that the new member states received significantly more FDI due to their EU membership than they would have received as non-EU members (Dorakh, A., 2020).

Following the push and pull factors-related (Dunning, 2004 and Szunomár, 2020) expression form applied in Finding 4:

$$\textbf{Push EUDev}^{\mathbf{EU}}\textbf{+Pull V4}^{\mathbf{EU}} > 0$$

3. Equation: The effect of EU membership on push/pull

Where,

Push EUDev^{EU}: The push factor of the developed EU member countries to invest within the EU.

Pull V4^{EU}: The pull factor of the V4 countries to attract investors from the developed EU members.

Therefore, the assumption is that one of the reasons[17] why the Visegrad Four countries could invert the manufacturing-related FDI trends is their EU membership and the closeness to the leading European industrial FDI-source countries.

The analysis did not support the original assumption, as it was not proven that the Visegrad Four region is losing investments as a result of robotisation. On the contrary, it seems that the V4 countries are still relative winners of the global investment process. Therefore, **I *reject* the related hypothesis as no evidence has been found that the robotisation-related growth in the leading industrial countries**

[16] In order to focus on the key factors of this study, the analysis was carried out in a "ceteris paribus" manner, e.g. the other investment related factors were considered as static ones.

[17] There are obviously other reasons behind the important role of the manufacturing sector, one key one is the government intentions and support for manufacturing-related investments in several V4 countries.

has a negative impact on the foreign direct investments of the leading multinational companies in the manufacturing sector of the V4 countries.

3.2. Investigating the Technological Upgrading Progress

My technological upgrading-related assumption was that global technological development enables technological upgrading in the V4 countries. I also presumed that this process occurs mainly via large multinational companies.

As detailed in my analysis, the robotisation-related growth rate in the V4 outpaces many leading industrial countries, including Germany. As robotisation itself is considered an important factor signalling technological upgrading, I understand there is a "catching-up" process in the V4 to the leading industrial countries in this respect.

The qualitative research supports this claim; both the managers and the experts in the field confirmed that they had noticed a technological upgrading process. As my interviews revealed, there are examples of the level of automation in the V4 subsidiaries being very close to the equivalent manufacturing sites in the leading industrial countries. In a certain case, the Hungarian factory oversteps the German factory in the quality and performance of the robots deployed. In addition, in recent years, significant developments have taken place in research and development activities, as some multinational firms opened up new research centres or expanded their existing ones in the V4.

This development process can be expressed in a simple formula:

$$\mathbf{\Delta Up}^{TECH} > \mathbf{0}$$

4. Equation: Technological upgrading

Where,

$\Delta \mathrm{Up}^{TECH}$ means technological upgrading.

Whether a technology upgrading-related "glass ceiling" exists in the manufacturing sector of the V4 or not, as the statistics and the primary research results show, there is currently an upgrading process in the region. On the basis of my analysis, **I *accept* the second hypothesis. I found evidence that there is a technological upgrading process in the manufacturing sector of the Visegrad Group countries, mainly due to the presence of large multinational companies.**

3.3. Upgrading in Global Value Chains as a Result of Technological Development

The related assumption was that the V4 countries upgraded the GVCs due to the ongoing technological developments in the local factories of large multinational companies. The reasoning was that primarily multinational companies invested in robotisation, and also the higher level of automation enabled these units to gain control over more complex activities.

However, my quantitative analysis did not support this assumption. First of all, except for Poland, the V4 countries are substantially more integrated into GVCs than the five selected leading industrial countries. As the previous section indicates, technological upgrading takes place mainly through the multinational companies in the region; this fact might provide a ground for GVC-related upgrading as well. Nevertheless, according to the TiVA statistics, there is no upgrading in the GVCs in the V4 region during the period 2010 – 2018.

The manifestation of this relationship in a formula is the following:

$$\mathbf{\Delta Up}^{GVC} = \mathbf{0}$$

5. Equation: Upgrading of the V4 in Global Value Chains from 2010 - 2018

Where,

$\Delta \mathrm{Up}^{GVC}$ means upgrading in GVCs.

The literature (e.g. Szalavetz, 2019) confirms the significant differences between the position of the V4 companies in GVCs and the headquarters companies of large multinationals.

Why is there a difference between the identified progress in technological upgrading and the non-existing GVC-related upgrading?

The probable answer is that there is a considerable difference between the various kinds of subsidiaries of multinational companies in the V4. As the two example companies in the micro-level quantitative analysis showed, the two factories in Hungary performed different upgrading-related values. One of them is a factory of an automotive OEM producing high-value products, while the other is a factory performing simple assembly and packaging of relatively low-value products. This means there is a duality within the subsidiaries of multinationals in the V4 manufacturing industries. This duality is different from the duality observed between multinationals and domestic companies (Éltető, 2021); in this sense, these economies have a "double duality". There are examples of companies with significant technology developments, e.g., increasing research and development activities, shared service centres, functional and process upgrading due to automation, robotisation and other Industry 4.0-related developments. On the other hand, many multinationals still perform relatively low-value-added activities in the V4. Examples of them are, for example, the recent implementations of battery factories in Hungary, which mean substantial investments in volume, but the forecasted value-added is low (Győrffy, D., 2023). The value-added statistics show that the latter outperforms the first category.

In addition to the above-mentioned reasoning, it is essential to note that the V4 countries are "shooting on a moving target", e.g. there is a global technological process benefiting everyone, including the headquarters of large multinational companies. Although the V4 countries show compelling statistics

regarding the increase in robotisation, the catching-up can be less noticeable in other more qualitative developments (for example, the use of artificial intelligence in product design processes).

Consequently, although there is an assumption that the progress in technological upgrading is a "positive force" in GVC-upgrading as well, as no evidence was found to prove it on a general level, **I *reject* the third hypothesis, that the technological development in the subsidiaries of the large multinational companies in the V4, promote the upgrading of these units in the global value chains.**

3.4. Analysis of the Effects of Robotisation on Employment

As introduced earlier, the employment-related hypothesis is that the increase in the level of robotisation in the manufacturing sites of multinational companies in the V4 region impacts the number and type of workers employed.

As described in the literature and mentioned by the managers, the key motivation in manufacturing is keeping production costs low. With the rise of automation and technology development, the earlier capital versus labour nexus is extended with technology improvement. This change can also be expressed formally following the production function-related studies introduced in the literature review.

Extending the production function (Mankiw, 2009) with the new element will look like this:

$$Y=F((RK^{18}+TK^{19}),L^{20})$$

6. Equation: Extending the production function

The aforementioned theoretical considerations entail that the assumption that the robotisation in the V4 factories might negatively affect employment in these sites might be right. However, the statistics do not support this supposition; the participation rate has grown significantly in these countries in recent years. Besides, the significant increase in salaries in these countries implies that the competition from automation did not push workers to a position where the jobs can only be kept at the expense of salary reductions. What can be noticed is that the number of indirect workers is growing, as automation not only eliminates jobs but also creates new ones. These kinds of jobs are usually skilled, and many require an engineering degree. Second, despite the increase in productivity due to the growth in the production volume, the number of workers in the manufacturing industry is rising. Moreover, according to the interviews and quantitative results, the observation is that the pace of robotisation is still below the level of increase in the scarcity of workers in the V4. As expressed in the formula below:

[18] RK: robot capital (Battisti et al., 2022)

[19] TK: traditional capital

[20] L: labour

$$\mathbf{D^{L\Delta}+D^{Lnmr\Delta} > D^{Lmr\Delta}}$$

7. Equation: Changes in labour demand in the V4 manufacturing sector

Where,

$D^{L\Delta}$: Is the increase in the demand for workers in the manufacturing industry due to larger production volume,

$D^{Lnmr\Delta}$: Is the extra demand for non-manual workers due to robotisation,

$D^{Lmr\Delta}$: Is the decrease in the demand for manual workers due to robotisation.

Therefore, the labour situation in the V4 so far supports the "optimists" (for example, Autor, 2015) rather than the "pessimists" (Ford, 2015). It means that robotisation and worker substitution are in progress in the V4, but they do not increase unemployment due to a considerable increase in worker demand. On the contrary, as robotisation is connected to investments in manufacturing, and there is a growing production volume in the sector, my finding is that the increasing robotisation in the V4 supports employment. Consequently, **I *accept* the fourth hypothesis: the increase in the level of robotisation in the manufacturing sites of multinational companies in the V4 region impacts the number and type of workers employed.**

CONCLUSIONS

This dissertation aimed to study how FDI-hosting catching-up countries, like the V4, developed during the era of swift robotisation. As was described, the Czech Republic, Hungary, Poland and Slovakia are trying to progress towards Western Europe, and the investments of large multinational companies in these countries' manufacturing sectors are a significant tool in reaching the desired development level. Robotisation, both indirectly via the headquarters of large multinationals and indirectly in their subsidiaries in the V4, impacts the development of these countries. This potential impact was analysed in four streams: foreign direct investment, technological upgrading, upgrading in global value chains and employment.

The study has a number of implications.

First, there is no evidence that the increasing robotisation in the production sites of the leading industrial countries negatively affects the investments in the manufacturing sector of the V4 region. The underlying assumption was that because of robotisation, the decreasing production costs in the major "FDI-sending" countries, particularly in Western Europe, might weaken the attractiveness of the V4 for investments. Both the quantitative and qualitative research results support the opposite: the manufacturing industry in the V4 is still an investment destination, and there are no signs of backshoring from these countries. Although a robotisation-related negative impact might be present, it is outbalanced

by the other investment-related push and pull factors, which dominantly still favour the V4. Two factors are the proximity to Western Europe and the EU membership.

Second, I verified that there was a technological upgrading in the manufacturing industries in the V4. Large multinational companies are the primary enablers of this process via robotisation at their local production sites. Moreover, the increasing share of skilled workers at the expense of unskilled ones is another indication of upgrading. The results of my primary research conducted in interviews with managers and experts also support these findings.

Third, the expectation that in parallel with the technological upgrading, the subsidiaries in the V4 also upgrade in the GVCs was not confirmed. The statistics do not uphold my related supposition; according to the TiVA values, the V4 countries stagnated in GVC-related upgrading from 2010 to 2018. The literature supports the statistical evidence; most studies in the field show that production and assembly activities are dominantly the focus of the operations of the subsidiaries of the large multinationals in the V4. These activities are traditionally considered to possess a lower added value. Consequently, although there are some technological upgrading-related processes, these activities are mainly in the production field. Albeit there are some examples of high-added value activities in the V4, there is a counterbalancing effect from processes representing lower added value within the particular value chain.

Fourth, I found that the rise in robotisation in the subsidiaries in the V4 influenced the workforce. However, this relation is not negative, as some researchers forecast, but positive. As robotisation in the region mainly results from investments, it goes conjointly with establishing new jobs. Therefore, even if robotisation might eliminate specific workplaces, the new investments and the growing production volumes are more powerful forces. What is observed via the field research is that automation is propelling development. Statistics also support this finding as despite the significant growth in robotisation, the unemployment rate is decreasing, and salaries are increasing in the V4. An equilibrium was found: the increase in robotisation keeps pace with the increase in employee-related costs.

Based on the findings, I detect no evidence that the global robotisation tendencies negatively affect the catching-up of the V4 to the highly developed industrial countries, on the contrary, the conclusion is that **robotisation and the related automation processes, support the development of the V4 economies.**

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