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Difficulties of catching-up in Central-Eastern Europe

PhD dissertation

Zoltán Fülöp

assistant lecturer

Department of Business Economy

Supervisor: Dr. Dávid István Losonci

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Acknowledgment and testimonial

I dedicate my thesis in honor of my "two fathers"!

I dedicate it in honor of my father, **László János Fülöp**, who constantly motivated me during my PhD studies and persistently believed in my progress!

I dedicate it in honor of my scientific father, **György Boda**, from whom I have learned the most in my scientific life!

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Table of contents

List of Tables

List of Figures

Abstract

Hungary's growth has always been characterised by periods of strong growth and higher employment. However, these were never really sustained and often ran into periods of crisis that always set back the country's long-term convergence (Boda et al. 2019).

My doctoral dissertation is a series of articles that emerged from several independent yet closely interconnected research endeavors. Throughout my investigations, the question that lingered was how Hungary and the Central-Eastern European region are progressing on the trajectory towards of catching up (or, conversely, falling behind). The exploration of parallels between the region's characteristic state of a middle-income trap and its economic structure emerged as an objective, with one less-discussed aspect being the examination of engagement with global value chains.

Throughout my research, I employed various methodological approaches. I examined the entire GDP balance from both the production and consumption sides. Additionally, I harmonised macro-level indicators with results derived from a corporate-level database. The smile curve framework flows through my entire dissertation. In a quantifiable manner, I integrated it into the core of global value chain analyses. Alongside the data from the Hungarian Central Statistical Office (KSH), I also analysed data from the World Input-Output Database, as well as Eurostat and Ameco data.

The majority of countries in the Central-Eastern European region are reliant on external factors, leading to a focus on external demand rather than internal development. This is primarily driven by multinational companies outsourcing production, creating a complex situation. Two significant forces are at play: the impact of the regime change in the European region over the past 30 years and the rapid technological advancements that have transformed supply chains in the latter half of this period. These forces have intertwined to shape the region's dynamics, making it challenging to isolate their individual effects.

The fragmentation of global supply chains has provided the Eastern European region with many opportunities, so that many companies tend to be engaged in less complex, low-value-added activities. At the sectoral level, this implies a shift towards the production of 'input-like' products, which can be well quantified by the upstreamness indicator. The two

groups of activities with the largest shares of upstream activities are the production of raw materials and low-value-added assembly activities.

The emerging Eastern European models have brought a certain semblance of catching up, as from 2000 to 2014 the region's value-added volume moved closer to that of Western countries, but no real and comprehensive upgrading can be identified. The narrowing of the gap is mainly due to an increase in the volume of production. Unfortunately, the overall value-added content has also declined moderately.

The situation is further nuanced by the fact that a significant part of the additional value-added generation is linked to the performance of Western countries. In the case of Hungary, between 2010 and 2015, 60 percent of the growth in the value added of the dominant small, medium, and large enterprises was generated by mostly foreign-owned businesses, and the share of nationally owned enterprises in this group of companies in value-added production fell by 4 percent.

This seemingly successful but still trap-like structure needs to be abandoned and the focus shifted to real and large-scale upgrading. One way of doing this could be to focus on higher value-added activities, for example, more complex and higher knowledge-intensive activities in the global value chain being carried out by nationally owned companies. Another development direction could be found in the services sector, which already has a high value-added but is not yet fully exploited in terms of volume and integration. One such priority sector in the region could be the IT services sector. As the results show, it is not so simple to highlight the IT sector, as it also has a different position in each country within the global supply chain, and it is also not true that all positions are highly profitable.

It is important to draw attention to the fact that the trap situation has also emerged in IT development, as modern communication technologies have also created pressure to outsource "execution", low value-added activities. The cluster analysis of the IT sector shows that countries around the world are organised along three main orientations. One main direction is that the IT sector produces inputs for other sectors at lower value added or is "assembling", i.e. behaving as an upstream and manufacturing sector, the second category is shifting towards the middle but with medium to high value added, and finally there are countries that keep their downstream IT sector stable with a high value added. It is instructive to note that here too, there is pressure to move towards the middle in terms of value-added share and also towards the upstream.

The shift of the IT sector towards manufacturing and upstream is a natural consequence of the increasing use of digital technology in our everyday devices and objects. By having this in mind, achieving real upgrading in the region requires a focus on the direction that potential breakout sectors, such as IT services, are taking and how they are integrated into the global value chain.

As key finding, I would like to highlight some key messages from my article-based dissertation. As an introduction, it is highlighted, that even a trap situation has been identified, a thoughtful way must be chosen. The apparent trap situation and the economic growing in the Central-Eastern European region is highly influenced by foreign capital. We must note that, while Hungary is a Western Europe-exposed economy, its internal development is also burdened by internal regional tensions. If we look closely at the global value chain positions, then it is various how each countries' industries catch any positions. In the Central-Eastern European region there are several forms of value chains (GVC positions), but we can claim that the shifting in the past fifteen years is not running like in the Western trends.

In conclusion, it can be stated that Central-Eastern European countries are catching up to the West, but they have not yet caught up entirely. Economic development is a complex process influenced by disparities between sectors and the interrelation of industries within global value chains. Countries that can effectively increase their productivity and value-added ratio, along with building the right economic relationships, have a better chance of achieving sustainable development and competitiveness in the global economy.

1 Introduction

1.1 My research career and reasons for the choice of topic

The beginning of my research career dates back to my Master's studies. It was during this period that I started working with György Boda and Dávid Losonci. I became involved in their existing research on labour force and employment, as well as on national economic performance. Subsequently, a digitalisation research area was added to the research. Inspired by this research, I formulated my own ÚNKP research, for which I won a grant. The title of the resulting study was "Future trends in labour demand and labour supply and their impact on organisation and organisational strategies". My thesis supervisor was György Boda. The research was not published as a journal article, only as a study.

The research consisted mainly of secondary data analysis, literature review, and interviews with managers. I felt it was important to examine the unfolding labour market changes (mainly domestic but also global). Technological developments, changes in market structures and demographic changes are closely shaping labour demand and supply, as well as training needs. I soon realised that, overall, this is a large and complex topic, and that to understand it, its individual components need to be examined in detail. My next major research unit was built around digitalisation and Industry 4.0, but also included 'Work 4.0' and labour market research. When applying for PhD studies, I designed my research plan around this. This resulted in my first independent journal publication, in the Labour Review, in 2018, entitled "The impact of Industry 4.0 on employment". During the research, I reviewed a wide range of literature related to digitalisation and employment, as well as company databases.

At the same time, I was also involved in a growth rate research project, during which Tamás Révész joined the team. The research provided me with a high level understanding of the system of the sectoral linkages balance sheet, the so-called input-output tables (IOT), and the related input-output analysis methodologies. This brought research issues at the national economy and sectoral level to the centre of attention. In the course of the research, the total GDP balance sheet was studied, both from the production and consumption side. In addition, macro-level indicators were linked to results from a firm-level database.

The methodological skills I learned here and the research questions I was able to answer inspired me further, and my initial research plan changed direction somewhat. In particular, I was attracted by the World Input-Output Table/Database (WIOD) and its potential for modelling the world economy. The complexity and scope of the system is rather daunting for most researchers, but its consistency and potential were rather motivating for me. My attention soon turned to the sectoral problems and how to address them. With this approach, I continued my research and my work with my peers, which gave me the opportunity to understand the importance of supply chains and the smile curve framework that expresses their characteristics. By this time, the structural issues were already evident, as indicated by the positions held within supply chains (global value chains). This prompted the integration of the analytical database with a sectoral analysis, which also accommodates my original interest in the IT field.

The thought process of the smile curve flows through my entire dissertation, so a detailed description can be found in the methodology section and related articles. It should be emphasised that the framework is used by most researchers as a guideline or a guideline for thinking. Many studies cite its lessons. After a detailed literature review, I found that there are very few researchers who conduct quantitative analyses of the smile curve framework (at the sectoral level), so by combining known and accepted methodologies and supplementing them with my own results, I have developed an analytical framework to analyse the WIOD database in a consistent way, with a quantifiable measure of the global value chain. During the research, I prepared several methodological descriptions and workshop studies, with the aim of including them in my dissertation. In addition, two manuscripts of articles were produced, also with an emphasis on the approach and methodological framework. These are presented in the introductory section. In my background research, I analysed the related methodology of Antras et al. (2012; 2013) and quantified the upstreamness and downstreamness values of the WIOD database countries. I also compared the sectoral rankings for both indicators and examined the rank correlation coefficient between them. I examined how common the characteristic "U" shape of the smile curve is across countries and time periods. Based on calculations, I have identified the "cut-off values" according to which sectors can be classified as upstreamness, manufacturing or downstreamness based on their upstreamness or downstreamness index. This exact categorisation is not common among researchers, although I think it is important that if simplifying classifications are used, there is a robust, derived methodology that can be consistently repeated over time on other data sets. The details of these are set out in the introduction, as these background studies have not been published, only in simplified form, integrated into the individual articles.

During my research, I was interested in the question of how Hungary and the Central and Eastern European region are moving along the road to catching up. Exploring the parallels between the region's middle-income trap situation and its economic structure emerged as a goal, one of the less discussed aspects of which is the examination of the linkages to global value chains.

1.2. Content of the article based dissertation

The article-based dissertation is a relatively new genre. The formal and content-related requirements do not yet have a well-established system of expectations and conventions. The advantage of this is that the author can enjoy greater freedom in shaping the structure, but this also presents a burden. In the previous chapter of my dissertation, I presented my research career so far, how I have evolved, and the directions my thinking has taken. In this chapter, I am now focusing on how the articles and studies included in the dissertation have developed, how they were created, what their main ideas and methods are, and how I connect them in the dissertation. For the sake of clarity of this heavy content, at the end of this chapter, a brief summary table and a diagram have been included on this topic.

For introducing the research field and idea, I must start with the thesis that Central and Eastern European countries have always experienced periods of strong economic growth and higher employment. However, these were never really sustained and often ran into periods of crisis. The gap between the region's economic performance and that of Western countries has narrowed, but is still far from closing. Examining the growth difficulties and the middle-income trap that have emerged, and the potential for a breakout from these, is the central question of my thesis. Three of my included articles and one study strictly focus on this theme, building somewhat on each other.

In the first article (**Article 1 "On the possibilities of increasing the growth rate and employment"** - my contribution is 30%), my colleagues and I present a comprehensive analysis of the Hungarian economy. The paper includes a summary of the knowledge of the IOT (Input-Output Table) and the national accounts necessary to understand the topic and also discusses the necessary corporate accounting systems. In the literature review, studies focusing mainly on economic structure and structural change have been reviewed. In the empirical part, two separate calculations were performed, one half of which is a structure analysis based on macro data and the other half is a structural change modelling based on firm-level data. Several studies have shown that value-added production and efficiency increase with firm size. A recent example examining this statement can be Szász et. al [2023] paper. We have confirmed this in our study. This suggests that increasing the size of the company may be a logical way out, but our research has shown that without real upgrading, the expected results will not be achieved. "The problem we see is with the law of economies of scale. Within the group of continuously operating SMEs and large firms, companies that scale up significantly relative to their numbers, doubling value-added, employment, and increasing gross fixed capital formation by 150%, but do so with declining productivity and deteriorating efficiency. It is as if there is only extensive growth in this circle of companies. Efficiency is not growing at a sufficient pace." (Boda et. al. 2019, p.406.)

The next way forward could be to focus development on high-value-added sectors. It is in the context of this issue that I conceived the design for Article 3 and 4, as well as the overall research framework that forms part of this dissertation. As a first step, I looked at the sectors' value-added production. The smile curve framework was then used as the framework for the analysis, which examines the value-added content of the companies/sectors involved in the supply chain. The aim was to analyse which sectors produce a higher value-added share and to identify the differences between countries. The results were not included in a journal article but are discussed in the dissertation. However, the results raised the question of: what are the links between the role of each sector in the global value chain, and between the share of value added, and between the economic catching-up? This inspired **Article 3 ("Evolvement of global value chain positions in the Central – Eastern European countries – A new dimension in catching up?"** - my contribution 100%)

The results of the article 3. show that the upstreamness index of many sectors is getting lower, so that compared to the classic smile curve classification, sectors are shifting from manufacturing to upstream, and typically with a low value added share. For this reason, it can be observed that, in contrast to the "U" shaped curve of the developed countries, the curve of the CEECs often takes a "/" shape, but also "r" and "^" shapes are not uncommon. These production structures only allow for extensive catching-up. It is easy to recognise that the production structure of western countries (Germany, USA) would lead to a significant increase in value added even if the production volume remained unchanged. Overall, this is neither the right direction to sustain growth nor the appropriate way to catch up.

In addition to my independent research, I continued my work with György Boda and Tamás Révész, along with Regina Thék. This collaborative research built well on the lessons learned in Article 1, but also synergised with the GVC theories explored in my independent research. We published a joint article based on the findings and methodological innovations that we uncovered, which I refer to as **Article 2** of my dissertation (**Productivity and profitability**). Chronologically it can be considered as the third, but since the 2nd and 3rd were published almost simultaneously I have preferred to number them in order of logical connectivity. I recommend this reading order to the reader of my dissertation, but as the articles were published in their own right, switching the order does not prevent understanding. In a pioneering way, Article 2 not only examines international import-export relations, and in net terms, but also territorial relations within Hungary (territorial/regional IOT), which reflects the local presence of global laws in the functioning of the economy. In summarising the articles, it will be well connected that Article 2 actually highlights the fact that the trap situation discussed in Article 3 is also present within Hungary among the regions, and if Budapest were to be excluded, it would not be in a bad position internationally either. However, this may be one of the costs of not being able to say the same for the rest of the country.

In parallel with Article 3, an investigation has been launched into other break-out routes, but the lessons of previous analyses suggest that here too caution should be exercised in singling out one sector. Firstly, I have highlighted the IT services sector (NACE J62_63), which is renowned for its high value-added content and for the fact that this sector has been growing and developing by leaps and bounds over the last decades. This led me to formulate the research question for **Study 4 ("International analysis of the IT sector based on GVCs "** - my contribution is 95%). In the course of the research, I will examine which IT service sectors in different countries have significant links with other sectors, and the relative position of IT in each country based on macro indicators (indicators: upstreamness, downstreamness, value added share, share of IT sector value added in the value added produced by the country, IT value added of the country in the total world IT value added). The cluster analysis based on the indicators highlighted will show that IT sectors are also classified along three main directions. An important cautionary note is that even with this prominent position, the sector could be heading for a trap and could take on a kind of "assembly service" character, with medium profitability.

The articles in this dissertation have all been published in peer-reviewed journals. The publication of the study referred to as Paper 4 in the dissertation has not yet started, as the dissertation is already a series of volumes and has been overshadowed by recent publications. The manuscript has already been widely presented in my PhD thesis draft, but also before that (at conferences, in work settings). The quality of the paper was enhanced by the professional support of Zsolt Matyusz and the continuous review of Dávid Losonci. Zsolt Matyusz supported the methodology and implementation of the cluster analysis, while Dávid Losonci helped to refine the conceptual arc and conclusions of the study. Following the completion of the dissertation process, we aimed at the joint publication of a focused journal article based on the study.

It is important to mention that my co-authors and I have also worked on the background research for Article 1. The result is a scientific publication that presents all the calculations and analyses that were not available in the Economic Review (original Hungarian name: Közgazdasági Szemle). This complex volume of studies is freely available online. Reference: About the possibilities to enhance growth rate and employment - Background study of the article published in the April 2019 issue of Közgazdasági Szemle, Budapest, April 2019; ISBN number: 978-615-80240-2-0; Publisher: Boda & Partners Kft.

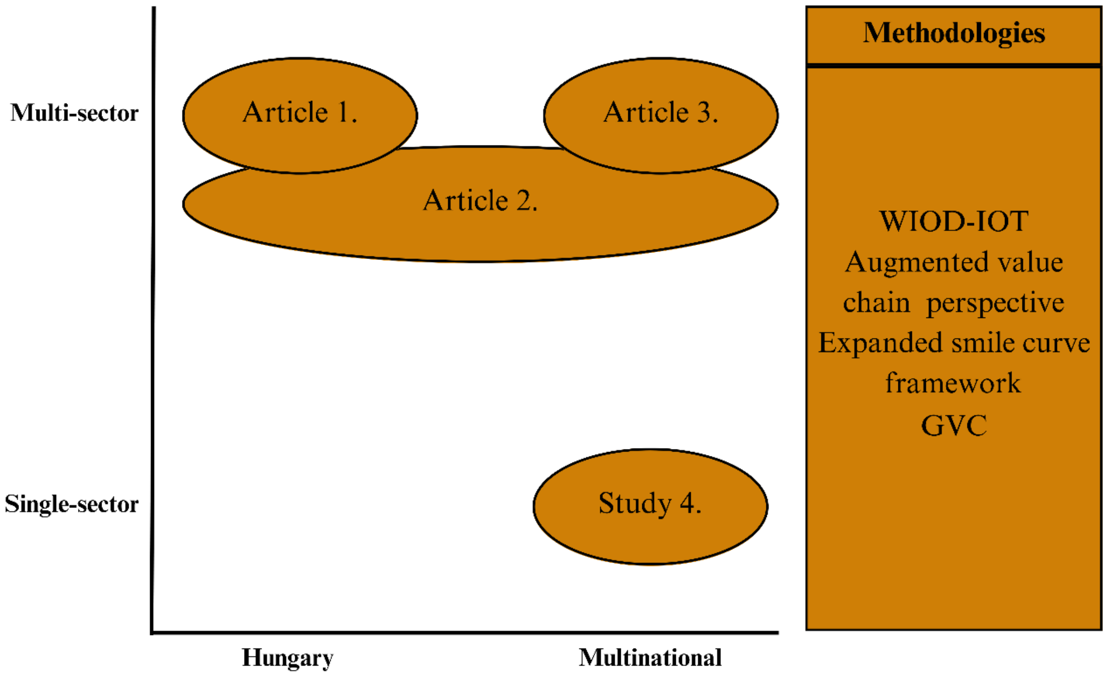
Table *1* summarises the links between the sections in the dissertation and highlights the main elements. Figure *1* also provides a visual representation.

Table 1: Summarising the structure of the dissertation

	Introduction	Article 1	Article 2	Article 3	Study 4
Focus of analysis	Economic growth and GVCs	Economic growth rate and GVCs	Productivity and profitability analysis, GVC	Position of sectors in the GVC, catching up	IT sector in the GVC
Emphasis	Theoretical introduction and methodological extension	Methodological, empirical analysis	Methodology, empirical analysis	Literature introduction and methodology	Empirical analysis
Geographic focus	Global	Hungary	Central and Eastern Europe	CEER countries	Global
Methodology 1	WIOD	Input-output methodology, IOT, WIOD			
Methodology 2	Up-, Downstreamness, UMD	National accounts	Hungary territorial IOT	Methodologies related to the smile curve framework (upstreamness, AV ratio)	
Methodology 3	Rank correlation	Enterprise database analysis	FIGARO IOT	UMD	Cluster analysis
Main findings	Even after a trap situation has been identified, a thoughtful way out must be chosen	Apparent growth, trap situation, influence of foreign capital	Hungary is a GEEI-exposed economy, while its internal development is also burdened by regional tensions.	Global value chain positions not moving in the direction of Western trends	The IT sector is not a way out of the income trap in all countries
Conclusion	The majority of Central and Eastern European countries are in the income trap, which can be identified from the GVC position. There are several break-out paths, one of which is upgrading and pursuing higher value added and developing sectors (e.g. IT) that can be well positioned.				

Source: own contribution

Figure 1: placement of the articles and study covering the chapters of the dissertation, by the space studied



Source: own contribution

Article 1: “*On the possibilities of increasing the growth rate and employment”*

Article 2: *"Productivity and profitability"*

Article 3: *" Evolvement of global value chain positions in the Central – Eastern European countries – A new dimension in catching up?"*

Study 4: *“International analysis of the IT sector based on GVCs"*

In the context of article-based dissertations, there is often a question about the areas and extent of the contribution of the author in the articles that are part of the dissertation. Determining this is a thankless task, since participation in a scholarly work also implies an increase in knowledge, and if an area is shared or discussed jointly by several people, how should it be divided up? 50-50% or has everyone put in 100% of their knowledge? In addition, it is also difficult to determine how much the tasks that led to the article are counted in the total output. Does the visual (writing, graphing) or the less visual calculation and discursive contribution count?

To remove any doubt, however, we drew some lines and, based on the statement of my fellow authors, we have defined my contributions below (Zoltán Fülöp's contributions):

My fellow authors unanimously stated that Zoltán Fülöp's contribution to the joint results is:

	Article 1.	Article 2.	Article 3.	Study 4.
Creating a concept	30%	40%	100%	95%
Data collection	70%	60%	100%	100%
Data analysis and methodological input	20%	25%	100%	95%
Carrying out analyses and calculations	50%	25%	100%	95%
Writing and drafting of study	15%	35%	100%	100%
Further contribution	25%	35%	100%	90%
Overall	30%	30%	100%	100% (95%)*

*Study 4: *“International analysis of the IT sector based on GVCs"*

Formally in this study, I do not have co-authors, but Zsot Matyusz and Dávid Losonci helped me in the concept creating and testing my idea and in the cluster analysis part. I think I need to mention their contribution and ask their permission to publish it as my and mention them in the acknowledgment part. They supported my plan and they unanimously stated that my (Zoltán Fülöp's) contribution to the joint results is at least 95%, so I can be the only author of the paper.

Note: the articles and the study in this dissertation are identical to the originally published content, differing only in language and format. The translations have been finalised with the assistance of a specialist translator who has compared them with the original publication.

1.3. Theoretical background

There is a lot of literature dealing with the catching up. Researchers often employ a high-level measurement to evaluate the progress of these countries in catching up to their more developed counterparts. For instance, studies by EU (2023) and Jones and Klenow (2016) and Smith et al. (2018) highlight the significance of GDP growth, technological advancement, and human capital investment as crucial components of the catch-up process. This study also focusses on high-level measurements and macro data, but it opens new aspects via the production and the GVC connections.

The problems of possible underperformance or inefficient development of the economy are mainly to be found in the structure of production. In addition, the structure of production, driven by foreign direct investment (FDI), which does not serve convergence effectively, also has a significant impact (Lux [2017], Gorynia et. al. [2015]). To mitigate this, countries need to undertake internal upgrading (Lin et. al., 2008; Lin, 2017). One pillar of this is to change the structure of the economy. Sector upgrading should emphasise sectors with higher value-added ratio and with higher knowledge intensity. More specifically, the set of activities carried out by each sector should be directed in this direction. We need to mention, that the FDI driven structure results that manufacturing firms in less competitive countries, (especially in the South-East Asian region) invest significantly more in technology and Industry 4.0 than countries ahead in competitive rankings or CEE countries. (Szász et. al [2021]) It might not support the knowledge intense upgrading path.

The concept of upgrading has been used several times, but it is worth clarifying here that this thesis is mainly concerned with the economic dimension of upgrading, which is generally defined as 'moving into higher value-added (ratio) stages', i.e. a move to a higher value-added level, often resulting from some positive technological or productivity improvement. A recent cornerstone work in the GVC literature, Marcato - Baltar, 2020, has also highlighted this definition.

Future economists give clear statements on the content of structural change (Boda-Virág [2010], Boda [2017a], [2017b], Brynjolfsson-McAfee [2014], McAfee-Brynjolfsson [2016], Ford [2017], Marosán [2017]), as well as empirical labour market (Frey-Osborne [2013], Hanushek et al. [2017], Trąpczyński [2013]) and other industrial organisation research (Szalavetz [2016], [2017], Gorynia et. al. [2014]). In the context of structural change, these authors mainly refer to and urge the rapid unfolding of the knowledge economy. They are mostly agreeing on that the knowledge intensive sectors should be encouraged.

To see the problem from a bit higher perspective, we can claim that for decades, the development of national economies has been the subject of continuous research by eminent experts, and many theories have been put forward in economics as to why sectors in some countries can develop successfully while the same sector in another country stagnates or even declines. (Vakhal, 2021) There are many complex reasons for this. Vakhal (2021) has also argued that neither economic history nor modern science can provide satisfactory answers to these questions. One reason is that economies are taking increasingly complex and integrated forms. Many earlier theories have been transformed as the quantitative description of phenomena has become more complex, but fortunately the analytical tools have also become more sophisticated.

It is also clear from the discourse of György Boda and Andrea Szalavetz (2022) that statements such as "the economic structure is fundamentally a function of the consumption structure" are no longer entirely correct, since nowadays, in the era of global value chains, this is not the case, or more precisely, it is not enough to observe the consumption of a country or a region, but the whole world is involved. This is also illustrated by the crisis linked to the coronavirus that started in the 2020s and then to the Ukraine-Russia war. Global and regional issues have drawn attention to how integrated economies are and the huge importance of foreign trade. Vakhal (2021) also mentions a phenomenon highlighted by the situation in the 2020s: 'The organisation of firms, and thus indirectly of countries into production networks, has redrawn dependency relations, and it can no longer be said that the direction of dependence is clearly from the smaller country to the larger.' (p 9.) I have experienced an example from my own corporate practice (2022 and 2023) in the context of the Ukrainian-Russian war which illustrates this. What happened was that suppliers from Western, mainly German, companies, or even capacity at the end of the supply chain, failed, causing serious problems at the end of the chain. The companies concerned began to look for alternative solutions at a rapid pace, and this is how, for example, production and even the value-added share in metalworking in Hungary, at least for a significant number of companies in the sector, increased. Even if only temporarily, the West was left in a situation of dependence and was forced to open up to any alternative solution. In this situation, the question of the network of links between domestic companies and sectors, their role in the supplier network, their development path and direction, the opportunities they can and cannot exploit, has come to the centre of attention. This is also a kind of market knowledge, which is also discussed in Boda et al. 2021 (and some basic elements in Boda et al.2009). Not all companies have been able to take advantage of this, and often it is only temporary, with the West pushing the value-added content down again. The lack of knowledge capital and knowledge management capabilities has a major impact on the performance of a value chain firm (Boda et. al. 2021; Szalavetz 2011), but I do not elaborate on this in this dissertation. Instead, I will focus on the phenomenon itself and its characterisation. In the CEE region, it is typical that companies and policymakers take advantage of the opportunities offered by outsourcing and input sourcing, but these are often associated with low added value, which in the long run is likely to reduce growth rates and cannot be the sole basis for strategy.

The definition of a middle-income trap has been formulated by several people. This is well summarised in Glave-Wagner (2020). In a research project with György Boda, we reviewed a wide range of these and ultimately formulated a definition that is aligned with the analytical framework of my dissertation, which can be also derived along the logic of the smile curve. According to our interpretation, a country is said to be in a middle-income trap if its production and resource structure is essentially concentrated in the sectors that generate the least 'income' in specific terms, i.e. those in which the value added per unit of output is low. Three main trap paths can in fact be identified here:

The first is where the smile curve is at a relatively low level so that even if the familiar "U" shape persists in some groups of sectors, it is still at a lower level with a lower value-added ratio than in other countries.

The second, often occurring phenomenon, is that the curve also persists, but that a large part of production is concentrated in the middle, in manufacturing, where the value added ratio is the lowest. In the past, researchers have mainly used this variant to illustrate the problem of individual economies.

The third case, which is common in Central and Eastern European countries, is that the base of the curve is not "U" but "/" or "r" or, in the worst case, "^". This would not be a problem in itself, but coupled with the first case, the level in the middle of the curve, where value added is higher, does not exceed (or does not significantly exceed) the level in other developed countries. The focus shifts here to the middle, but this alone is not enough to catch up. We need to mention here, that, from different aspects, there are different paths within manufacturing sectors. Based on the connection between supply chain position and the extent and type of services offered dominant business models are identified both in Eastern and Western Europe (Szász-Demeter, 2011).

In the examination of middle-income trap and GVC relations, Csontos (2023a) Using world-system analysis and the smile curve framework, he develops the model of participation and self-reliance, and within this new framework, interprets the trap of moderately developed countries. The goal of the participation strategy is described as to attain production, consumption, and institutional factors that facilitate catching up through engagement in global labor division. The self-reliance strategy involves efforts to neutralise factors hindering catching up through participation. The author agrees that the most Central-Eastern European country is in middle income trap. In connection with the author's other parallel work (Csontos, 2023b), he examines that in the Central-Eastern European countries there are several catching-up models (or strategies). As this dissertation will show, it can be confirmed, because there are lot of different GVC position models in this region, and the catching up process is ongoing, but it always reaches somehow a peak, and the economic distance is not decreasing significantly anymore. Thise findings are also consistent with Bohle – Greskovits (2012).

To maintain the trap situation (or to remain in trap), it is important to note that it is also necessary that, due to some external influence or internal problem, the country in the supply chain is unable to increase the share of higher value-added activities/sectors and it is forced to engage in lower value-added activities. It is important to note that the fact of income trap is linked to the evolution of some selected economic indicators, for example, by Magdolna Csath (2019, 2020), but I do not use them in my dissertation, so I will explain the definition used in detail in the relevant section.

Given that one of the central elements of the study is the smile curve, in this chapter I will describe in detail what I mean by it and what methodological elements are associated with it. I will also organise the terminology here so that it is consistent later in the dissertation and in the articles included.

I use the term "smile curve" to describe the phenomenon in its entirety, and I have included in this terminology, for simplicity, the method of calculating the two dimensions of the coordinate system (value added ratio of production and upstreamness/downstreamness). I have also used the groupings associated with the upstream, manufacturing, downstream (UMD) sector groups and the economic context that can be discerned in the picture that emerges. It is in fact a mixture of several methodologies and analytical tools. These are explained in detail in the methodological description. I use the term smile curve essentially as an analytical framework. Many researchers use the smile curve to describe the phenomenon without quantifying the horizontal axis (upstreamness/downstreamness) in an exact way. To do this, I introduced Antras' methodology, which in itself only measures the proximity and distance of the consumer to the end-use. I have also included the value added ratio used in the smile curve and, ultimately, the size of each sector. The third innovation linked to the study (mainly in Article 3, but also covered in the introductory methodological description) is that the classification of sectors into UMD categories is based on a direct, detailed derived and calculated methodology. Together, these three elements give rise to a specific 'methodology', which I will refer to simplistically in English as 'smile curve theory', but prefer to call it 'smile curve framework' on several occasions.

1.3.1 Detailed description of the smile curve connectivity

In the following section, I will show how the smile curve relates to my research and what levels of interpretation can be found in the literature. The application of the methodology is explained in the methodology chapter. This section has several overlaps with Article 3, but these redundancies are necessary for the sake of clarity throughout.

The global value chain came to the forefront of business thought decades ago. In studying the issue of value chains, Porter (1985), when examining competitive advantage in business, pointed out that when examining the achievement and maintenance of competitive advantage, it is necessary to analyse the activities of the value chain separately, since they add different value to the products and services being sold. Porter's interpretation at the enterprise level soon reached other levels of economic organisation. Extending the line of thought to global trade relations, the analysis is based on the positioning of sectors in the value chain. Technological progress and the reduction of transaction costs have led to dramatic changes in the tasks of production and the international division of labour (Krugman et al., 1995), so that the relevance of national or global analyses has increased alongside the firm-level interpretation. This paper also discusses global relations at the sectoral level.

Baldwin also thought in terms of a global value chain when he created his model of the unfolding of globalisation (Baldwin, 2015). Baldwin shows in his research that, as a result of changes in trade activity, a significant proportion of EU companies are able to outsource work that was previously classified as non-tradable. In addition, it has introduced the perception that larger companies are now planning their production workforce partly by using domestic labour and skills, and at the same time are now also considering labour from elsewhere in the world. Some of the high-skill jobs have been found to be well outsourceable, but there remain occupations that have been repeatedly confirmed as not being outsourceable or not well outsourceable (Baldwin, 2006)

It is important to underline that the article in this dissertation focuses on only one specific case of the definition of the classical term non-tradable. The term non-tradable is primarily described as having a " non-outsourceable" character. The term non-tradable itself is defined in the WTO "Dictionary of Trade Policy Terms" as "Non-tradables: goods and services that are not, or only rarely traded internationally.". The scope of non-tradables has narrowed with the development of the international economic system and the factors that influence it, such as technology. Some of the services that were previously considered distinctly non-tradable have been transferred to the tradable category. Nowadays, a large part of international trade is the movement of semi-finished goods (and services) at different stages of the value chain, either within a company (group) or as output of activities that have been outsourced to another country ('location'). Obviously, some of the activities are outsourceable and some are not, which often also means that the output of the activity is not tradable - i.e. non-tradable. In essence, therefore, the candidate's interpretation of the term "non-tradable" does not contradict the definition, but provides a narrower interpretative framework for it (clarified by László Kacsirek, 2023).

In this paper, I do not distinguish between the different types of outsourcing, but simplify it by using the term "outsourcing", although for the sake of clarity, I should mention: outsourcing is the outsourcing of an activity to an independent company outside the company; offshore outsourcing, when this is done abroad; and offshoring, the relocation abroad to the company's own subsidiary. It is not necessary to distinguish between the sub-types in this dissertation as it does not examine ownership, but the importance of this is highlighted in the relevant articles.

Based on what Baldwin calls in his 2016 work "third unbundling", it can be said that the production and consumption of services will be more decoupled than researchers have described in previous periods. In effect, this will enable a new and different kind of outsourcing, bringing together service providers from all over the world, previously virtually isolated, into global value chains (Baldwin, 2016).

One of the pioneers of value chain analysis, Gary Gereffi and Karina Fernandez-Stark (2016), have published the most fundamental related publication, Global Value Chain Analysis: A Primerit, clarifies previous GVC-related concepts and theories, details the top-down and bottom-up decision making of global industries, and extends thinking to the question of how these business decisions affect economic and social "upgrading"/"catching-up" or "downgrading" in specific countries and regions.

In the literature research related to the smile curve, I first accessed the studies of Rungi and Del Prete (2017), Mudambi (2008) and Antràs-Chor (2013), which provided insights into the theoretical framework.

The 2017 study by Armando Rungi and Davide Del Prete is very much related to Baldwin. The authors also examined the distribution of value added along the global value chain. There are significant differences in the distribution of value-added per unit of output across sectors. This phenomenon is called in the literature the smile curve, because if we sort the sectors into three categories (upstream, production, and downstream; or pre-production, production, and post-production (Mudambi, 2008)), the curve described in the coordinate system becomes a parabola resembling a smile. (See relevant figure in Article 2.) Typically, the sectors on the sidelines included in the analysis are the "smiling" ones, as they have a higher value-added per output. Rationally, these sectors should be targeted.

In the analytical framework, value-added creation (y-axis) becomes measurable: it is defined as the ratio of value added to output (value added ratio). This can be calculated either for a company or for a sector. The original outline of the framework also shows which sectors are typically closer to inputs and their production, and which sectors are closer to consumers (to the market). Article 3 "Figure 1." in addition to this, indicates the strategic options for where a sector can move. The usual understanding of strategy is at the company level, but sectoral strategic directions can also emerge if the companies involved operate according to similar principles. Increasing the value-added content is a fundamental objective for all companies and sectors, as higher value-added content can ensure higher profit. There are of course several ways to increase the value-added share, such as investments in efficiency. Based on the smile curve framework, an efficiency-enhancing intervention could be to reduce, outsource or buy activities located in the middle of the smile curve and to focus resources in upstream and/or downstream directions. When a sector increases the ratio of input to pre-production processes, it moves towards an upstream strategy. For example, it increases R&D, conducts new basic research, experiments, and exploration. If an industry is moving more towards consumers, it is moving towards a downstream strategy; for example, if its products and services are moving towards end-use and it is increasing its marketing, sales promotion, and after-sales activities. If it still remains in the middle but wants to increase its value-added as a ratio of output, it can pursue an upgrading strategy by improving and modernising its manufacturing functions. A sector can be examined by its relative position along the curve, i.e. the section along the horizontal (x) axis it falls in, and its value-added and output ratio in a given year. In determining the relative position, it is necessary to look at the deviation from other sectors to ensure that different countries are comparable. By including the time factor, further conclusions can be drawn from the analysis. In the case where the relative position is determined for two points in time, the direction of the shifts along the x and y axes show towards which part of the value chain (top/bottom/end) the sector has oriented itself and whether the given strategic change has led to an increase or decrease in efficiency. The smile curve framework can thus be validated by sector dynamics. For example, if a company moves from manufacturing to upstream with a corresponding increase in its value-added share, or vice versa, from downstream to manufacturing with a decreasing value-added share, the smile curve framework is thus validated. Thus, by including temporality in the analysis, we can infer the strategic direction of growth, whether a sector is "upstreaming", "downstreaming", squeezed in the middle or increasing its efficiency by not moving along the value chain. This method is only partially suitable for determining the direction of development, as a number of external environmental factors can move a sector in a particular direction.

It is important to point out that the original term "smile curve" speaks rather of a "value chain", which classically describes the relationship between value-creating processes within a firm (Porter, 1985), whereas the analytical framework I use speaks of a value chain that can be extended to inter-firm relationships (Bowersox and Closs, 1996). The National Economic Input Output Tables used in the analysis allow the examination of the global value chain elements at the sectoral level.

It is generally accepted that geographically dispersed links in the value chain can operate as separate enterprises, specialising in a particular task of the value chain, with the remaining tasks of the value chain being performed by completely separate enterprises, regardless of any ownership or location, thanks to information communication technologies and tools (Jones and Kierzkowski, 1990, 2001), which have greatly reduced the transaction costs of outsourcing. In order to make specialisation, outsourcing parts of sectoral activities or even selling sectoral outputs to a completely separate operator profitable, different wage levels in different countries are of course necessary, because if the savings in wage costs are much higher than the transaction costs, then profits can increase (or maintain). Together, these have contributed to the development of the theory of the smile curve, as the study of the striking differences in value-added capabilities between fragmented production and similar sectors in different countries is becoming increasingly important (Stöllinger, 2019). The theory suggests that there will be significant differences between countries when examining the same sector, as there are both "upstream" and "downstream" activities within a given sector, which are easily outsourced internationally thanks to globalisation and lower transaction costs.

Rungi and Del Prete's 2017, and Mudambi's 2008 study describe the basis for the classification of sectors into upstream, manufacturing and downstream categories (this is discussed in the methodology section).

Rungi and Del Prete (2017) also used previous results from other authors for their figure. The figure also shows the observation of Shih, Stan (1992) in the "U" shaped curve. The unit value added per unit of output (or the value added ratio of service of a basic activity) is lowest in manufacturing, while it is much higher in the other two groups of activities. In the case of the output or output ratio, it is important to note that it also includes the input content, which implies that in sectors with very high input requirements, the value added ratio of output is inherently lower than in sectors with no or hardly any input, since the value added already includes results net of the value of the input. Koppány and Kovács (2011) derived these in their study in a way that can be calculated at the firm level. Before value added, there are two intermediate categories: the non-material production value, which is the gross production value minus the cost of materials and services used; and the net production value, which is the non-material production value minus depreciation. Value added can be calculated as the sum of personnel costs, depreciation and amortisation and profit before tax (Koppány-Kovács, 2011). Sectoral value added can also be calculated by summing up the value added of the actors in the sector, thus resulting in a bottom-up calculation system.

Regarding the measurement of value added, for the completeness of the dissertation, it is worth mentioning that several methodological problems have been collected in the literature (e.g. Marcato - Baltar, 2020; Tian et al., 2019), among which it is worth highlighting that the value added indicator is often criticised for being difficult to calculate accurately, for being subject to uncertainties, and for being difficult to distinguish whether it is of domestic origin or linked to another actor. At the micro level, it is also important to mention the phenomenon of value capture, which refers to the process by which a firm or organisation exploits the value creation processes or resources it generates or influences and acquires, retains or uses economic benefits that are of value to the firm. The resulting benefits can take various forms, such as increasing market share, gaining a competitive advantage, achieving higher profitability, gaining a technological advantage or even developing new products and services. The acquisition of value is a strategic issue, which the big multinationals are trying to exploit in a rational way. In this paper, I would like to nuance that one of the causes of the sectoral earnings trap is a well-established theory, already at the micro level, which is one of the drivers of the phenomenon described.

The decline in the value of output (production) is also explained by Prahalad and Hamel's (1990) 'core competence' theory: firms focus on what they do best and outsource the rest. If outsourcing is done to a place where they are more competent, overall efficiency is expected to increase. This in turn may reduce the measured value added (absolute value), because if a company used to do the transportation itself and now outsources it, the value added of this will not be recorded in its company, but because it will be the output of another company, the value added will be recorded there. These point out that it is primarily the value added content of output that should be observed, not its absolute mass, thus reinforcing the importance of the observational dimension of Shih, Stan (1992).

1.4. Methodological supplements and related results

The chapter in Article 1 entitled "The methodology developed for structural analysis" discusses in great detail the key methodologies related to the IOT, national accounts and enterprise databases. I will not repeat this in the introduction.

It should be noted that, although in Article 1 it was possible to divide some of the analytical data according to whether a given output is linked to a domestic or a foreign majority-owned enterprise, this was not possible in the other analyses (Article 3 and Study 4).

The WIOD database does not express the ownership of factors of production, so it is not suitable for separating enterprises in a country by ownership. This distinction is not emphasised in Article 3 and Study 4, but it should be pointed out here. The good news is that I am also exploring this timely topic in the context of other research, which provides a colourful perspective. The research uses data for countries and groups of countries and makes it interpretable at the sectoral level. It does not affect the main findings, but it is worth noting that many studies highlight the importance of the region being an important destination for the various foreign-owned companies that are included in the data, as they are classified by geography. This problem is covered in Article 1. Unfortunately, the full international analysis does not present performance by company ownership. This problem has recently been addressed in detail by Roman Stöllinger, in the context of import-export value-added netting. The topic of GVCs always brings up the issue of foreign-owned enterprises and the pull of foreign orders and their mixing, so it is not possible to write about the topic without mentioning it in some way, but a detailed examination is not always necessary.

The remainder of the draft dissertation methodology describes in detail the methodologies and input data required to calculate the smile curve (including the UMD analysis). This chapter emphasises parts that were not included in Article 2, but for the sake of consistency, it is necessary to repeat in this chapter parts that are later mentioned in Article 2. Reducing this redundancy would make the introduction too difficult to follow, so in writing the following sub-chapter I have aimed for clarity in itself. Only in the case of illustrative diagrams, which could otherwise be omitted, do I refer to the details that may be found later.

1.4.1 Classification of sectors according to their position in the value chain

For the review of methodologies related to the smile curve framework, I adapted the Antràs-Chor approach, as the authors' methodology is interpreted at the sectoral level, which is central to my research, and several of the studies reviewed refer to this pair of authors as the basic methodology. I consider the methodology highlighted to be detailed and operationalizable, mathematically verifiable, and applicable to my research based on the available data. The analysis of Hagemejer and Ghodsi (2017) is also based on the methodology of Antràs-Chor (2013), covering EU and OECD countries, which include the target countries of my research. The methodology of Cieślik-Biegańska-Środa-Murawska (2016) is macro-level, thus it treats national economies as a whole and does not analyse at sectoral level, which is not appropriate for my research, so I discarded this methodology. In addition to using Antràs-Chor's methodology as a starting point, the two studies mentioned above use the WIOD database, which I also use as a tool in my research.

For each sector, the Antràs-Chor procedure calculates an indicator based on the Sectoral Input-Output Table (IOT), which relates the aggregate direct use of the sector to the total production of the sector beyond the production of the final product, i.e. total production use. The indicator can also be derived by formula.

This indicator is interpreted by the authors as follows: 'The higher is this indicator for a given industry, the more intensive is its use as a direct input for final use production' (Antràs-Chor, 2013, pp. 26.). The higher the share of final product, the more downstream the sector, and the lower the share, the more upstream the sector.

The currently available dataset allows an analysis between 2000 and 2014. 15 years is a long period. Experiments to compile world input-output tables provide an opportunity to study this phenomenon. Among these, I use the data of the so-called WIOT[1] (World Input-Output Table, also known as WIOD - World Input-Output Database). It compiles the input-output tables of a large part of the world into a single input-output table. (The individual input-output tables - the IOTs - of 43+1[2] countries can be derived in current prices, in US dollars, per year from 2000 to 2014[3].) These input-output tables are presented by sector:

- the added value,
- total output, i.e. production, and
- the breakdown of total output:
    - production consumption, final consumption, gross capital formation and exports, and
    - domestic and import consumption of materials, taxes and subsidies on products, and value added.

From these data, the smile curve can be derived by adopting the upstream-production-downstream calculation methodology developed under the Antràs-Chor procedure for the horizontal axis and adding the value added share of emissions as the vertical axis.

The smile curve (including the UMD classification) has already been described in principle in the previous chapter, but without a description of the upstream-production-downstream classification, the methodological chapter cannot be complete. It is necessary to describe the formulas and their corresponding indicators. For this purpose, I present in detail the methodology of Antràs-Chor (2013). Hagemejer-Ghodsi (2017) also took

[1] http://www.wiod.org/home
[2] A list of the country name abbreviations used in WIOD is given in the Annex.
[3] As this is a very deep structural analysis, measuring the evolution of very slow processes, the time-consuming nature of the databases means that the 2014 date cannot be considered outdated.

Antràs-Chor's (2013) methodology as a basis and applied it in empirical calculations from the WIOD database.

1.4.2. Antràs-Chor (2013) methodology

This subsection contains the methodological description and highlights based on the work of ANTRÀS, Pol and CHOR, Davin (2013): Organizing the global value chain. The plotted formulas and texts in this chapter are taken from the referenced work, except where other source citations are noted.

1.4.2.1 Upstreamness and downstreamness

The novelty of the model is that it uses mathematical methods to rank and classify a previously unquantified explanatory variable, namely the relative position of the sector in the value chain, into three categories (UMD upstream - manufacturing - downstream), which have not been used before. To construct the methodology based on the metrics in the balance of sectoral relationships used for the analysis, the authors used the simple Input-Output basic framework:

Equation 1.

$$Y_i = F_i + Z_i,$$

where Y_i is the total output of sector *i*, F_i is the sum of outputs from sector *i* that are used for final consumption and investment ("final consumption"), and Z_i is the outputs of sector *i* that are used as inputs to other sectors (or "total consumption" as input). In a world with N sectors, the formula can be extended further:

Equation 2.

$$Y_i = F_i + \underbrace{\sum_{j=1}^{N} d_{ij} F_j}_{\text{direct use of } i \text{ as input}} + \underbrace{\sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik} d_{kj} F_j + \sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il} d_{lk} d_{kj} F_j + \cdots}_{\text{indirect use of } i \text{ as input}},$$

where d_{ij} is the coefficient (i,j) linking two sectors, 1≤ i, j ≤ N, and shows how much input *i* used to produce an output equal to one dollar[4] of *j*. Note that the second term on the right-hand side of equation 2 shows *i*'s "direct use" of inputs, nominally the total value of inputs *i* purchased from *j* and used to produce outputs for final use. The other terms, which include higher-order summations, reflect how much of *i*'s "indirect use" as inputs as they enter other upstream processes in the value chain, but are at least two production states behind final use. The above can also be represented as a compact matrix by overlaying the sectors *i*:

Equation 3

$$Y = F + DF + D^2F + D^3F + \cdots = [I - D]^{-1}F,$$

where Y and F are the N×1 vectors whose *i*-th entry is Y_i and F_i, respectively, and D is the N×N direct condition matrix whose (*i,j*)-th entry is d_{ij}. The first measure of downstreamness is DUse_TUse (for ease of distinguishing the indicators, I refer to this indicator consistently throughout the paper as the upstreamness indicator), which is the ratio of aggregate direct use of i to total aggregate use as input. Specifically, it is calculated by dividing the i-th element of the column vector DF (e.g. the value of *i*'s direct use as input to final consumption, summed across all buyer sectors *j*) by the element Y, F (which is equal to the value of *i*'s total use as input, summed across all buyer sectors *j*). The higher the value of the DUse_TUse measure for sector i, the more intensive the use of direct inputs to produce final consumption, so that the majority of the value of i enters production relatively far from the downstream. Conversely, a low value

[4] The currency dimension of the data used by Antràs-Chor is calculated in dollars.

of DUse_TUse indicates that most of the contribution of input i to production processes is indirect, namely more upstream.

In simple terms, the higher the value of the DUse_TUse indicator, the more likely it is to be a downstream sector, while the lower the value, the more likely it is to be an upstream sector.

They have complemented their analysis with another measure of downstreamness, DownMeasure (I will consistently refer to this metric as the downstreamness indicator in the articles for ease of differentiation between the metrics), which aims to make fuller use of information on the use of indirect inputs in the upstream stages. A further calculation that distinguishes the value of indirect use by the number of stages of production of the final use, depending on the stage at which the input enters the value chain. This is done by returning to equation 2, the output used for final consumption (the first term on the right) is weighted by 1, the input used directly in the production of final consumption (the second term on the right) is weighted by 2, the third term on the right is weighted by 3 and so on. In matrix form, this leads to the following calculation:

Equation 4.

$$F + 2DF + 3D^2F + 4D^3F + \cdots = [I - D]^{-2}F.$$

For each sector i, the i-th entry of {I-D}-2 F was taken and then normalised by Yi. The higher the input enters the value chain (upstream), the higher weights are used. This gives the measure of upstreamness, which is calculated to be greater than or equal to 1. (The measure can only take the value 1 if all the outputs of the sector are used as final inputs and these outputs are not used as inputs by any other sector). To maintain the DownMeasure measure for each sector i, the reciprocal is taken, so the DownMeasure is now in the interval of {0,1}. The second variable has a number of desirable properties that confirm the measurement of the sector position.

The reciprocal of DownMeasure (or Down_Rec) is an indicator which, in a simplified way similar to the DUse_TUse indicator, the higher the value of the indicator, the more likely it is to be a downstream sector, while the lower the value, the more likely it is to be an upstream sector.

Fally and Hillberry (2012) find that the upstreamness value of the variable (upstreamness-variable) is in fact equivalent to a measure of the distance of a sector from final demand, defined recursively (Fally, 2012). Fally's (2012) finding is based on the concept that sectors that buy many inputs from other upstream sectors are themselves relatively upstream. The upstreamness variable can also be taken as a measure of "cost push" effects or "forward linkages" - how much a one-dollar increase in the value added of the sector in question would increase the output of all sectors in the economy - a point highlighted in the supply-side strand of the so-called input-output literature by studies by Ghosh (1958) and Miller-Blair (2009).

Unsurprisingly, sectors with low downstreamness values tend to be involved in the processing of fuels, chemicals or metals, while those with higher values tend to be those where the goods are near the end of the value chain.

1.4.2.2 Empirical definition

In the next section, I describe the authors' empirical definitions of the share of manufacturing in intra-firm trade. As a starting point, a cross-sector regression analysis was used.

Equation 5.

$$S_{it} = \beta_1 D_i \times \mathbf{1}(\rho_i < \rho_{\text{med}}) + \beta_2 D_i \times \mathbf{1}(\rho_i > \rho_{\text{med}}) + \beta_3 \mathbf{1}(\rho_i > \rho_{\text{med}}) + \beta_X X_{it} + \alpha_t + \varepsilon_{it}.$$

The dependent variable S_{it} is the share of imports in the US company in sector *i* in year *t*. An attempt was made to explain this as a function of the sectoral downstreamness Di in question, as captured by DUse_TUse or DownMeasure. An important aspect is that they distinguish between the effects of downstreamness in sequential supplements and other proxy cases, taking into account the guidance of their model. This is done by examining Di, the interaction of the indicator variables 1(ρi > ρmed) and 1(ρi < ρmed) in sectors where it equals 1, when the average demand elasticity of demand of the sectors *i* purchasing as input is lower, i.e. below the intersectoral median value of this variable.

The model suggests that cross-country differences in the prevalence[5] of integration may be useful to eliminate biases in the endogenous location decisions of firms at different stages of production. Therefore, specifications that reveal the variation across sectors at the whole country level were investigated:

Equation 6.

$$S_{ict} = \beta_1 D_i \times \mathbf{1}(\rho_i < \rho_{\text{med}}) + \beta_2 D_i \times \mathbf{1}(\rho_i > \rho_{\text{med}}) + \beta_3 \mathbf{1}(\rho_i > \rho_{\text{med}}) + \beta_X X_{it} + \alpha_{ct} + \varepsilon_{ict}.$$

Put simply, this formula explains the share of imports within a firm, S_{ict}, at the annual sectoral level of the exporting country as a similar set of sectoral variables, while controlling for the country's fixed effects, α_{ct}, and (conservatively) sectoral standard errors in a given year.

1.4.3. Overview of other related results

This chapter aims to calibrate the methodologies described in the previous chapters. It contains the testing and validating of the finetuned methodologies at sectoral level.

1.4.3.1. Sectoral results

In order to investigate the sectoral relationships and to verify the theory used for the smile curve, several calculations have been carried out, the results of which are presented in the following section. I have calculated the upstreamness (DUse_TUse) and downstreamness (Down_Rec) indicators for all sectors of the countries included in the WIOD and calculated the overall value of the sectors for the world as a whole.

Before presenting the specific result, it is important to recall other logical assumptions of the theory, which have been presented in various ways by several researchers. Along the logic of the smile curve, it can be pointed out that the regularity of the "U" shaped curve in Antràs-Chor's concept is plausible on the basis of our assumptions, if we consider the following aspects (Boda et.al. 2021):

[5] Prevalence is the occurrence of a phenomenon affecting a given population at a given time (or period).

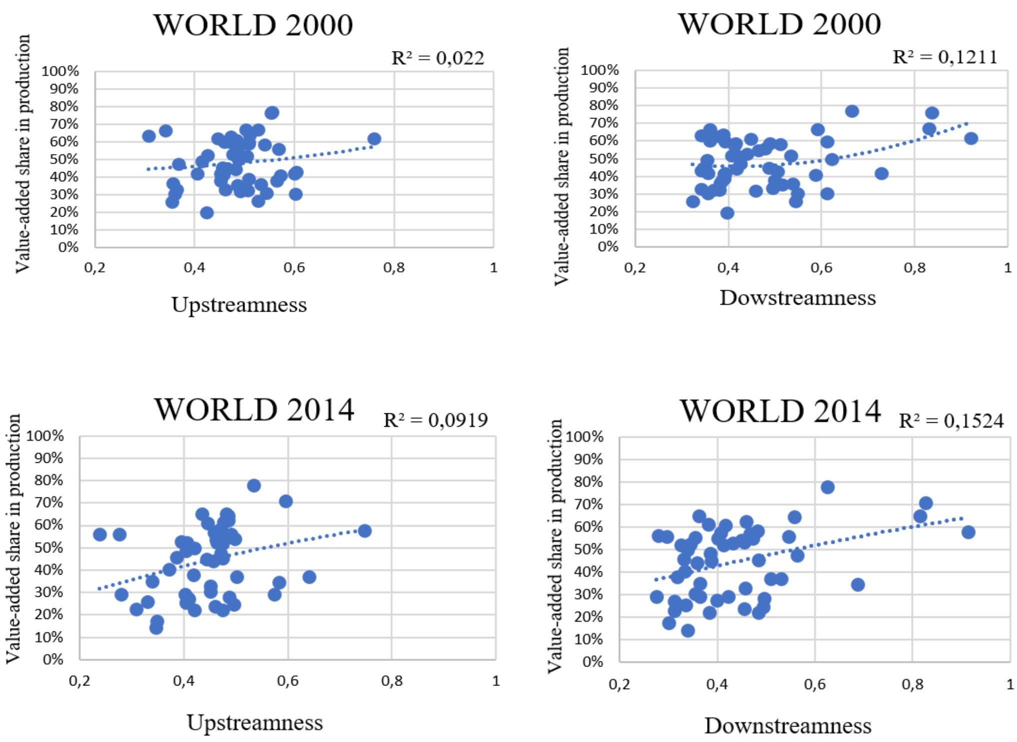
- Upstream and downstream activities have higher risks, which can only be managed with higher value-added rates, and a risk surcharge.
- Upstream and downstream positions in the value chain provide certain monopoly positions. These sectors have greater ability to influence prices, which creates the opportunity to increase the value added margin.
- Companies with less bargaining power can be locked into the value chain (even in a manufacturing position) and their prices (wages) can be squeezed.
- In the middle of the chain, both supplier and buyer bargaining power can be significant and powerful.

These findings emphasise the need to aim for the edges of the smile curve, not the middle, and therefore to move into the non-manufacturer category. It should be noted here that this is not a strict law, as the analysis has shown that there are a number of very well performing sectors with high value added shares in the 'middle' sectors.

As a verification of the methodology, I plotted the sectors of the countries in a coordinate system according to upstreamness/downstreamness and value added ratio, and classified the sectors into UMD categories according to the indicators, aggregated the values (thus creating the "UMD sector groups") and mapped the curves. When classifying into UMD categories, it should be noted that in addition to the mere upstreamness and downstreamness values, the country's sectoral linkages have to be taken into account, which makes the classification quite complicated. The upstreamness and downstreamness of a sector's supplying sectors and the upstreamness and downstreamness of a sector's consuming sectors should be examined, and it is appropriate to classify a country's sectors into the UMD category on the basis of a combined picture of these relationships. For several countries this is too complicated and simplifications are recommended (e.g. direct cut value along the upstreamness or downstreamness indicator). It is possible that almost all sectors in a country would be classified as manufacturing and downstream based on upstreamness and downstreamness values if the sectors were classified according to an exact cut value (e.g. India, USA). The classification should be corrected for sectoral linkages and thus the UMD categories of the smile curve are drawn for these countries.

The results show that the upstreamness and downstreamness indicators and the value added curve for most countries (especially the more developed countries, e.g. USA, Switzerland, Germany, Austria, Belgium, etc.) show a good "smile" shape, albeit with a relatively low R^2 value of around 0.2. For some countries, the same plot shows more of a "/" shape. The calculation for the whole world also describes a more "/" curve with an R^2 value of around 0.15. These findings are otherwise consistent with those of Boda (2020), who also used the WIOD database for his research.

Figure 2: World sectors along the smile curve, 2000 and 2014



Source: own calculations and editing

Figure *2* shows that

- Using the two methodologies (upstreamness and downstreamness metrics), a similar curve emerges at the global level.

- Between the two years, sectors shifted slightly towards the middle from the Upstream category using the same methodology.

- Looking at the time factor, the "/" shape emerges in both years, but in 2014 the curves changed from convex to concave, i.e. the "smile curve" is disappearing globally over the two years.

The fact that the smile curve is well defined for many mainly developed countries, but not for the 'world average', suggests that developed countries have tended to focus on the edges, keeping only what is necessary in the middle of the manufacturing activities, while less developed countries, specialising in these activities on the basis of the international division of labour, have made a major effort to increase efficiency and catch up. It is important to note that this presentation takes no account of the weight of the sectors. It treats each point value only along the two dimensions and does not give any weighting to the whole analysis. This is a simplifying presentation. A more sophisticated solution is shown in Article 3, where weights of sectors are taken into account in the aggregation.

Looking at the sectoral data in Table *2* and in Table *3*, it can also be seen that the two methodologies give similar results, as

- Both methodologies show the same shifts over time for almost 90% of the sectors.

- Looking at the order of Upstreamness and Downstreamness, the results of the two methodologies show a correlation of 0.72.

The relationship between upstreamness/downstreamness and efficiency (value added ratio) is supported by the result that the direction of the shift along the value chain and the direction of the change in the value added ratio coincide in about 75% of the sectors, i.e. a shift in the sectors downstream is associated with an efficiency gain in most cases, while a shift upstream is associated with an efficiency loss, if the value added ratio is considered as an efficiency indicator. (Exceptions to this are highlighted in red in the tables.)

Table 2: List of sectoral values along the upstreamness indicator

		Upstreamness		Value-added content		Shifts*			Upstreamness		Value-added content		Shifts*
		2000	2014	2000	2014				2000	2014	2000	2014	
1	Crop	0,57	0,47	56%	58%	- +	29	Wholesale Trade	0,48	0,45	61%	61%	- +
2	Forestry	0,34	0,28	67%	56%	- -	30	Retail trade	0,53	0,49	67%	64%	- -
3	Fishing	0,54	0,48	59%	62%	- +	31	Land transp	0,43	0,40	52%	48%	- -
4	Mining	0,31	0,24	63%	56%	- -	32	Water transport	0,36	0,34	36%	35%	- -
5	Food	0,60	0,50	30%	25%	- -	33	Air transport	0,45	0,45	38%	33%	- -
6	Textil	0,54	0,46	31%	24%	- -	34	Warehousing	0,41	0,39	49%	46%	- -
7	Wood	0,51	0,41	33%	27%	- -	35	Postal	0,47	0,46	60%	52%	- -
8	Paper	0,36	0,33	33%	26%	- -	36	Accommodation	0,49	0,47	50%	48%	- -
9	Printing	0,46	0,42	43%	38%	- -	37	Publishing	0,47	0,49	45%	55%	+ +
10	Coke	0,42	0,35	20%	14%	- -	38	Video, TV	0,37	0,40	47%	53%	+ +
11	Chemicals	0,36	0,31	30%	23%	- -	39	Telecomm	0,48	0,50	53%	54%	+ +
12	Pharmaceutical	0,60	0,64	43%	37%	+ -	40	Programming	0,48	0,46	55%	57%	- +
13	Rubber	0,46	0,40	33%	26%	- -	41	Financial	0,46	0,43	60%	65%	- +
14	Mineral	0,56	0,57	38%	29%	+ -	42	Insurance	0,50	0,47	52%	45%	- -
15	Basic metals	0,35	0,35	26%	17%	- -	43	Auxiliary finance	0,45	0,42	42%	50%	- +
16	Fabricated metal	0,51	0,45	39%	30%	- -	44	Real estate	0,55	0,53	77%	78%	- +
17	Computer	0,50	0,41	34%	28%	- -	45	Legal	0,45	0,41	62%	52%	- -
18	Electrical eq	0,49	0,42	32%	22%	- -	46	Architectural	0,49	0,47	58%	55%	- -
19	Machinery	0,49	0,40	36%	29%	- -	47	R+D	0,51	0,46	59%	53%	- -
20	Motor v.	0,53	0,48	26%	22%	- -	48	Marketing	0,46	0,46	45%	44%	- -
21	other transport	0,53	0,49	36%	28%	- -	49	Other scientific	0,51	0,48	64%	55%	- -
22	Furniture	0,57	0,50	41%	37%	- -	50	Admin	0,47	0,48	63%	61%	+ -
23	Repair machinery	0,48	0,44	44%	45%	- +	51	Social security	0,50	0,48	67%	65%	- -
24	Electricity, gas	0,41	0,28	42%	29%	- -	52	Education	0,55	0,59	76%	71%	+ -
25	Water	0,49	0,47	52%	52%	- -	53	Health	0,76	0,75	62%	58%	- -
26	Sewerage	0,46	0,37	41%	41%	- -	54	Other service	0,51	0,49	60%	56%	- -
27	Construction	0,60	0,58	42%	35%	- -	55	Households	0,47	0,51	69%	77%	+ +
28	Motor Retail	0,48	0,47	58%	58%	- +							

Source: Own calculations based on WIOD

*It points to the direction of change between 2000 and 2014. The first symbol indicates a change in the upstreamness indicator: if a sector moves downstream, it is marked with a "+", if it moves upstream, it is marked with a "-". The second symbol indicates a change in the value-added share. If the VA content has increased from 2000 to 2014, "+" is placed in position 2, if it has decreased, "-". It is highlighted with red colour if the shifts have different directions.

Table 3: List of sectoral values along the downstreamness indicator

		Downstreamness		Value-added content		Shifts*			Downstreamness		Value-added content		Shifts*
		2000	2014	2000	2014				2000	2014	2000	2014	
1	Crop	0,48	0,41	56%	58%	- +	30	Retail trade	0,59	0,56	67%	64%	- -
2	Forestry	0,36	0,30	67%	56%	- -	31	Land transp	0,42	0,38	52%	48%	- -
3	Fishing	0,49	0,46	59%	62%	- +	32	Water transport	0,38	0,36	36%	35%	- -
4	Mining	0,34	0,28	63%	56%	- -	33	Air transport	0,50	0,46	38%	33%	- -
5	Food	0,61	0,49	30%	25%	- -	34	Warehousing	0,35	0,33	49%	46%	- -
6	Textil	0,55	0,46	31%	24%	- -	35	Postal	0,36	0,34	60%	52%	- -
7	Wood	0,38	0,31	33%	27%	- -	36	Accommodation	0,62	0,56	50%	48%	- -
8	Paper	0,34	0,32	33%	26%	- -	37	Publishing	0,49	0,47	45%	55%	- +
9	Printing	0,34	0,32	43%	38%	- -	38	Video, TV	0,43	0,43	47%	53%	+ +
10	Coke	0,40	0,34	20%	14%	- -	39	Telecomm	0,44	0,45	53%	54%	+ +
11	Chemicals	0,36	0,31	30%	23%	- -	40	Programming	0,46	0,47	55%	57%	+ +
12	Pharmaceutical	0,51	0,51	43%	37%	+ -	41	Financial	0,39	0,36	60%	65%	- +
13	Rubber	0,37	0,33	33%	26%	- -	42	Insurance	0,53	0,48	52%	45%	- -
14	Mineral	0,39	0,36	38%	29%	- -	43	Auxiliary finance	0,39	0,34	42%	50%	- +
15	Basic metals	0,32	0,30	26%	17%	- -	44	Real estate	0,66	0,63	77%	78%	- +
16	Fabricated metal	0,39	0,36	39%	30%	- -	45	Legal	0,36	0,32	62%	52%	- -
17	Computer	0,50	0,40	34%	28%	- -	46	Architectural	0,41	0,40	58%	55%	- -
18	Electrical eq	0,46	0,38	32%	22%	- -	47	R+D	0,41	0,46	59%	53%	+ -
19	Machinery	0,51	0,42	36%	29%	- -	48	Marketing	0,35	0,36	45%	44%	+ -
20	Motor v.	0,54	0,48	26%	22%	- -	49	Other scientific	0,39	0,36	64%	55%	- -
21	other transport	0,54	0,50	36%	28%	- -	50	Admin	0,38	0,38	63%	61%	+ -
22	Furniture	0,59	0,53	41%	37%	- -	51	Social security	0,83	0,81	67%	65%	- -
23	Repair machinery	0,42	0,39	44%	45%	- +	52	Education	0,84	0,83	76%	71%	- -
24	Electricity, gas	0,36	0,28	42%	29%	- -	53	Health	0,92	0,91	62%	58%	- -
25	Water	0,41	0,41	52%	52%	+ -	54	Other service	0,61	0,55	60%	56%	- -
26	Sewerage	0,39	0,33	41%	41%	- -	55	Households	0,53	0,62	69%	77%	+ +
27	Construction	0,73	0,69	42%	35%	- -							

Source: own calculation based on WIOD

*It points to the direction of change between 2000 and 2014. The first symbol indicates a change in the upstreamness indicator: if a sector moves downstream, it is marked with a "+", if it moves upstream, it is marked with a "-". The second symbol indicates a change in the value-added share. If the VA content has increased from 2000 to 2014, "+" is placed in position 2, if it has decreased, "-". It is highlighted with red colour if the shifts have different directions.

The smile curve raises the question of how the value-added ratio has changed. There are two ways for a group of sectors to achieve a higher value-added share. One way is for each sector in the group to increase its efficiency. The other possibility is that the group's composition changes, with lower performing sectors leaving the group or higher performing sectors joining.

Another result worth mentioning is that I compared the two indicators: the upstreamness and downstreamness indicators. One reason for this is that it is a great effort to constantly visualise the results with both indicators, and another is that it is unfortunate that the classification along the cut value does not produce exactly the same ordering based on the two indicators. I have expressed this similarity using Spearman's rank correlation. I have ranked both the upstreamness and downstreamness indicators based on the results summarised for the world as a whole. These were used to determine the 'ranking' of each country. The results of this calculation show a relatively strong relationship for both the 2000 and 2014 data. For the former, ρ^2=60%, for the latter it is close to 70%. The variance of downstreamness is larger: it varies between 0.28 and 0.91, while upstreamness only varies between 0.24 and 0.75 (2014). In addition, it is observed that for classifications with large variance, the downstreamness indicator tends to yield the result that logic would dictate on the basis of theory. For example, the mining sector is moved to the downstream category based on upstreamness, while the downstreamness indicator shows a strong upstream sector on the borderline of manufacturing. It is also observed that the more downstream a sector is, the more similar the two indicators classify the sector. There are larger differences at the border between manufacturing and upstream. The reasons for the differences are not currently focused on, but overall, based on these studies, I rate the downstreamness indicator as a better indicator and preferably both should be considered.

If I define the cut value according to the world aggregate classification by dividing the 54 sectors into thirds, the upstreamness indicator takes 0.46 as the upstream cut-off in 2000 and 0.51 as the downstream cut-off. In 2014, the U and M cutoff is 0.42, the M and D cutoff is 0.47.

And along the downstreamness, based on 2000 data, the U and M cutoff is 0.39 and the M and D cutoff is 0.50. This is 0.36 and 0.46 in 2014. Manufacturing is from the upper value of Upstream to the lower value of Downstream (see Table *4*)

Table 4: Cut values based on world UMD classification

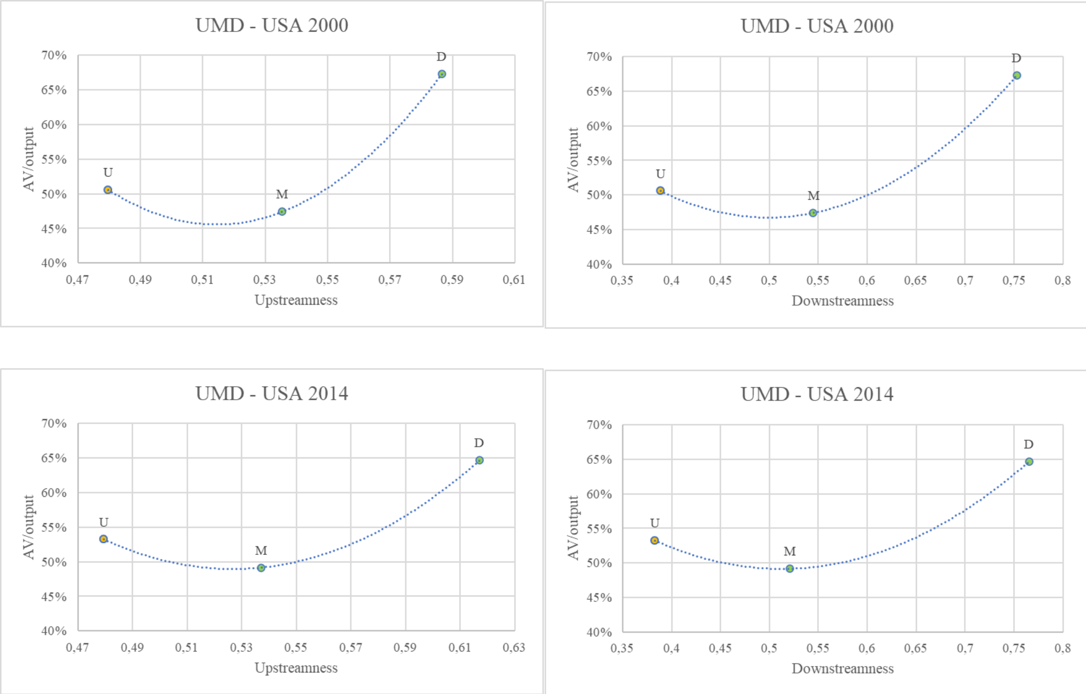
Based on Upstreamness	**Upstream**	**Downstream**
2000	Upstream<**0,46**	Downstream>**0,51**
2014	Upstream<**0,42**	Downstream>**0,47**
Based on Downstreamness		
2000	Upstream<**0,39**	Downstream>**0,50**
2014	Upstream<**0,36**	Downstream>**0,46**

Source: own calculations

Note that the cut values show how the values of the sectors are shifted upstream. The distance between the two values is unchanged, with a difference of approximately 0.05 for upstreamness and 0.1 for downstreamness, so the sectors have shifted downstream together. It is important to underline that for this global examination, the division into thirds of sectors represents a major simplification in the calculations, as the research is not currently focused on the precise identification of the number and nature of sectors in each category. This simplifying criterion has nevertheless drawn attention to the shift.

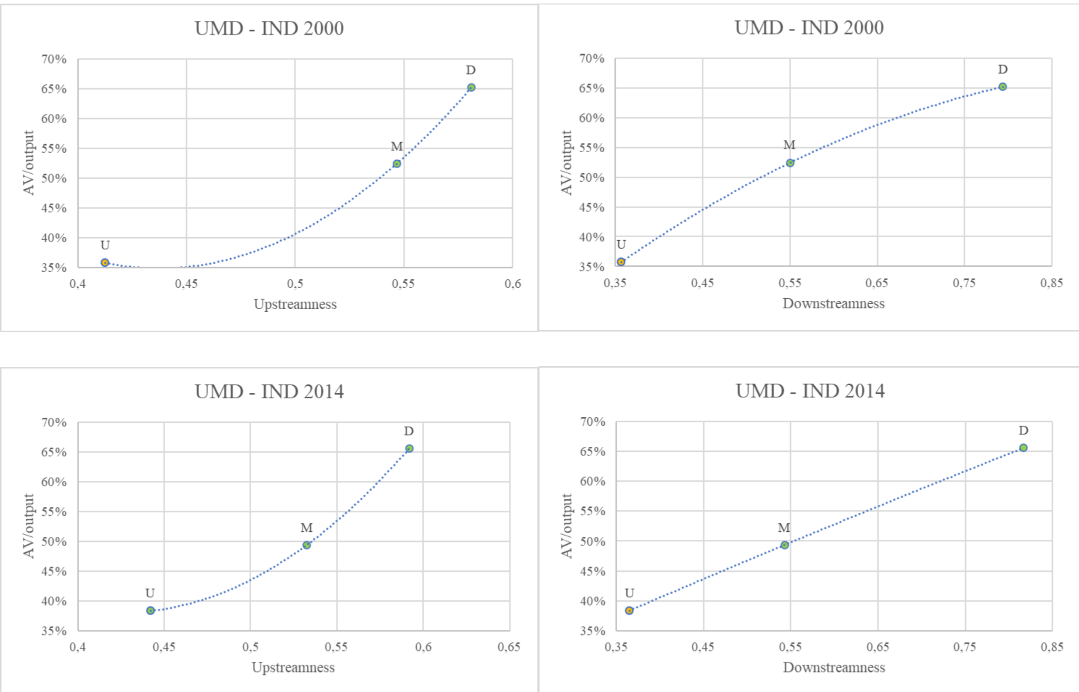
The smile curve is calculated and plotted for 43+1 countries. In the following section, I present the main conclusions through graphs for some of the countries highlighted.

Figure 3: Plotting the smile curve in the United States



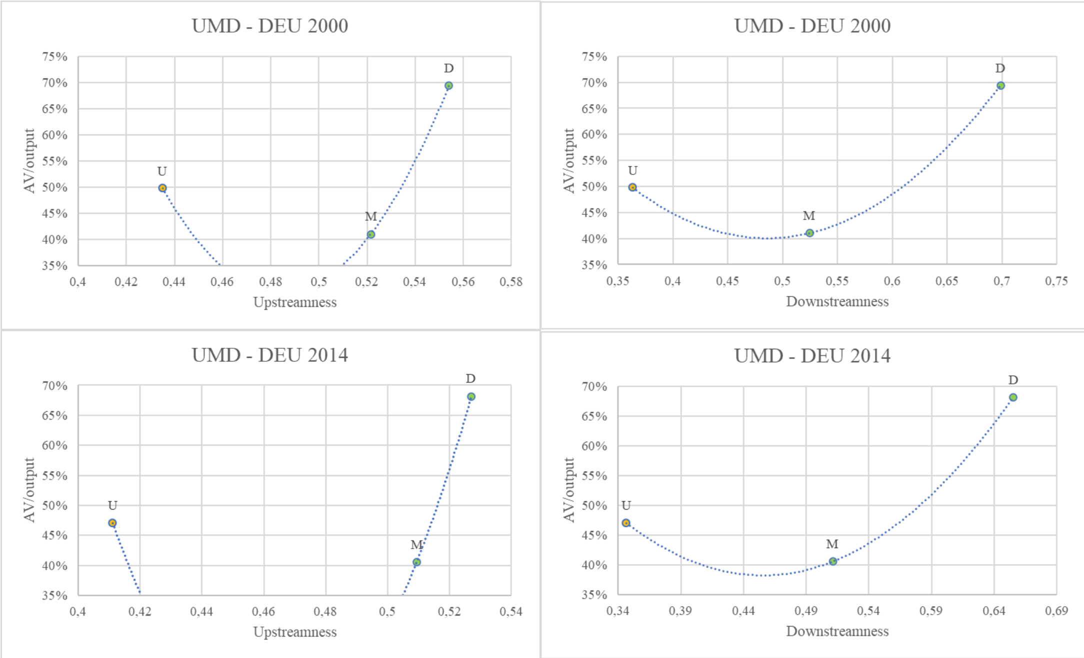
Source: own calculations and editing (based on WIOD)

Figure 4: Smile curve in India



Source: own calculations and editing (based on WIOD)

Figure 5: Smile curve in Germany



Source: own calculations and editing (based on WIOD)

The above examples show that the smile curves in the countries differ significantly, and the countries are not the same in terms of upstreamness and downstreamness. In general, however, the downstream sectors are able to generate the highest value added. Note that the trend lines in the figures are for better visualization, and it is just a simple fitted exponential function to the three spots. It just highlights the differences which shows conspicuous differences in the points positions and in the steep changes.

Exploring the reasons for the differences between countries and the correlations between the shape of the smile curve and other country indicators could be the subject of another study.

1.4.4. Summary

One of the main themes of this section is a review of the existence of the smile curve. In most of the figures for the countries studied, a 'smile' can be detected, but the depth of the 'U' shaped curve can vary considerably, and for some countries a '/' shape has been drawn along the UMD groups instead of the expected 'U' shape.

This is because, according to the methodologies used, the sectors did not always fall into the same UMD category, and also because different activities remained within each sector within each country, as the spread of the global division of labour has made it possible to outsource low value-added activities to other countries at low transaction costs. Those countries, typically less developed, to which production is outsourced achieve higher value-added margins by increasing the efficiency of the sector.

In general, it can also be concluded from the analysis of the value added of the UMD categories that the Downstream sector group tends to perform better than the Manufacturing and Upstream sector groups. The high value-added ratio suggests that this sector group has the strongest bargaining power of the sectors, i.e. it is the sector group that has the most ability to influence prices - in some cases they are able to create a monopoly position when carrying out sales activities. The opposite can be observed for sectors "squeezed" into the middle of the value chain.

Comparing the results of the 2000 and 2014 analyses, the curve differs only minimally between the two periods, taking the shape "/" in both years under study. However, it is interesting to note that between the two years there was a shift along the horizontal axis, i.e. upstreamness, in several sectors in several countries, while the value added share followed the "/" line, as the overall curve did not change. A further result is that the shifts between the two study dates (2000 and 2014) draw attention to which countries are worth focusing on, as they have moved differently from the average in terms of the values measured. In addition, the graph helps to quickly identify countries with relatively good positions and the strengthening or weakening of their position over the period. Of course, it also highlights the opposite, countries in a poor position. These should be analysed in a focused study at a later stage.

I also carried out the analysis for the group of countries in the sample using the two classification methods discussed in the methodology chapter. The analyses drew similar smile curves within each country, but the sectors were not always placed in the same sector group based on the two methodologies.

The smile curve theory thus appears to be confirmed for a number of countries' economies, while for other countries and the world economic aggregate the expected "U" curve does not emerge. The analysis can be further deepened by looking at specific sectors in more detail (typical firm size in the sector, detailed analysis of certain financial indicators, examination of activities) to gain a deeper understanding of the sectoral efficiency gap between countries and the reasons for the different UMD classifications.

In this summary, I would like to highlight a specific feature not discussed in the scientific literatures. It should be pointed out that the categorization of UMD based on the upstreamness or even downstreamness indicator and the assigned cut-off value somewhat contradicts the originally associated meanings. This is mainly because many sectors, which are essentially engaged in some kind of manufacturing activity, are increasingly specialising in less complex tasks, and value chains are lengthening, so that some manufacturing sectors - in the classical sense - are moving upstream. This phenomenon has also been observed by other researchers. For example, in Figure 2 of Szalavetz A. (2020), she has drawn a very graphic picture of the bottom of the "U" becoming wider and the lower value added share becoming a feature towards the edges. The author attributes this mainly to the digitalisation effect. I agree with his result, but I believe that other factors also contribute, but I share the view that the main driver is the potential of digitalisation.

2. Article 1. On the possibilities of increasing the growth rate and employment

Original title and reference: Boda et.al. (2019): *A növekedési ütem és a foglalkoztatás növelésének lehetőségeiről*, Közgazdasági Szemle, LXVI. évf., 2019. április (376—417. o.), DOI:10.18414/KSZ.2019.4.376

BODA GYÖRGY — FÜLÖP ZOLTÁN — LOSONCI DÁVID — RÉVÉSZ TAMÁS

The experiences of the past decades raise serious doubts about the long-term sustainability of our successful growth phases. Have we overcome the bottlenecks that may restrain the pace of convergence in the long term? The analysis of the structure of the Hungarian economy and the development of companies in the 2010-2015 growth period indicate that we have not overcome these difficulties yet. The production structure controlled by foreign working capital investments is still dominant, and that makes the growth - with low added value content and relatively low number of employees - dependant exclusively on the interests of multinational companies. There is no sign yet of the internal development correction that - relying on knowledge-based and service activities - could significantly reduce Hungary's exposure to the fluctuations in the development of world economy. This kind of correction should commence in both central developments and in the establishment of an institution system that properly supports corporate growth. The study considers the key factors we can observe in this respect about backwardness, and identifies the possibilities of evolution, too.*

Journal of Economic Literature (JEL) code: D22.

* Our research forms an integral part of the research carried out in the Institute of Business Economics of the Corvinus University of Budapest. We are grateful for the material and moral support of the institute and for the colleagues' help. We have freely drawn upon the competitiveness researches of the institute, and hope that our results have strengthened primarily these researches. We are also grateful to the staff of the Public Service Foundation of the University for their support to the research. The research of György Buda and Zoltán Fülöp was supported by EFOP (Human Resource Development Operational Programme) project No. -3.6.2-16-2017-00007, titled Aspects of the development of smart, sustainable and inclusive societies: social, technological and

innovation networks in employment and in the digital economy. The project is implemented with the support of the European Union, co-financed by the European Social Fund and the budget of Hungary.

Hungarian economic analysts generally agree that the most significant problems of Hungarian economy are generated by the difficulties of long-term convergence. It was not possible to work off the backlog compared to developed economies neither before, nor after the change in the political system. One of the 'bitter' experiences of the period following the change in the political system is that long-term potential economic growth and the current GDP growth index have a loose connection. Although presently the key growth indicators show favourable values over the average, and the key indicators used to describe the employment situation are also fairly favourable, we have serious doubts about their maintenance, based on the experiences of past years. While paying attention to sustainable convergence, we have to keep thinking about the bottlenecks in economic performance and find the possibilities of making changes that would allow for the acceleration of both economic growth and primary employment[6].

The subject of sustainable convergence has been examined by using multiple levels of analysis. Our sectoral analyses focus on the examination of the economic structure: how do the supply and the demand sides change, how is the employment structure transformed, and what may be the impacts of giving priorities to different sectors on the demand side on added value and employment. The problems of economic performance will primarily be found in the structure of production and in the fact that a production sructure driven by foreign working capital investments does not serve convergence efficiently (Lux [2017]). The improvement of this situation in Hungary requires internal development steps (upgrading) (Lin et al. [2008], Lin [2017]). On the one hand, this requires adequate additions to foreign capital injections, and, on the other hand, this should go hand in hand with the modification of the economic structure, which assumes, for example, the responsible re-thinking of industrial development and the implementation of major developments outside the industry, too, especially in soft services that develop knowledge content.

The macro-level examination of the economic structure is not enough for convergence. In addition, the utilisation of the potentials of corporate structures is another important task.

[6] By primary employment we mean employed people without community workers and people employed abroad.

Our corporate analysis focuses on growing (upsizing) companies playing key roles in modernising the fragmented population of companies. Upsizing companies have major impacts on the extension of employment. Their more conscious management and incubation are necessary, as they operate on an extensive growth path because of their 'stuck productivity'. Another reason why active and deliberate intervention may be needed is that - especially in the case of companies in Hungarian ownership - this is a very slow process. Finally, it is worth connecting corporate concentration and corporate growth with objectives related to the economic structure and proposed in analyes of sectoral level.

Our study has the following structure. After the summary of the relevant literature, we will present the methodology worked out for our analyses for the joint use of national and corporate accounting. Building on this analysis framework, we will analyse the structure of the national economy, and carry out a multiplier analysis related to structural change. Then we will analyse companies.

Following the assessment of the structure of the population of companies and the key economic indicators of individual size categories, we will examine the impacts of upsizing companies. Our study is closed with a summary and proposals[7].

2.2. Summary of literature

We processed the literature in five comprehensive groups: 1. studies on methodology, 2. economic structure and structure analysis, 3. analysis of the population of companies, 4. growth theories and models and finally 5. the reform of the institutional system.

1.METHODOLOGY STUDIES were searched primarily in the subject of connecting national accounts and corporate accounts. We found that the report of the KSH (Central Statistical Office) [2011] and the study of Bálint Murai on the connection between basic national economy data and national accounts (Murai [2011]) offered good guidance, as

[7] As all the statements in our study are supported by metering and model calculation results, the space necessary for them would exceed the framework provided by the Economic Review (Közgazdasági Szemle). This is why the study that served as a basis for the whole chain of thought was posted on the website of Boda & Partners Kft., and the study published in the Economic Review contains the links that can take you to the background study from the electronic version of the article, and the detailed figures and the basic data of the study can be viewed there (Boda et al. [2019]). Naturally, the train of thought in the study is independent,–it is only extended by the backgrund study - so it can be processed without using the background study, too.

they made our task easier to describe and algorithmise. The report compiled by Stiglitz et al. [2009] was important for the use of national accounts, as it drew attention to the requirements of consistent stock-flow based analysis. As the balance of inter-sectoral relations (BIR or in other translation form or terminology it is referred to IOT as input-output table, but this abridgment might mess up the understanding because ot the association to Information Technologies as IOT) plays a central role in the targeted connection, we processed a number of earlier BIR studies, including the basic book of Wasily Leontief (Leontief [1941]), the publications of Mária Augusztinovics, which we consider the best Hungarian input-output summary (Augusztinovics [1968], [1979]), Boda et al. [1989]), the study summarising the practice of compiling the BIR before the change in the political system, earlier works describing the input-output applications used after the change in the political system (Révész [2019], Zalai [2012]), and the recently produced Koppány [2017]. The latter work also properly illustrates the mature methodology of the BIR, and nicely presents its higher value in the current economic thinking. We have also processed a number of documents from the data store, they were required to extract data and analyse the contents (publications disclosing the national accounts of Hungary, descriptions of the BIR methodology of 2010, Eurostat documentations etc.). An outstanding role in formulating our findings was played by one of the biggest international input-output undertakings of our days, the production of the World Input Output Tables (WIOT)[8] , which intends to compile a BIR describing the whole world economy (Timmer et al. [2015]). All in all, we can say that one of the key directions of developing a methodology to efficiently support economic policy decisions is an integrated approach to the features of the population of companies and individual sectors.

2.After the review of the literature of methodology bases, we reviewed works focusing on ECONOMIC STRUCTURE AND THE STRUCTURAL CHANGE – mainly with macro or sectoral approach. Although the issue of structural change - mainly because of opinions focusing on re-industrialisation - often seems to be a novelty, we think it is important to note that in Hungary there was a similar great interest in the relation between industry and services already before, in the 1970s (Árvay [1973], Benedeckiné [1968], Bertóti [1969], Csernók [1965]). One of the important lessons of that debate is that instead of a one-sided

[8] http://www.wiod.org/database/wiots16.

industrialisation concept, the issues of industrialisation should be examined without any preconceptions and ideologies.

The works on economic restructuring (Cséfalvay [2017], Lux [2017], Rodrik [2015], Madár [2014], NGM [2016]) clearly indicate the dilemmas about future directions. It is generally agreed that the economic processes of the past decades project the further shrinking of processing industry (for instance, the share of this sector in added value, lower ratio of employees). However, the authors warn us that restructuring should not be done in a hurry without a good reason. Gábor Lux's opinion is quite remarkable: Hungary is not in a situation to skip taking full advantage of industrial production based on foreign capital (Lux [2017]). The consideration of the direction and the timing of restructuring is made even more difficult by the opinions of various advisors and industrial policy experts, who say that it would be desirable to increase the added value share of the industry. Although the one-sided increase of the added value share of the industry is a strongly debated objective, these works also suggest a kind of restructuring, if the success of the industry of the future depends on the servicing ecosystem organised around the industry. As to the contents of restructuring, the researchers of the future express clear views (Boda–Virág [2010], Boda [2017a], [2017b], Brynjolfsson–McAfee [2014], McAfee–Brynjolfsson [2016], Ford [2017], Marosán [2017]), and so do empirical labour market (Frey–Osborne [2013], Hanushek et al. [2017]) and other industrial organisation researches (Szalavetz [2016], [2017]). In relation to restructuring, these authors primarily refer to the development of the knowledge-based economy as soon as possible, and urge this process.

3.Apart from sectoral features, the integrated approach to economic processes calls for the review of works on the population of companies, too. Hungarian CORPO- RATE RESEARCHES (Andrási et al. [2009], Békés–Muraközy [2012], Boda [2012], Reszegi–Juhász [2014], [2017], Palócz [2016a], [2016b], Szabó [2012]) give an important warning that changes taking place in the Hungarian economy should not be squeezed into simplifying patterns. It seems, however, that one of the key questions remains open for the time being: which Hungarian companies are able to improve their future economic performance most? The most systematised results probably belong to the most dynamically growing companies, the so-called gazelles. We would like to point out here that the one that goes furthest is not the one who jumps highest. Although we can prove that the Hungarian gazelles play exceptional roles in the extension of employment

(Békés-Muraközy [2015]), the short and temporary growth of this group of companies makes their future economic potentials questionnable. It is easy to see that the gazelles may be real catalysts in a restructuring if they maintain their fast growth at a relatively high level. But this requires more than achieving a spectacular growth in a few output indicators, as their production function should be transformed in a permanent and innovative way. Szerb et al. [2017] indicate that these profound processes are often missing at the gazelles, as the 'mysterious' sources of fast growth are rather due to their connections and local embeddedness, and not so much to the trained workforce, the creative or infocommunication sector or the exports. While it is justified to maintain the differentiated approach to companies, it is important that short-term growth in itself is not a basis for concentrated support. First of all, we have to identify companies and company groups that offer significant contributions to future economic growth.

4.The best summary of studies related to growth theories and models is the study of Gabardo et al. [2017] which gives a systematic overview of researchers' ideas about the role of restructuring in growth. For a long time, researchers explained growth with one-sector growth models, but later there were multi-sector experiments, too, which added the production, consumption, investment and other restructuring processes to the key endogeneous variables explaining growth. They are also the engines of growth, just like the growth of endogeneous variables identified in individual sectors.

These are the most important works for us: 1. analyses describing the increasing role of knowledge capital, 2. studies analysing the impacts of the increasing returns to scale, 3. researches analysing the transformation of agriculture - industry - services, 4. modelling experiments analysing the impacts of changes in consumption demand, 5. researches analysing the enforcement of Engel's Law, 6. examination of the impact of tradability by separating domestic and foreign trade processes, and finally, 7. modelling attempts to describe the dual economy.

Swiecki [2017] adds an important consideration to this list; he does not only mention these factors, but attempts to meter their importance, too, and it is clear that these factors have different weights. Our study is not a growth theory study, but we point out several of these factors, and assume that they have major impacts on growth, based on certain causal relations.

The following works - although not exactly growth theory studies - make very important statements about the nature of the growth processes: Kim– Mauborgne [2005], researching the reasons behind restructuring; Hall–Soskice [2001], Kang [2006], Nölke–Vliegenthart [2009], Nölke et al. [2015], about the Eastern European dependent market economy model (Dependent Market Economy, DME), Wil- liams [2014], explaining the concept of the 'enabling state', and publications presenting the analysis of upgrading processes (for example Lin [2012], [2017], and Williams [2014]).

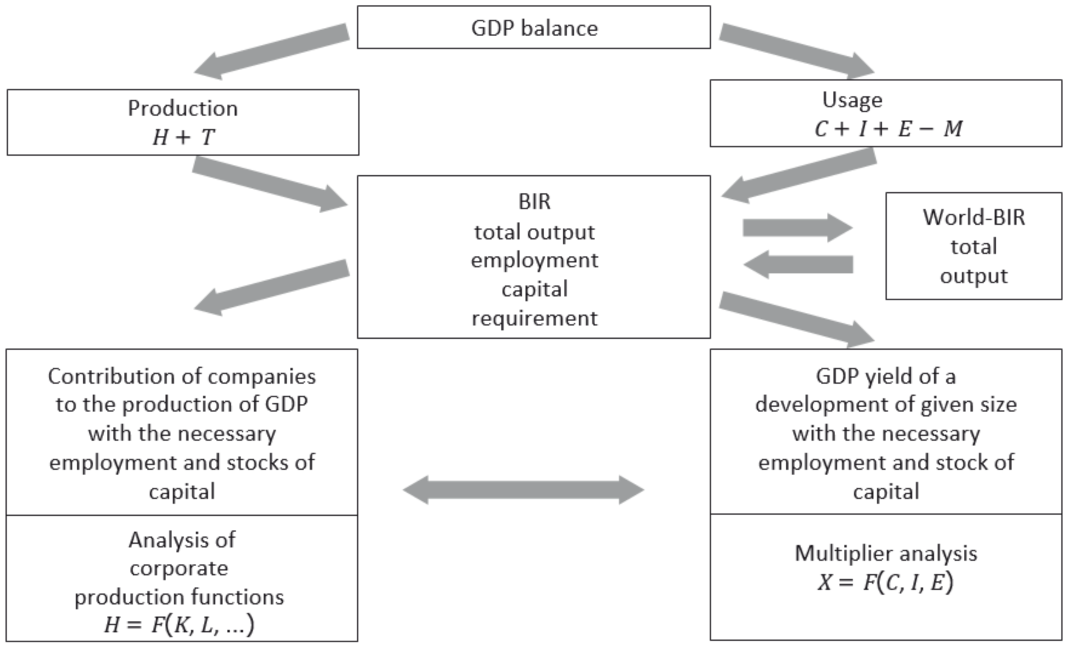
5.Studies regarding the need for the reforming of the institution system and the accelerating role of growth are also important (Acemoglu–Robinson [2013], Berend [1999], Kaposi [2002], Kornai [2005], Papp–Felméry [2016], Pitti [2010], Oszkó [2017], Piketty [2015], Plaschinsky [2015], Pogátsa [2016], Szűcs [1981], Tömpe [2015]) or the book titled Hegymenet (Uphill) (Jakab–Urbán ed. [2017]). These works - even on the basis of Hungarian experiences of a century - clearly indicate that we cannot get any closer to the solution without proper system-level and institutional reforms.

2.3. The methodology developed for structural analysis[9]

Our analyses concentrate on the optimal activity structure that ensures maximum employment in the long term, together with an economic growth that supports convergence. The concept of structure precludes the possibility of examining certain phenomena in themselves, independently of other phenomena. The structure supposes a system in which the examined elements are interrelated and have a meaning from their definition with other elements. Our methodological description - the general diagram of which is summarised in Figure *6* - concentrates on the description of this system.

[9] The study was compiled in a way that - from the next chapter examining the impacts of changes in the national economy structure on growth and employment - it could be processed with minimum methodological skills. So if you are not interested in the methodology, feel free to jump to the next chapter. You should know, however, that the analysis results of the study could not have been produced without the methodological considerations.

Figure 6: Methodology of the analysis



T = Balance of product taxes and supports
H = Added value
K = Tangible capital
L = Number of employees
X = Total output (gross production value)
C = Consumption
I = Accumulation
M = Import
E = Export
Source: own editing.

Our basic question was what makes the nation's economy grow at the highest speed. In spite of all the thorough crtiticisms, GDP is still one of the best indexes of growth, and it is specified in the GDP balance that is derived from the national accounts. In this regard, we have processed Stiglitz et al. [2019]. One of their key conclusions is that the growth of GDP is not always a good index without a thorough stock-flow control. For example, if governments had taken the deteriorating trends in the debt portfolio of the population seriously before the global financial crisis in 2009, they would have treated the soaring GDP growth indexes with more caution (Stiglitz et al. [2009] p. 9). For this reason, our analyses focus on not only the GDP, but the examination of the employment and the stock of capital, too. This ensures a continuous stock-flow control. Owing to our social theory approach, we find the improvement of the employment situation even more important than the growth of GDP. There are situtations when the two indicators do not show the same quality.

The joint observation of the three categories encouraged us to proceeed toward the BIR from the GDP balances and the underlying detailed national accounts. These three categories are easier to connect with the use of the BIR.

With the transition to the BIR, we did not wish to abandon the system of national accounts, but intended to extend that with additional relations. The BIR is the only national economy accounting system from which we can derive the GDP in usage and production approach, and we can derive the total output, too, and all these three derived categories are in perfect harmony with the system of national accounts.

However, there are several types of BIRs. This is a flexibly applied national economy equation system, which allows a large variety of analyses. Therefore the key consideration in its compilation is the type of analysis we wish to use it for. For this reason we established a special BIR that basically serves our analysis objectives, and it is identical with the KSH BIR in many elements, but differs from that in key points. What analysis considerations did our BIR have to meet?

The first consideration was to have a harmony with international BIR analysis methodologies, and to allow for the integration of the changes in the domestic production structure into international processes. The requirements of the international BIR analyses are described by one of the most significant international input-output undertakings of recent years, the so-called WIOT table, the scheme of which is presented in *Table 5*.

The WIOT table allowed us to produce the consumption vectors (what products and services are consumed by the individual countries) of 44 countries - including Hungary -, and to produce the production/total output vectors that describe the production structure of countries producing the consumer, accumulation and export goods and the services. This way we can see how much the structure of the total Hungarian output or production follows or does not follow the main trends of the world. We were able to compare these results with similar analyses made on the basis of the Hungarian KSH BIR.

The second important requirement was that it should be possible to derive the GDP from the BIR edited by us, and not only in one amount, but in a division by sector, too, in other words, it should show the roles of individual sectors both in the usage and in the creation and production of the GDP, too.

The third consideration was to be able to analyse the multiplier impact which, through the final use behind the GDP, determines the total output or the related production value, which in turn defines further staff number and capital usages. The economy modelling practice developed over the past decades, for which the scientific background was created by Leontief [1941], and for the Hungarian economy by Augusztinovics [1968], [1979], Zalai [2012] and Révész [2019] has been updated: the usages of production factors are not related directly to the GDP, but to its Keynesian multiplier, to the total output, in other words the gross production value[10] , and this can be done consistently with the BIR only.

The above three requirements were satisfied by the KSH BIR, but it did not allow us to divide the added value produced by it to company groups, and then combine these company group data and use the corporate production factors to calculate corporate production functions. KSH BIR data summarised contain the corporate, the public finances and the household sector data. For this reason, from each column and line of the KSH BIR, we deducted the public finances and the household performances accounted there, then combined them into a public finances column and line, and into a household column and line. This is demonstrated by *Table 6*.

[10] An important methodology note: our experience is that the concept of production is much better known and its use is more widespread than the concept of output. Thus production and total output are used as synonims in this study.

Table 5. The world's BIR (WIOT table) scheme

<table>
<tr><td rowspan="4" colspan="2">Outputs from a given sector of a given country</td><td colspan="7">Producers' usages in a given sector of a given country</td><td colspan="7">Final usages
for the final usage of a given country</td></tr>
<tr><td colspan="3">Country 1</td><td>…</td><td colspan="3">Country m</td><td colspan="3">Country 1</td><td>…</td><td colspan="3">Country m</td></tr>
<tr><td>1.</td><td>…</td><td>n</td><td></td><td>1.</td><td>…</td><td>n</td><td>1.</td><td>…</td><td>k.</td><td></td><td>1.</td><td>…</td><td>k.</td></tr>
<tr><td colspan="7">sector</td><td colspan="7">final usage</td></tr>
<tr><td rowspan="3">Country 1</td><td>Sector 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Sector n</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Sector n</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Added value</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Total expense / output</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Source: own editing based on Timmer et al. [2015].

Table 6: Scheme of BIR consistent with the national accounts and the NTCA corporate database.

		Producers' usage Corporate sector 1. sector … sector n	Final usage household	public finances	consumption	gross accumulation	export
Corporate sector	Sector 1						
	…						
	Sector n						
Household							
Public Finances							
Import							
Product taxes *minus* supports Added							**t**
value Total		**h**	$\mathbf{h_h}$	$\mathbf{h_g}$			
expenses							
Added value from NTCA database		**h***					
Staff number		**l**					
Gross fixed assets		**k**					
Company number		**n**					

Source: own editing.

According to the system of relations of national accounts, the GDP is equal to the added value increased by product taxes and decreased by supports (sum of elements of **h + hh + hg + t**). Earlier we worked out a procedure to break down the **t** amount to the sectors of the corporate sector, to households and to public finances, so we can precisely meter the contributions of individual sectors to the production of the GDP. (The exact description of the procedure is a matrix artihmetic deduction of several pages, it can be seen in the methodology part of the background study at the following link Boda et al, [201] pp. 55-60) These researches lead to the finding that the sectoral contributions to the GDP in volume depend on the role played by the added value in production. So the basis of the production of the GDP is the production of the added value (vector **h**). It is important that this vector **h** does not include public finances and the household sector. The **h** contains only the added value of financial and non-financial companies in sectoral breakdown[11].

In Table *6*, the data scope that is fully consistent with the KSH national account data is in a bold frame in the BIR scheme. However, we had to exit this data scope, because we wanted to divide vector **h** of the BIR beyond the sectoral breakdown, according to company size and owners. This is why we inquired the so-called approximate added value from the NTCA corporate tax database, too, and that was similar to vector **h** in volume only. Not in amount. However, we considered the inquiry usable. The added value vector inquired from the NTCA database was marked with **h***.

From the NTCA corporate tax database, we also inquired the sectoral staff number **(l)**, the gross fixed assets **(k)** and the company number **(n)** data, too. We compared their volumes with several KSH sources, and either accepted them, or corrected them on the basis of the KSH data.

This allowed us to use the estimates and break down the corporate sector data into company groups, based on the NTCA corporate tax statistics, according to the model in Table *7***.** Actually, the system in Table *6* and in Table *7* is considered as the final database of our calculations, the so-called framework model.

[11] Our research is not closed. We identified a number of consistency problems between the natinoal accounts and the NTCA corporate database, but we have not been able to achieve full consistency yet. However, we paid attention to volume inconsistencies during the analysis.

Table 7: Framework model of our analyses

	Disaggregation of key company data								National economy sectors producer usage
	Foreign companies				National companies				
	micro	small	medium -size	large	micro	small	medium -size	large	
	sector groups								companies in total
Added value									**h***
Number of employees (thousand people)									**l**
Gross fixed assets									**k**
Number of companies (pieces)									**n**

Sector groups analysed in the study: Food economy, Processing industry, Hard services, Soft services

The contents of the sectors are given in Table *8*.

Source: own editing.

We created equations from the corporate data of the framework model.

Added value equation:

$$H = V \times [v_{micro} \times (H/v)_{micro} + v_{small} \times (H/v)_{small} + v_{medium\text{-}size} \times (H/v)_{medium\text{-}size} + v_{large} \times (H/v)_{large}].$$

Employment equation:

$$L = V \times [v_{micro} \times (L/v)_{micro} + v_{small} \times (L/v)_{small} + v_{medium\text{-}size} \times (L/v)_{medium\text{-}size} + v_{large} \times (L/v)_{large}].$$

Tangible assets equation:

$$K = V \times [v_{micro} \times (K/v)_{micro} + v_{small} \times (K/v)_{small} + v_{medium\text{-}size} \times (K/v)_{medium\text{-}size} + v_{large} \times (K/v)_{large}].$$

H = added value,
L = number of employees,
K = stock of tangible assets (metered in gross fixed assets),
V = number of companies,
v_{micro} = number of micro companies/V, v_{small} = number of small companies/V, $v_{medium\text{-}size}$ = number of medium-size companies/V, v_{large} = number of large companies/V.
Contents of technological coefficients:
$(H/v)_{micro/small/medium\text{-}size/large}$: added value produced by a company in the given company category,
$(L/v)_{micro/small/medium\text{-}size/large}$: number of employees at a company in the given company category,
$(K/v)_{micro/small/medium\text{-}size/large}$: capital tied up by a company in the given company category.

As these equations help in the description of the relation between production factors used in the companies and the added value produced by the companies, hereinafter we will call them *corporate production functions*[12]. Their significance is that they connect the added value production of the most important company groups with the national economy factor usages. With the production functions, it is possible to compare the roles and impacts of individual indicators.

The equations can be detailed in any way. The micro company may be a national micro company in the processing industry. Accordingly, the added value may be the added value produced by the national micro companies in the processing industry. From the production functions of such details, we can derive the productivity of national micro companies in the processing industry. The biggest depth of the development of equations: company category × owner × sector group.

We have to mention the sectoral breakdown of calculations, too. In the framework model, there are four sector groups as internal breakdown. Later, in the detailed structural analysis, we will see that these four sector groups have special roles in the description of Hungary's economic situation. Without these, the current economic situation is simply impossible to interpret. Naturally, the creation of a database of that size was carried out in bigger depth, in the KSH BIR 64-sector breakdown. From these basic sectors, we combined the four sector groups according to Table *8*.

[12] The profession has worked out multiple variations of production functions. In the lack of data, we work with these simpler production functions at the moment.

Table 8: Contents of sector groups used in the analysis

Food economy	Processing industry	Hard services	Soft services
Agriculture	Mining and quarrying	Electricity, gas, steam and air conditioning supply	Financial service activities, except insurance and pension funding activity
Forestry	Manufacture of textiles, apparel and leather products	Water collection, treatment and supply	Insurance, reinsurance and pension funding (except compulsory social insurance)
Fishing and aquaculture	Wood processing (except furniture), manufacture wicker products	Sewerage, remediation and other waste management activities	Other financial activities
Manufacture of food, beverages and tobacco products	Paper and paper products waste management	Construction	Real estate activities
	Printing and reproduction of printed media	Wholesale and retail trade and repair of motor vehicles and motorcycles	Imputed home service
	Manufacture of coke and refined petroleum products	Wholesale trade, except of motor vehicles and motorcycles	Legal, accounting, and tax consultancy activities; business management; executive consultancy
	Chemicals and trading in chemicals and product	Retail trade, except of motor vehicles and motorcycles	Architectural and engineering activities; technical examination and analysis
	Manufacture of pharmaceutical products	Land and pipeline transport	Scientific research and development
	Manufacture of rubber and plastic products	Water transport	Advertising and market research
	Manufacture of non-metallic mineral products	Air transport	Other professional, scientific and technical activities; animal healthcare
	Manufacture of raw metal products	Warehousing and support activities for transportation	Leasing and operating leasing
	Metal processing product manufacturing	Post and courier activities	Labour market services
	Computer, electronic and optical products manufacturing	Accommodation and food service activities	Travel mediation, travel organisation and related activities
	Manufacture of electrical equipment	Publishing activities	Security and investigation activities; building and grounds management; administrative, support service and other business support service activities
	Manufacture of machinery and equipment n.e.c.	Motion picture, video and television programme production, sound recording and publishing activities;	Public administration and protection; mandatory social insurance
	Manufacture of transport equipment	programme production and broadcasting activities	Education
	Manufacture of other transport equipment	Telecommunications	Human health activities
	Manufacture of furniture; other manufacturing		Social care
	Repair and installation of machinery and equipment		Creative, arts and entertainment activities; library, archives, museums and other cultural activities; gambling and betting activities
			Sports, amusement and recreation activities
			Interest representation

Source: Own editing

The sector groups include two new terms, the *hard services* and the *soft services*. By hard services we mean services for which significant material networks need to be operated. The role of material networks may be important in soft services, too, such as school buildings in education or hospital buildings and equipment in healthcare, but the basic services are usually not of material type in these cases. This can be seen in western literature under the names of hard and soft infrastructure, and we find these more meaningful than the material and the non-material differentiation.

2.4. The impacts of changes in national economy structure on growth and employment

Growth and employment greatly depend on the economic structure. If activities with high added value contents have big weights in the economy, then the GDP will be higher, and primary employment will increase, as the primary source of GDP is the produced added value, and this category is mainly wages, behind which there is employment. If activities with low added value contents are dominant, the potential rate of GDP may drop, and the growth of primary employment may slow down, or even stagnate.

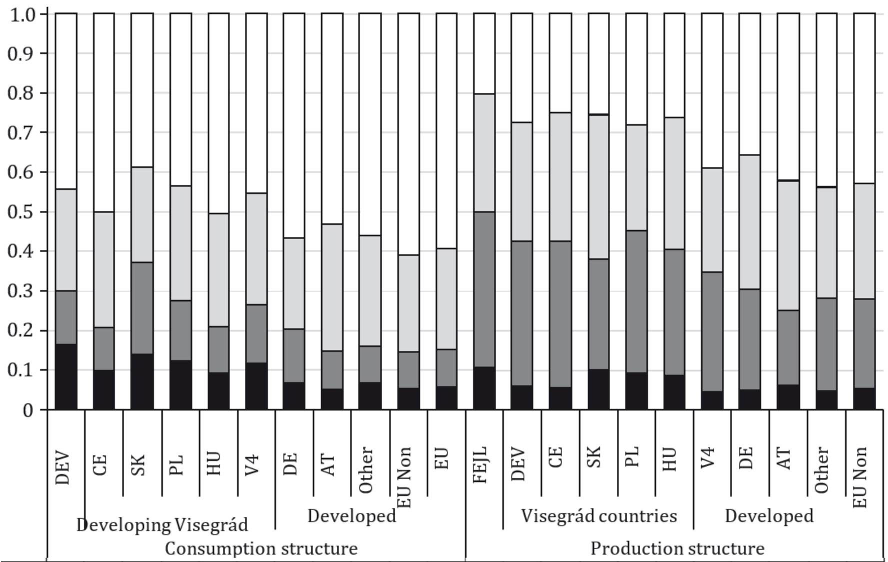
The transformation of the economic structure primarily depends on the transformation of the consumption structure. This has a clear international trend. Main stream: with the increase in economic development, which is indicated by the GDP per capita curve, under consumption, it is mainly services, and mainly soft services that play the main roles, while the weight of food economy and industry gradually decreases (Figure *7*). (The message of Figure *7* is illustrated by additional figures in the background study at the following link: Boda et al. [2019] pp. 18–20) The source of the calculations is the 2014 version of the so-called WIOT tables. A research team (Timmer et al. [2015]) used the BIRs from around the world and other statistical data to compile the World Input Output Table (WIOT) matrixes for years 2000–2014, which is a world BIR series. It is nothing else but the joint BIR of the 44 countries involved in the examination, and Figure *7*can be derived from it. As the WIOT tables are not based on the official state statistics, the restructuring observed in the table was checked in the official data published by Eurostat, too. We can observe the same structural transformation there.

The transformation processes of the economic structure play two roles.

1. We tend to consume food economy and industrial products more and more in one of the service sectors[13]. This leads to increased time of free disposition, which allows for a significant increase in the standard of living.

[13] See Hámori–Szabó [2012] for more details.

Figure 7: Differences of consumption and production structures in the developed, developing and Visegrád countries, 2014 (percentage)



	DEV	CE	SK	PL	HU	V4	DE	AT	Other	EU Non	EU	FEJL	DEV	CE	SK	PL	HU	V4	DE	AT	Other	EU Non
Soft services	0,44	0,50	0,39	0,44	0,51	0,45	0,57	0,53	0,56	0,61	0,59	0,20	0,27	0,25	0,26	0,28	0,26	0,39	0,36	0,42	0,44	0,43
Hard services	0,26	0,29	0,24	0,29	0,29	0,28	0,23	0,32	0,28	0,25	0,25	0,30	0,30	0,32	0,36	0,27	0,33	0,26	0,34	0,33	0,28	0,29
Industry	0,14	0,11	0,23	0,15	0,12	0,15	0,14	0,10	0,09	0,09	0,10	0,39	0,37	0,37	0,28	0,36	0,32	0,30	0,25	0,19	0,23	0,23
Food economy	0,16	0,10	0,14	0,12	0,09	0,12	0,07	0,05	0,07	0,05	0,06	0,11	0,06	0,05	0,10	0,09	0,08	0,04	0,05	0,06	0,05	0,05

Soft services Hard services Industry Food economy

Abbreviations: DEV = developing countries (Brazil, Bulgaria, India, Indonesia, China, Mexico, Russia, Romania, Turkey); CE = Czech Republic; SK = Slovakia; PL = Poland; HU = Hungary; DE = Germany; AT = Austria; Other EU = EU countries, the Visegrád countries, without Austria and Germany; non EU = developed countries outside the EU (Australia, United States, Japan, Canada, Korea, Norway, Switzerland); FEJL = developed countries total (Austria, Germany, the Other EU and Developed countries outside EU together). Source: own editing based on the 2014 WIOT table.

2.Increased weight of knowledge work in the activity of service sectors[14]. The productivity of the food economy and the processing industry has been improved by the knowledge content coming from services, especially from soft services. This significant increase in productivity makes the traditional sectors of the economy repressed.

This kind of transformation in consumption can be considered as universal. It can be observed in every country, including the Visegrád countries. Changes in consumption structure entails changes in total output, i.e. in the structure of production, as we have to

[14] By knowledge work we mean work in which the instruments are mainly knowledge-based instruments, without material form.

produce what we consume. As the weight of services increases within consumption - with the economic development - it increases in the production structure, too.

The rule that changes in the structure of production follow the changes in the structure of consumption is valid as long as the volume of foreign trade is not significant. However, where the volume of export or import is high compared to the volume of domestic consumption, or even exceeds that, the changes in the structure of production may not be in line with the changes in the structure of consumption, and may follow the direction of the contents of the exports.

Developed countries have significant comparative advantages in industrial production. As they are able to sell the industrial products that are suitable for both consumption and accumulation with good profit, the share of the industry within their production structure is twice as high as the share of industry in their consumption structure.

There are advanced countries where the comparative advantages in their industrial production exceed the industrial comparative advantages of even other advanced countries. This is Germany and Austria that is integrally embedded in the German economy. In these countries, the share of the industry in the production structure is approximately two and a half times higher than the share of industry in consumption.

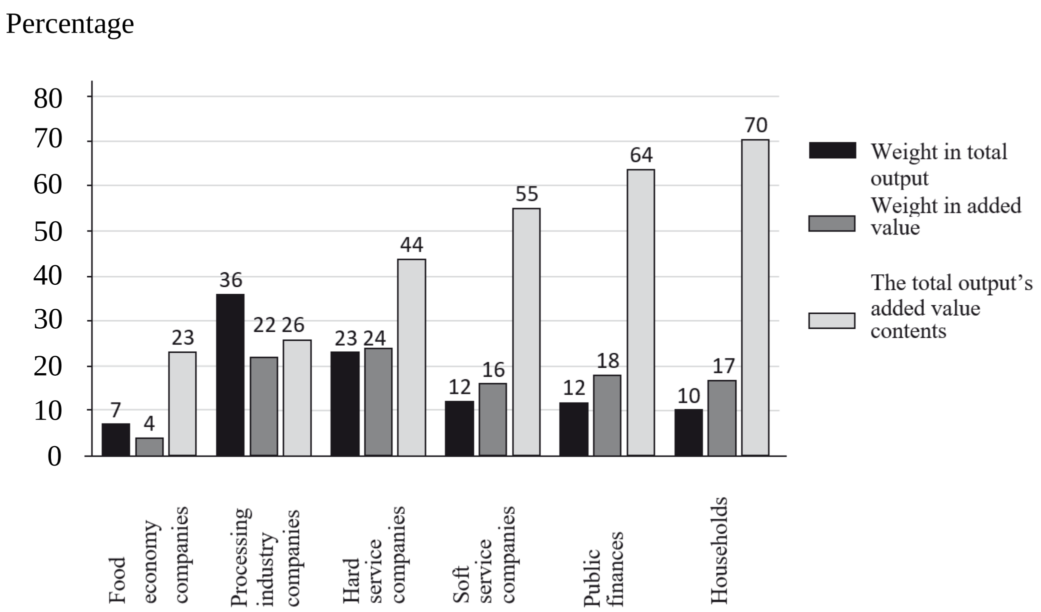
Developing countries have no major comparative advantages in industrial production, but they have cheap labour that can be used in industrial production. Developed countries outsource some of their industrial production to these countries. With the relatively low level of development of other domestic sector groups, this results in a four times higher industrial share in production, compared to the share of the industry in consumption. The Visegrád countries - mainly the Czech Republic and Hungary - with the transfer of the German processing industry’s production, belong to this group of countries. The growth of the weight of soft services is slowed down by this process, but the growth of hard services is expessly restrained by it.

Outsourcing always refers to activities that are either end-of-series activities, so the outsourcing parent organisation is able to produce it with lower added value only, or in which the added value content can be reduced with the bargaining power. Activities with really high added value contents - among others, because they are important from strategic aspects - are usually not outsourced. The activity of the processing industry is a typical example for that, as it means activities with the lowest added value content and partly end-of-series activities. It was true in each examined country that the added value contents of hard services are at least 10 percentage points higher than in the processing industry, and the added value contents of soft services are more than 10 per cent higher than those of hard services. (See the following link of the background study for the tables supporting the statements: Boda et al. [2019] pp. 23–27) This difference in returns directs the capital into the service areas, and foreign trade can only modify, not counterbalance this sucking effect[15].

The activity outsourced into the Visegrád countries will definitely be the activity with the lowest added value in these countries, with huge foreign trade turnover, and with imports and exports not integrated into the economy [see Figure *8, a)-c)*].

Figure 8: The role of the corporate sector, public finances and the households in total output and in the usage of the key production factors in Hungary, 2015.

a) The structure of the total output and the added value contents in Hungary, 2015 (percentage).

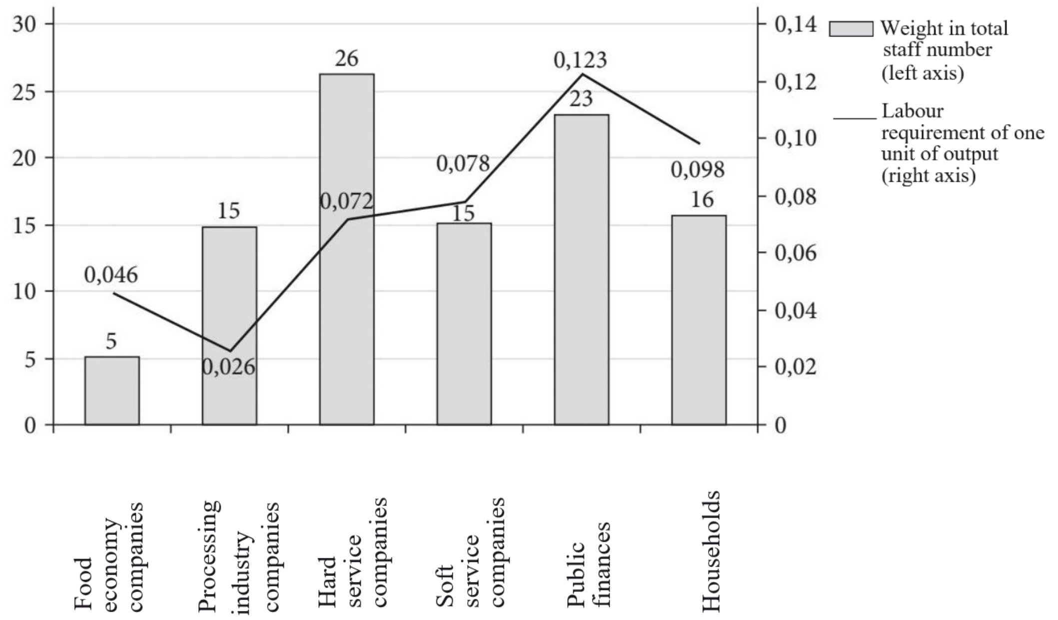


[15] Here we have to argue with a few extremist Roland Berger documents (Blanchet–Rinn [2016], Siepen et al. [2015]) or EU document (Blanchet et al. [2014]), which envisage the future rearrangement of the industrial share.

Continuation of Figure *8*

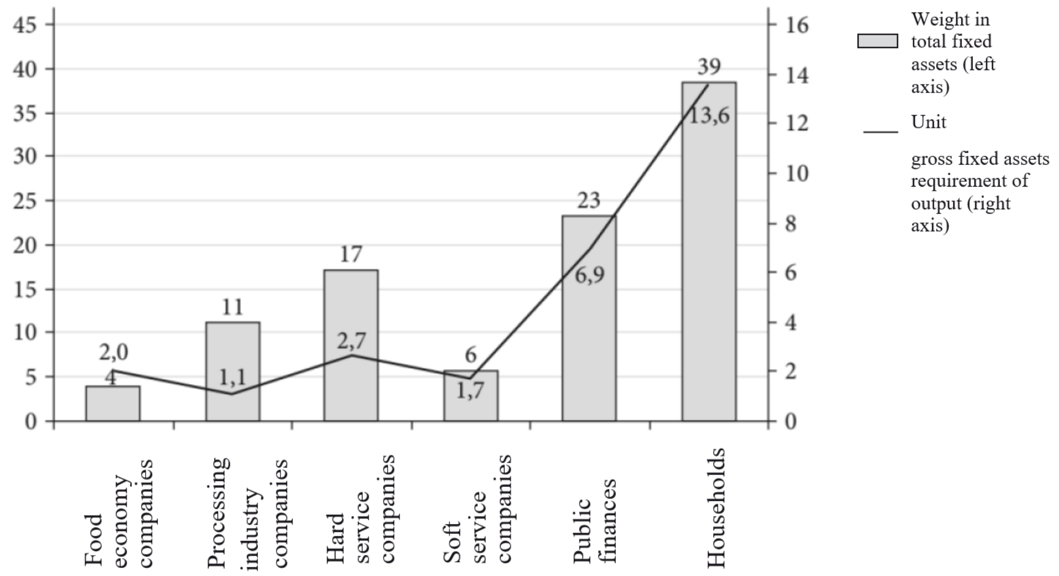
b) Employment structure and labour demand in Hungary, 2015 (percentage, person/million HUF)

Percentage Person/million HUF



c) Structure of gross fixed assets and capital requirement in Hungary, 2015 (percentage, million HUF/million HUF)

Percentage Million HUF/million HUF



Source: own editing based on the corporate BIR established with the transformation of the KSH BIR of 2015.

Among the Hungarian sector groups, the processing indusrty, and within that vehicle production has the lowest added value contents, while it has the largest weight within production structure. The low added value contents of the processing industry comes hand in hand with high import contents and similarly high exports, and it forms an island-like block within the Hungarian economy. For this reason, within the produced added value sructure, it is not the largest sector group any more, so it does not increase the GDP as much as its weight in production would suggest. In addition, some of this GDP will not stay in the country.

This processing industry employs a large volume of labour with wages that are relatively high under domestic conditions, in a legal way, but proportionally it employs less people than the service areas, as the processing industry has the highest productivity. In addition, the current digitalisation revolution will further increase the productivity of this sector to a significant extent, therefore a high number of people working here may lose their jobs.

This is how one of the basic problems of our economic growth emerges: our largest sector group in the production structure, i.e. processing industry is able to produce the least (gross) added value, and requires the lowest number of staff, while sectors, the development of which could improve this situation, demand a lot of capital.

The capital requirements of the hard and soft services of the corporate sector are lower than that of public finances. This is very important from the aspect of launching domestic developments, as the first step has to be taken in the competitive sector, where capital requirements are lower, and only the emerging yields of these developments will allow for the development of the processes in the direction of activities with higher capital requirements.

Quite a few signs suggest that the high capital requirement of public finances is no accident. In the competitive sector, a number of companies intensively use the capital owned by the state budget [think of private healthcare companies or spin off organisations in education]. So this high capital requirement is one of the basic conditions of their efficient operation, too. The difference, however, is important, because it reduces the capital requirements of the first development steps.

The high capital requirements of the household sector is primarily related to the housing portfolio recorded there. The subsequent development of this sector is also very important. In the first phase, however, we would not calculate with this sector.

Summarising the above points we can say that the above described outsourcing process - because of the low added value contents - will reduce both the growth rate and the primary employment in the long term. Compared to zero, it is, of course, an increase, but its actual role can only be compared to what an economic development based on independent development could bring. We assume that in the case of an efficiently modernised Hungary this would not be zero.

The Visegrád countries - as they have no major independent development activities (Nölke - Vliegenthart [2009] - are not in a position to reject this outsourcing offer. Thus they were forced to set up a special growth model, which, on the basis of Nölke–Vliegenthart [2009], is called Dependant Market Economy (DME), or based on Lux [2017] it is called a production structure driven by foreign working capital investments (KMTV).

If the Visegrád countries fully give up independent development activities, they will be in an exclusively accepting position, which leads to the conservation of backwardness and makes convergence impossible. The DME or the KMTV model, in which the Visegrád countries operate, was not created with the purpose of ensuring convergence. This model provides only the chance of convergence. The system was set up to facilitate the more efficient operation of the multinational capital, and it is advantageous only to parties who operate more efficiently in that.

If we wish to make the established Eastern European model more efficient, we need an accumulation process coupled with development (upgrading), and we mean significant and independent national development activities by that[16]. Following Lin et al. [2008] and Lin's [2012], [2017] idea, we talk about convergence of developing nature, if we use some of the achieved profit to increase the capital adequacy of future activities, which means the technical equipment for work and the increase in tangible and intangible assets per unit of labour[17]. This will be the source of full productivity increase, which may be the basis of further convergence.

[16] We selected the 'national' concept, because the domestic concept is misleading here, as foreign companies producing GDP in Hungary are also considered domestic. As national productivity is not identical with domestic, the national developments are not identical with domestic development activities.

[17] Presently we have a research in progress, which is not ready for publication yet, it uses accounting costs to draw conclusions about the assets behind the expenses. Based on our primary results, in our opinion costs related to the use of classic forms of instruments (wages and depreciation) make up smaller and smaller shares of costs. Based on this we can conclude that the use of labour and tangible assets have less weight,

Where to unfold this development? Primarily where higher added value contents can be achieved. Consequently:

1. In the processing industry

a) with the development and commencement of activities of higher added value (for instance, in pharmaceutical industry, in the manufacturing of high-tech products and robots).

b) by supporting stronger integration into multinational supplier chains, and

c) increasing the extension possibilities in niches opening for activities that satisfy special demands.

2. In the service sectors, where the added value content is higher anyway.

Here we connected the development with a structural rearrangement anyway. We verified the impact of the structural rearrangement with a multiplier analysis. By using a BIR based model, we examined the impact generated by the processing industry, the services and public finances development in the economy (Table *9*).

As the methodology of multiplier analysis is a genaral part of each relevant university curriculum, we consider the procedure well-known, and summarise only the essence of it: we took the internal square of the B type BIR, transformed it into a coefficient matrix with the divisiion by the production vector, deducted it from the unit matrix, and then inverted it. The received Leontief inverse was multiplied from the right with final usage vectors, in which only one element was increased by 1000 billion. Each of the received production vectors were multiplied by the unchanged import, product tax balance, added value, staff number usage and fixed assets usage contents, and this is how we received the data in Table *10*. The detailed matrix arithmentic description is in *Boda et al.* [2019] pp. 58–60)

The results have confirmed the need for the structural shift. The ceteris paribus change of the final usage unit in services and in public finances induces a stronger economic drive than in the processing indsutry.

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beside the use of intangible assets. So the need for tangible assets, which is consistently analysed in our study, is only one part, and a decreasing part of the real asset requirement.

We carried out the calculations of Table *9* in a more detailed sector breakdown, too, and we found the concept that processing industry sectors with higher added value contents drive the economy more than vehicle industry developments true.

To make such a change more effective, developments have to be started in a wide scope and at multiple levels. Here all the players in society have tasks in all the sectors of the economy[18]. It is not enough to expect the change from the state or the companies only.

[18] *By sectors we mean the sector of financial companies, the sector of non-financial companies, public finances, the households, and the non-profit organisations helping households, as it is interpreted by the BIR, too.*

Table 9: Multiplier analysis on the basis of the 2015 BIR (thousand people, change in percentage)

(How will the main aggregates change if the final usage of the given company group is increased by HUF thousand billion, while leaving the final usage of other company groups unchanged?)

	Basic case	Food economy	Processing industry	*Hard* service provider	*Soft* service provider	Public Finances	Households
		companies					
GDP (billion HUF)	34,379	35,064	34,824	35,156	35,258	35,309	35,326
Imports (billion HUF)	27,614	28,162	28,402	28,071	27,968	27,917	27,900
Number of employees (thousand people)	4,308	4,409	4,347	4,414	4,417	4,455	4,427
Gross fixed assets (billion HUF)	242,438	248,364	244,144	246,725	245,469	250,522	257,066
GDP growth (percentage)		2.0	1.3	2.3	2.6	2.7	2.8
Import growth (percentage)		2.0	2.9	1.7	1.3	1.1	1.0
Growth in number of employees (percentage)		2.3	0.9	2.5	2.5	3.4	2.8
Growth in fixed assets portfolio (percentage)		2.4	0.7	1.8	1.3	3.3	6.0

Source: own calculation and editing based on 2015 KSH BIR.

Public Finances is one of the most significant sectors of the economy. Important areas like education and healthcare belong to that. If we include state-owned companies, we have large areas like the MÁV (Hungarian State Railways), the motorway network etc. The development status of these areas basically determines the performance of companies. It is very important to develop these areas, as there is no convergence without them.

At the same time, public finances operate an institution system, too, which determines the framework of the operation of companies. Its development is also a priority task. This institution system is efficient if it facilitates the development of companies, which means that the companies

1. are able to produce higher added value,
2. they can provide productive employment to more and more people, and that
3. is done with higher labour and capital productivity.

All that raises the need for company level analyses, as the restructuring may come from the top only partially. That can be successul only if it is in line with the intentions and the development of companies. Hereinafter we will continue our analysis at company level.

2.5. The impacts of changes in corporate structure on growth and employment

We have examined the internal rules and differences of the population of companies in the developed countries and the Visegrád countries, and then identified a number of development directions that need to be incubated by the state institutions system. These are as follows!

In the company structure of developed countries, the ratio of small and medium-size companies within the whole population of companies is 5 percentage points higher than in the Visegrád countries. Accordingly, the ratio of micro companies is 5 percentage points lower (Figure *9*).

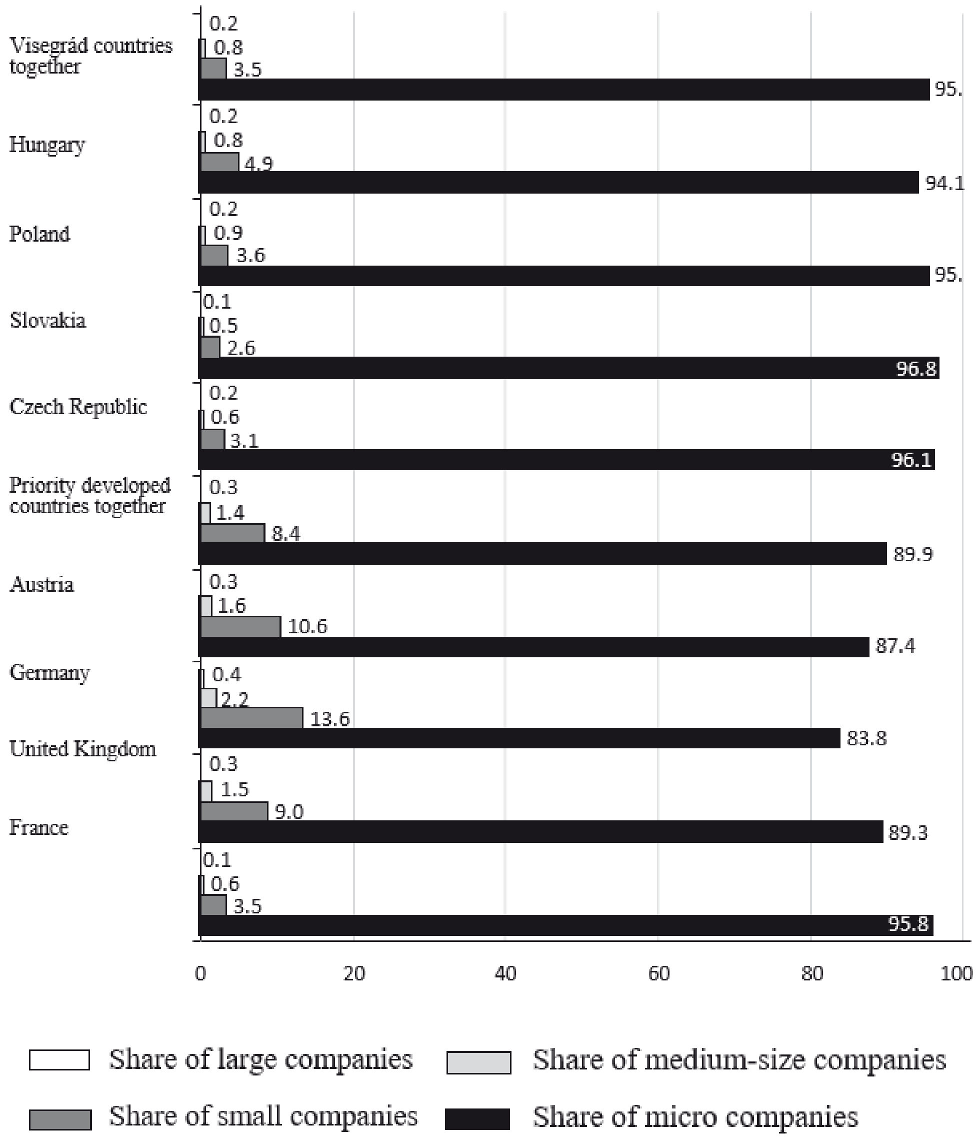
The basis of the breakdown to company categories is the well-known - staff number based - grouping by size of operation, which divides the companies on the basis of their staff numbers - to micro (0-9 people), small (10-49 people), medium-size (50-249 people) and large companies (250 or more people).

The majority, i.e. 92 per cent of Hungarian companies are micro companies. The number of larger companies exponentially decreases, 6.7 per cent of them are small businesses employing 10-49 people, 1.2 per cent are medium-size businesses employing 50-249 people, and only 0.2 per cent are large companies employing more than 250 people (Table *9*).

It is a general fact that company structure is a pyramid that exponentially grows narrower from the bottom to the top. At the first sight, these company structures are very similar to each other, but in fact they are significantly different. We used modelling calculations to prove that with unchanged productivity, the impact of the 5 percentage point difference is dramatic in the ratio of small and medium-size companies. For instance, if the small and medium-size sector of Hungary in the Hungarian corporate structure would be 5 percentage points higher, then more than 5 million people could be provided with primary employment. (See Boda et al. [2019] pp. 36–40 for model calculations supporting the statement.)

The reason for this significant change is that the use of production factors and the effectivity of small and medium-size companies - as a result of the development of the returns to scale - is multiple times higher than the production factor usage and the effectivity of micro companies. Therefore the expansion of the small and medium-size company sector has a huge impact. This can be proved with Figure *11* a)-g).

Figure 9: Company structures of the examined countries in 2017 (percentage)



Source: own calculation and editing based on Eurostat database.

In the domestic corporate production functions, when proceeding from one company category to another, the staff number employed by one company and the stock of gross fixed asset used by one company grow exponentially [Figure *11* b) and c)]. On average, a micro company employs 2 people, a small company employs already 20 people, a medium-size company employs a hundred, and a large company employs close to a thousand people. This is the reason why a corporate structure with more small and medium-size companies is able to employ more people, with productivity typical for small and medium-size companies.

Figure 10: Weight of individual company categories on the basis of the number of companies (percentage)

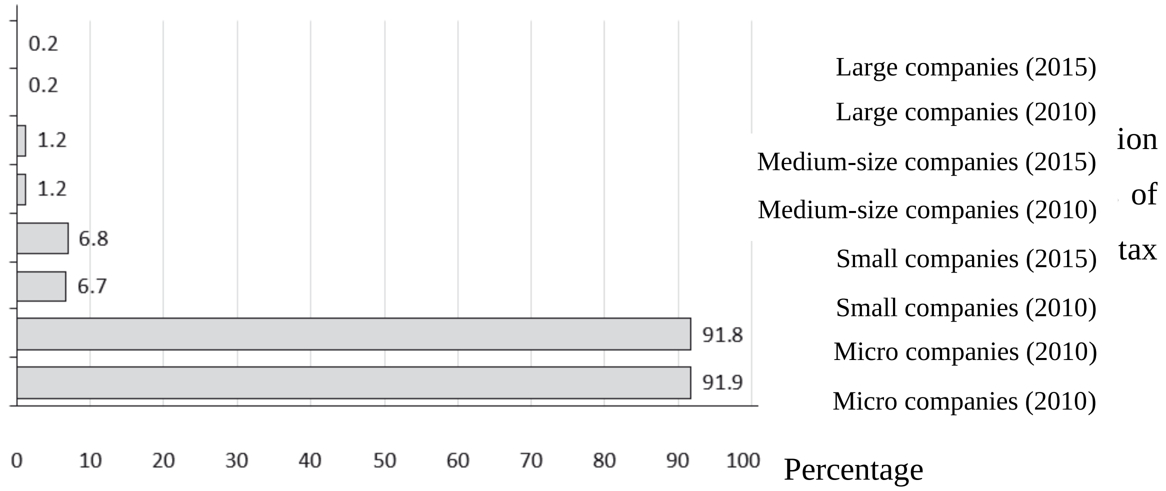
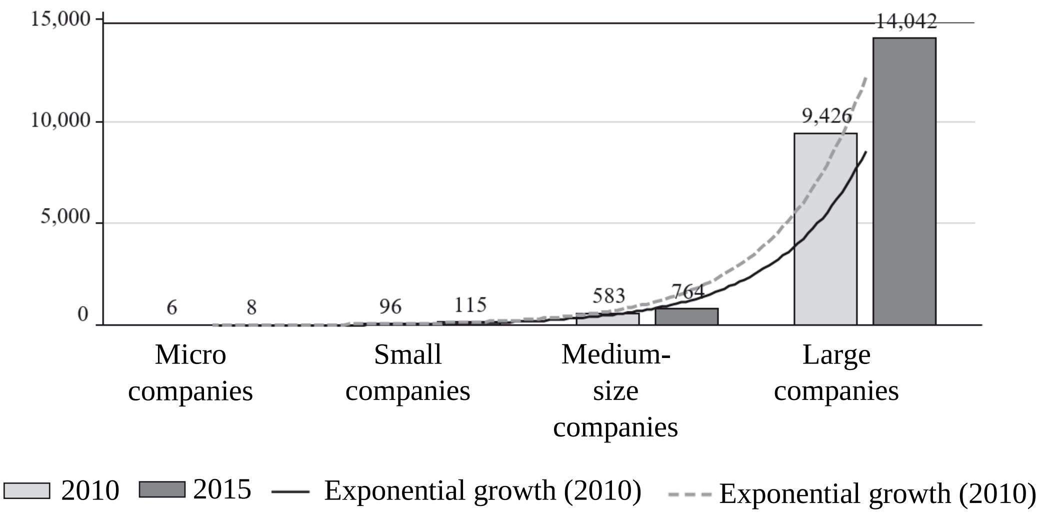


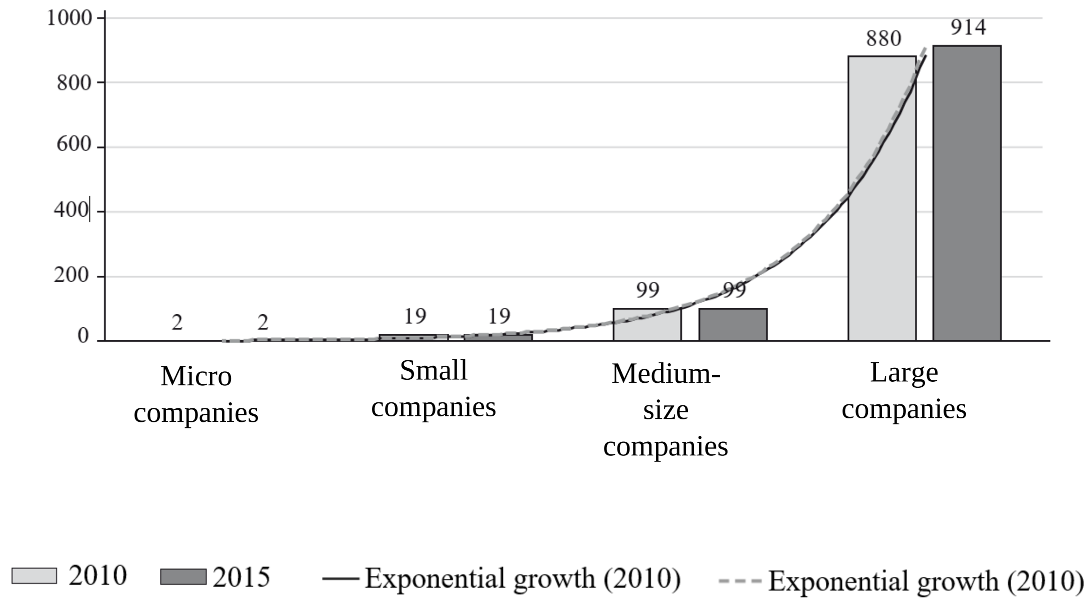
Figure 11: The impact of the development of the returns to scale on the use of production factors by small, medium-size and large companies, and on their efficiency

a) Added value produced by one company (million HUF/company)

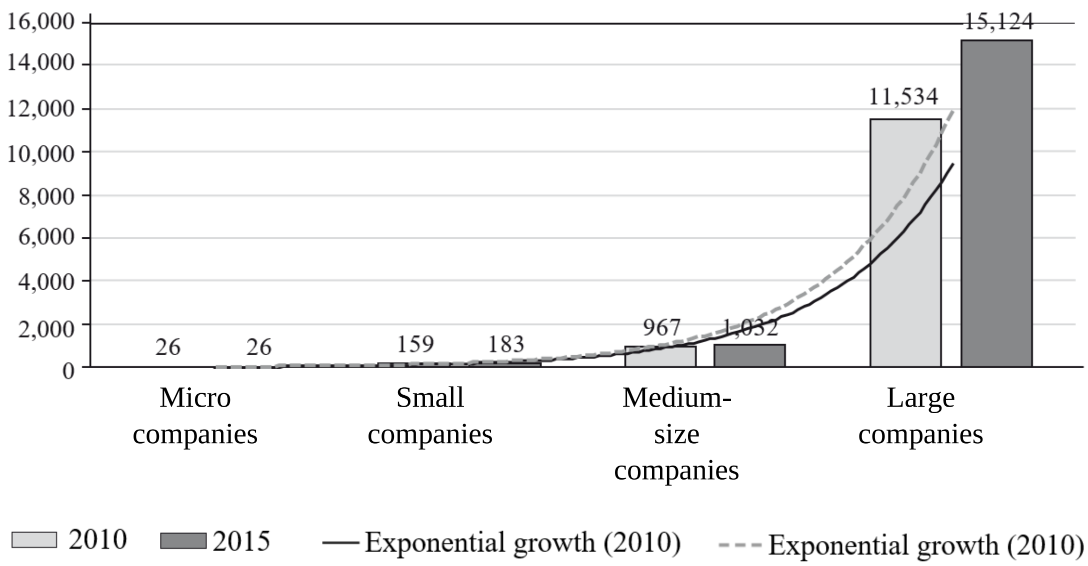


Continuation of Figure *11*

b) Number of employees required for the operation of a company (people/company)

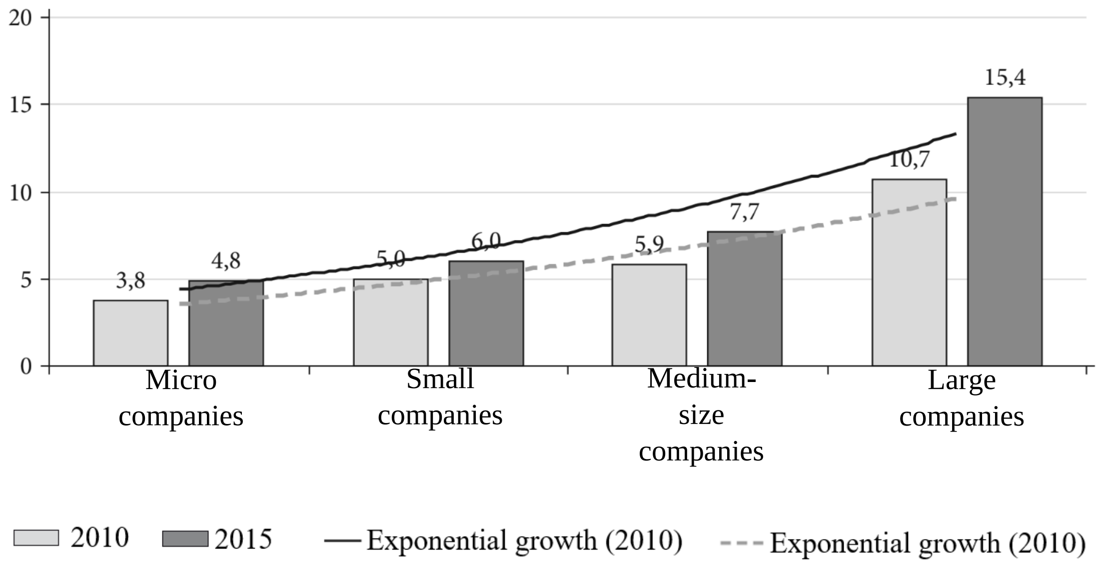


c) Gross fixed assets required for the operation of a company (million HUF/company)

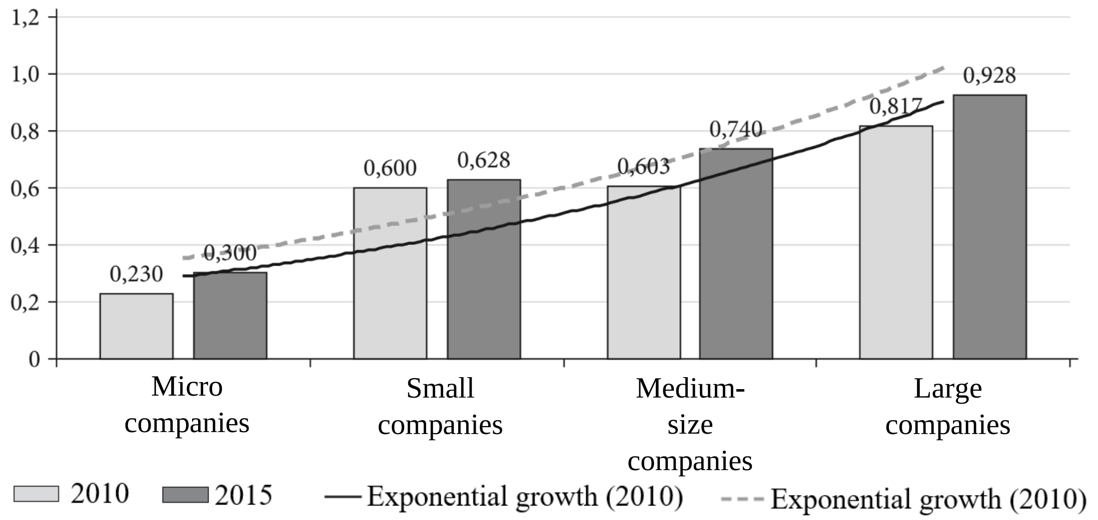


Continuation of Figure *11*

d) Added value produced by one employee (million HUF/people)

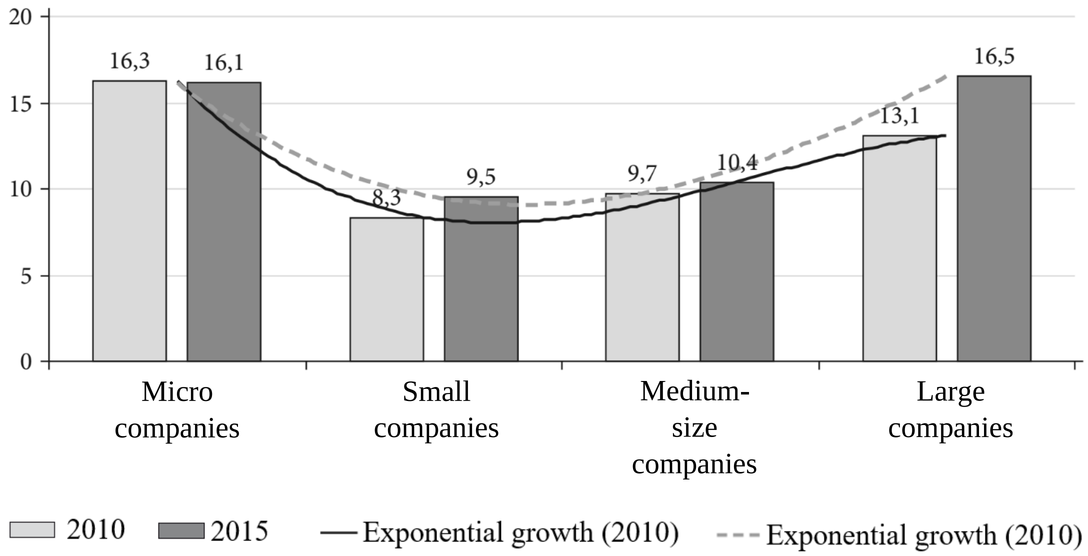


e) Added value produced by one unit of gross fixed assets (million HUF/million HUF)

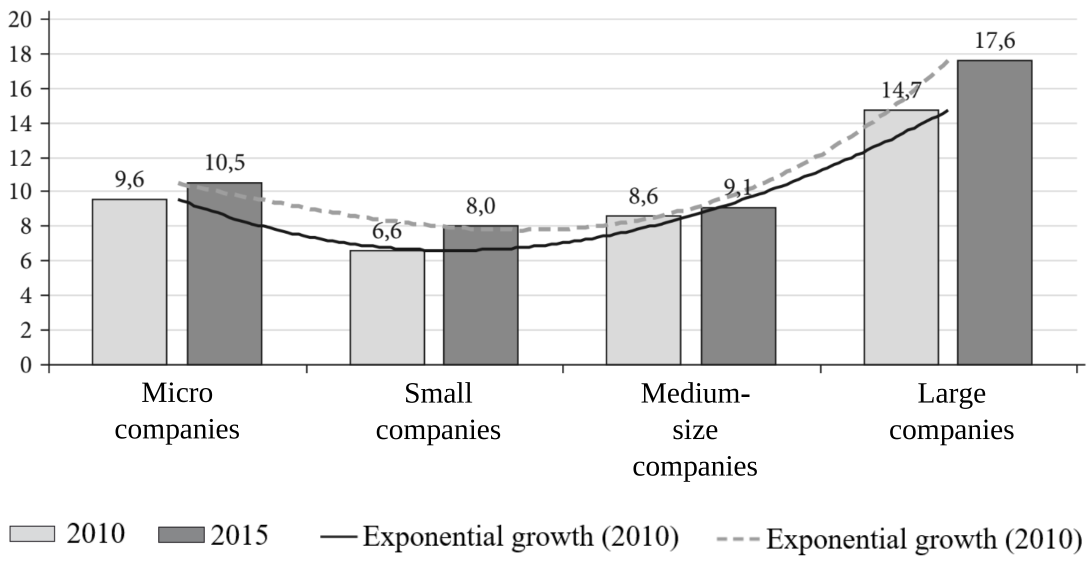


Continuation of Figure *11*

f) Gross fixed assets per one unit of staff number (billion HUF/people)



g) Gross fixed assets per one unit of staff number at the national companies (billion HUF/people)



Source: own calculation and editing on the basis of the NTCA corporate tax database.

We can see the same exponential changes in the gross fixed assets use, too. This also indicates that the strengthening of the corporate structure of small and medium-size companies requires serious conditions related to accumulation. Only successful accumulation may result in a growing share of small and medium-size companies in the population of companies.

As a result of use of production factors in higher volumes and in a more concentrated way, the added value produced by one company also grows exponentially [Figure *11a)*]. Question: does it happen with decreasing or increasing efficiency?

According to parts *d) and e) of* Figure *11*, efficiency, which is metered with work productivity and capital productivity, also increases between company categories. Although this increased efficiency is rather linear only, it is still significant.

This exponential growth can be observed in the use of production factors and in their efficiency in the case of all countires examined by us, and in the case of all analysed sector groups and owner categories. Their extents are different, but the phenomenon is clear.

Finally, regarding the growth of small and medium-size companies, we can observe a developing convergence, too, namely the fact that the portfolio of gross fixed assets per person also grows when changing for larger company categories [Figure *11, f)* part]. The high gross fixed asset portfolio / person of micro and small companies does not fit into this process. However, we have serious reservations about its contents. The capital / staff number indicators of micro companies are greatly distorted by the capital / staff number data of foreign companies, and by the phenomena in the domestic black economy. A foreign large company may capitalise a business even with a low number of employees, and they actually do that in their foreign expansions. Thus in the case of micro companies, the indicators shows not so much the development, but rather the special international division of labour and the distortions of the Hungarian economy (e.g. the process of hiding behind small companies). In the case of larger company categories, however, we think the development is real.

The presented phenomena are backed by the law of returns to scale. Small and medium-size companies are able to ensure a much bigger and more efficient production factor usage than micro companies. Similarly, large companies achieve a more efficient use of factors than small and medium-size companies.

Based on all that, the primary task is to support those companies that are able to grow, in our case to change for another size category, i.e. to become small companies from micro companies, and medium-size companies from small companies. A deeper analysis of the population of Hungarian companies shows that this change in size is significant n Hungary in the case of foreign companies only. In the case of national companies, the concentration and the evelopment of the population of companies is extremely slow, and has serious internal obstacles. Our national companies cannot or do not want to grow. As this is another central problem of economic growth, we examined the development of size-changing companies separately. Table *10* was worked out to illustrate their problems.

Table *10* starts with the 2010 performance of companies, and deducts the 2015 corporate performance When compiling this table, we attempted to the essential elements of change are described with data. Therefore certain data items are combined, and others are broken down.

Table 10: Changes in small, medium-size and large company performances in 2010-2015

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Total company	Micro companies	Small, medium-size & large companies	Small, medium-size & large companies						Small, medium-size & large companies	Micro companies	Total company
				No change in size	Downsizing	Upsizing	Continuous operation	Exits	Entries			
	2010			between 2010 and 2015						2015		
NUMBERof COMPANIES												
(1) Thousand pieces	384.2	353.0	31.2	16.7	0.7	1.2	18.6	12.6	14.1	32.7	366.4	399.1
(2) Share 1*	0.96	0.88	0.08	0.04	0.00	0.00	0.05	0.03	0.04	0.08	0.92	1.00
(3) Share 2**			0.96	0.51	0.02	0.04	0.57	0.39	0.43	1.00		
ADeD vAlUE												
(4) 2010 billion HUF	15,443	2,114	13,328	10,749	427	574	11,750	1,578		13,328	2,114	15,443
(5) share	1.00	0.14	0.86	0.70	0.03	0.04	0.76	0.10		0.86	0.14	1.00
(6) 2015 billion HUF				13,424	322	1,110	14,857		1,814	16,671	2,825	19,496
(7) share				0.69	0.02	0.06	0.76		0.09	0.86	0.14	1.00
(8) 2010–2015				2,675	–105	537	3,107			3,343	711	4,054
(9) 2015/2010				1.25	0.75	1.94	1.26			1.25	1.34	1.26

Continuation of Table *10*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Total company	Micro companies	Small, medium-size & large companies	Small, medium-size & large companies						Small, medium-size & large companies	Micro companies	Total company
				No change in size	Downsizing	Upsizing	Continuous operation	Exits	Entries			
	2010			between 2010 and 2015						2015		
NUMBER OF STAFF												
(10) 2010 thousand people	2,292	575	1,717	1,156	80	66	1,302	415		1,717	575	2,292
(11) share	1.00	0.25	0.75	0.50	0.03	0.03	0.57	0.18		0.75	0.25	1.00
(12) 2015 thousand people				1,255	35	145	1,435		375	1,810	585	2,395
(13) share				0.52	0.01	0.06	0.60		0.16	0.76	0.24	1.00
(14) 2015–2010				99	-45	79	133			93	10	103
(15) 2015/2010				1.09	0.44	2.21	1.10			1.05	1.02	1.05
GROSS FIXED ASSETS PORTFOLIO												
(16) 2010 billion HUF	27,738	9,178	18,560	14,349	524	1,180	16,053	2,507		18,560	9,178	27,738
(17) share	1.00	0.33	0.67	0.52	0.02	0.04	0.58	0.09		0.67	0.33	1.00
(18) 2015 billion HUF				17,847	404	1,849	20,100		3,319	23,419	9,417	32,836
(19) share				0.54	0.01	0.06	0.61		0.10	0.71	0.29	1.00
(20) 2015–2010				3,498	-120	669	4,047			4,859	239	5,098
(21) 2015/2010				1.24	0.77	1.57	1.25			1.26	1.03	1.18

Continuation of Table *10*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Total company	Micro companies	Small, medium-size & large companies	Small, medium-size & large companies						Small, medium-size & large companies	Micro companies	Total company
				No change in size	Downsizing	Upsizing	Continuous operation	Exits	Entries			
	2010			between 2010 and 2015						2015		
Work PRODUCTIVITY												
(22) 2010 million HUF/person	6.7	3.7	7.8	9.3	5.3	8.8	9.0	3.8		7.8	3.7	6.7
(23) 2015 million HUF/person				10.7	9.2	7.7	10.4		4.8	9.2	4.8	8.1
(24) 2015/2010				1.15	1.73	0.88	1.15			1.19	1.31	1.21
CaPITAL PRODUCTIVITY												
(25) 2010 million HUF/	0.55	0.230	0.718	0.749	0.815	0.486	0.732	0.629		0.718	0.230	0.557
7 million HUF (26) 2015 million HUF/ million HUF				0.752	0.797	0.601	0.739		0.547	0.712	0.300	0.594
(27) 2015/2010				1.00	0.98	1.24	1.01			0.99	1.30	1.07
DEVEloPING CONVERGenCE												
(28) 2010 million HUF/person	12.1	16.0	10.8	12.4	6.5	18.0	12.3	6.0		10.8	16.0	12.1
(29) 2015 million HUF/person				14.2	11.6	12.8	14.0		8.8	12.9	16.1	13.7
(30) 2015/2010				1.15	1.76	0.71	1.14			1.20	1.01	1.13

* Share 1: share in the population of small, medium-size and large companies.

Source: own calculation and editing on the basis of the NTCA corporate tax database.

We combined the small, medium-size and large companies, because they play extremely important roles in economic growth and in employment. Although they make up only 8 per cent of all companies [cell (2, 3)], they produce 80 per cent of the added value [average of cells (5, 3) and (7, 10)], provide 75 per cent of corporate employment [average of cells (1, 3) and (13, 10)], and tie up 70 per cent of corporate gross fixed assets [average of cells (17, 3) and (19, 10)]. These ratios correspond to the Pareto principle. The data of this company group can be seen in columns (4)-(9) of Table *10*. The Pareto ratios can be seen in the analysis of the changes in the added value, too. The micro company increment is close to 20 per cent of the total increment, so the majority of the added value increment also comes from small, medium-size and large companies. Based on that, in the analysis of changes, our attempt to concentrate our analysis primarily on the assessment of small, medium-size or large companies is justified.

In Table *11*, using the added value of 2010 we derive the added value of the small, medium-size and large company sector in 2015.

Table 11. Derivation of the 2015 added value of small, medium-size and large companies from year 2010 (billion HUF)

	Contribution to the added value increment (billion HUF)
Added value produced by the small, medium-size and large company sector in 2010 (4, 3)	13,328
Small, medium-size and large companies with unchanged size (8, 4)	2,675
Downsizing small, medium-size and large companies (8, 5)	–105
Upsizing small, medium-size and large companies (8, 6)	537
Entries into the category of small, medium-size and large companies (6, 9)	1,814
Exits from the category of small, medium-size and large companies (4, 8)	–1,578
Balance (6, 10)	16,671

Source: own calculation and editing on the basis of the NTCA corporate tax database.

It is clear from the deduction that there are problems with the contributions of upsizing companies. New entrants perform as expected, but upsizing companies do not.

In Table *11*, we consistently assigned the produced added value, the used staff number and the gross fixed assets to each company category. Based on these, we calculated work productivity (added value/ staff number), capital productivity (added value/gross fixed assets) and development (upgrading, which is = gross fixed assets / staff number).

The problem seems to be related to the enforcement of the law of returns to scale. Within the group of continuously operating small, medium-size and large companies, upsizing companies - compared to their number - significantly increase, actually double the added value, the employment, and increase the gross fixed asset value by one and a half, but that is realised with reduced productivity and deteriorating developments. As if this category of companies would have extensive growth only. Efficiency does not improve [see cell (24, 6) of Table *10*].

In the case of downsizing companies (column 5 in Table *10*), less added value is produced, employment and tied up capital decrease, but productivity and developments do not. Those who do downsizing are able to improve efficiency. As if we could not grow, only shrink efficiently. As the number of upsizing companies is higher than the number of downsizers, among continusoly working small, medium-size and large companies, the changes in sizes result in higher added value and more extensive use of production factors, but efficiency is basically unchanged, it remains at the level of 2010.

The production, production factor usage and efficiency balance of entities leaving the small, medium-size and large company category for good is slightly positive, and these movements clearly improve the absolute and efficiency indicators of the aggregate. This is also in line with the enforcement of the returns to scale. However, the behaviour of the upsizing category is not in line.

In the analysis of parts f) and g) of Figure *11*, we already mentioned that not all of the micro companies are truly micro businesses, and this phenomenon can be seen in the micro company blocks of Table *10*, too. The significant absolute and efficiency growth is especially striking in the case of foreign companies. Based on that, we wish to analyse this company group more thoroughly in the future. We assume that this company group includes a lot of quasi micro companies, which employ a low number of people, but are not truly micro companies, and primarily based on the capital tied up in the business, they should be among small and medium-size companies.

The insufficient performance of small, medium-size and large companies is partly explained if we look at column 6 in Table *10*, and break down the column of upsizers in the way indicated in Table *12*.

It is quite obvious from the breakdown in Table *12* that upsizing foreign companies achieve the expected performance, which proves the existence of the law of returns to scale. They increase added value [cell 8, 6)] while increasing their productivity, too. On the other hand, national companies increase added value [cell (8,1)] with decreasing productivity [cell 24, 1)]. That is why the expected contribution is not realised. The contribution of the 906 national companies [cell 1, 1)] to the added value increment is lower than that of the 271 foreign companies [cell 1,6)].

We summarise our analysis as follows. We examined the development of the company category from which we expect the most in boosting our growth. Sadly, we found that in upsizing national small, medium-size and large companies,

- growth is slow,
- the use of production factors increases significantly, but
- productivity goes down.

Table 12: Key indicators of small, medium-size and large companies upsizing in 2010-2015

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	National companies					Foreign companies				
	Sectors total	**Food economy**	**Proccessing economy**	**Hard services**	**Soft services**	**Sectors total**	**Food economy**	**Proccessing economy**	**Hard services**	**Soft services**
NUMBERof COMPANIES										
(1) Thousand pieces	906	26	279	373	228	271	1	123	102	45
(2) Share 1*	0.2	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
(3) Share 2**	2.8	0.1	0.9	1.1	0.7	0.8	0.0	0.4	0.3	0.1
ADDeD VAlUE										
(4) 2010 billion HUF	376	9	98	171	98	198	0.0	59	109	30
(5) Share 1*	2.4	0.1	0.6	1.1	0.6	1.3	0.0	0.4	0.7	0.2
(6) 2015 billion HUF	627	12	216	212	187	484	0.0	173	243	68
share	2.8	0.1	1.0	1.0	0.8	2.2	0.0	0.8	1.1	0.3
(8) 2015–2010	251	4	117	41	89	286	0.0	114	133	38
(9) 2015/2010	1.67	1.41	2.19	1.24	1.91	2.44	0.52	2.94	2.22	2.28
NUmBErOF StAfF										
(10) 2010 thousand people	45	2	15	18	11	20	0.0	10	7	3
(11) share	2.0	0.1	0.7	0.8	0.5	0.9	0.0	0.4	0.3	0.1
(12) 2015 thousand people	101	3	29	41	28	44	0.0	22	16	6
(13) share	4.2	0.1	1.2	1.7	1.2	1.8	0.0	0.9	0.7	0.3
(14) 2015–2010	55	1	13	24	17	24	0.0	12	9	3
(15) 2015/2010	2.22	1.73	1.87	2.35	2.58	2.19	2.38	2.13	2.28	2.15

Continuation of Table *12*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	National companies					Foreign companies				
	Sectors total	Food economy	Proccessing economy	Hard services	Soft services	Sectors total	Food economy	Proccessing economy	Hard services	Soft services
GROSS FIXED ASSETS PORTFOLIO										
(16)										24
(17)										).1
(18)										31
(19)										).1
(20)										7
(21)										.27
Wo										
(22) HU										0.0
(23) HU										0.6
(24) 2015/2010	0.75	0.81	1.17	0.53	0.74	1.12	0.22	1.38	0.97	1.06
CAPITAL PRODUCTIVITY										
(25) 2010 million HUF/ million HUF	0.392	0.345	0.980	0.237	0.878	0.891	0.291	0.460	1.563	1.227
(26) 2015 million HUF/ million HUF	0.444	0.296	0.975	0.210	1.324	1.106	0.234	0.627	1.855	2.207
(27) 2015/2010	1.13	0.86	0.99	0.89	1.51	1.24	0.80	1.36	1.19	1.80

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	National companies					Foreign companies				
	Sectors total	Food economy	Proccessing economy	Hard services	Soft services	Sectors total	Food economy	Proccessing economy	Hard services	Soft services
DEVELOPING CONVERGENCE										
(28) 2010 million HUF/person	21.1	16.4	6.5	41.0	10.3	11.0	10.6	12.5	10.0	8.1
(29) 2015 million HUF/person	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8
(30) 2015/2010	0.66	0.95	1.18	0.59	0.49	0.90	0.27	1.01	0.82	0.59

* Share 1: share in the whole population of companies. ** Share 2: share among small, medium-size and large companies.

Source: own calculation and editing on the basis of the NTCA corporate tax database.

All in all, the upsizing process is slower for national companies, and has less yields from the aspect of economic results. Most of the transitions - at least in the short term - are similar to a case when a football team of League II would like to play in the same way in League I as in League II, and not more efficiently. This implies serious obstacles in the process of changing categories, and the elimination of that is a very important institution development task. The slow development of the population of national companies is a very tough development indicator. If there is no breakthrough here, convergence remains an impossible dream.

Its importance can be seen clearly if we break down the total added value increment to national and foreign companies (Table *13*). This clearly demonstrates that in the examined period 60 per cent of the growth in the small, medium-size and large company categories was provided by foreign companies. This reduced the share of national companies in the production of added value. The share of small. medium-size and large companies in the increment is more favourable, therefore their share in the production of added value dropped by 4 per cent only.

Table 13. Breakdown of added value increment according to company ownership types
Added value

	(billion HUF)			Added value (percentage)		
	national	foreign	total	national	foreign	total
2010						
COMPANIES IN TOTAL						
Total	9,418	6,025	15,443	61	39	100
Food economy	194	134	328	59	41	100
Processing industry	2,292	2,237	4,530	51	49	100
Hard services	3,902	1,530	5,432	72	28	100
Soft services	3,030	2,124	5,153	59	41	100
MICROCOMPANIES						
Total	1,558	556	2,114	74	26	100
Food economy	25	104	128	19	81	100
Processing industry	146	5	151	97	3	100
Hard services	693	216	909	76	24	100
Soft services	695	232	926	75	25	100
SMALL, MEDIUM-SIZE AND LARGECOMPANY SECTOR						
Total	7,859	5,469	13,328	59	41	100
Food economy	169	30	200	85	15	100
Processing industry	2,146	2,233	4,379	49	51	100
Hard services	3,209	1,314	4,523	71	29	100
Soft services	2,335	1,892	4,227	55	45	100

	Added value (billion HUF)			Added value (percentage)		
	national	foreign	total	national	foreign	total
Increments between 2010 and 2015						
COMPANIES INTOTAL						
Total	2,028	2,025	4,053	50	50	100
Food economy	67	-98	-31	-215	315	100
Processing industry	688	1,272	1,960	35	65	100
Hard services	818	800	1,618	51	49	100
Soft services	455	51	507	90	10	100
MICROCOMPANIES' CONTRIBUTIONSTO THE ADDED VALUE-INCREMENT						
Total	686	25	710	97	3	100
Food economy	15	-102	-87	-17	117	100
Processing industry	50	8	58	85	15	100
Hard services	384	-53	331	116	-16	100
Soft services	237	171	409	58	42	100
SMALL, MEDIUM-SIZE AND LARGECOMPANIES' CONTRIBUTIONSTO THE ADDED VALUE-INCREMEENT						
Total	1,343	2,000	3,343	40	60	100
Food economy	52	4	56	93	7	100
Processing industry	638	1,263	1,901	34	66	100
Hard services	435	853	1,288	34	66	100
Soft services	218	-120	98	222	-122	100
2015						
COMPANIES IN TOTAL						
Total	11,446	8,050	19,496	59	41	100
Food economy	261	36	297	88	12	100
Processing industry	2,980	3,509	6,489	46	54	100
Hard services	4,720	2,330	7,050	67	33	100
Soft services	3,485	2,175	5,660	62	38	100
MICROCOMPANIES						
Total	2,244	581	2,825	79	21	100
Food economy	39	2	41	96	4	100
Processing industry	196	13	209	94	6	100
Hard services	1,076	163	1,239	87	13	100
Soft services	932	403	1,335	70	30	100

	Added value (billion HUF)			Added value (percentage)		
	national	foreign	total	national	foreign	total
SMALL, MEDIUM-SIZE AND LARGECOMPANY SECTOR						
Total	9,202	7,469	16,671	55	45	100
Food economy	222	34	256	87	13	100
Processing industry	2,784	3,496	6,280	44	56	100
Hard services	3,644	2,167	5,811	63	37	100
Soft services	2,553	1,772	4,325	59	41	100

Source: own calculation and editing on the basis of the NTCA corporate tax database.

It is striking, however, that in the increment of the examined period, the foreign dominance was spotted mainly in the processing industry. In addition, they played important roles in the hard services of the small, medium-size and large company categories, but not in other areas. We can say that in this field the national companies have the initiative. This is in line with steps suggested in the macro analysis.

2.6. Summary

Hungary's growth has always included periods that were characterised by outstanding growth rates and higher levels of employment. However, these were never really permanent, and often ended with crisis periods that caused declines in the long-term convergence of the country. Our study examined whether Hungary has really eliminated the bottlenecks that may slow down the crisis.

Unfortunately, these bottlenecks still exist. The Hungarian economy is primarily dominated by the so-called dependent market economy (DME) or a production structure driven by foreign working capital investments KMTV), which is able to achieve spectacular results (last time in 1996-2006), but it immediately turns into a decline that affects everything in the long run if the favourable world economy conditions of growth cease to exist. In our opinion, the reason for that is that in the lack of intensive internal developments, our development rides the waves of outsourcing activities, which will reduce both the growth rate and the primary employment in the long run, because of the low added value content.

If the Visegrád countries, including Hungary, give up all their independent development activities, they will be forced into an exclusively accepting position, which leads to the conservation of backwardness, and makes convergence impossible. The DME or the KMTV model, in which the Visegrád countries operate, was not created for the purposes of convergence. This model provides only the chances of convergence. The system was set up for the more efficient operation of the multinational capital, and it is really advantageous only for those who work more efficiently in that.

The Eastern European model established this way could be made more efficient with an accumulation process combined with development (upgrading), by which we mean the evolution of significant and independent national development activities. Where to unfold this development? Primarily where higher added value content can be achieved. In the

–processing industry, by developing and launching activities with higher added value content (for example in the pharmaceutical industry, in the production of high-tech products and robots), by supporting stronger integration into multinational supplier chains, and in gaps opening up for activities satisfying special demands (niches).

–Service sectors offer further possibilities, where the added value content is higher anyway

According to our international comparisons, this is the direction of changes in the production structure in developed countries, and this unfolds double contents:

–products of the food economy and the industry are offered more and more in one service bed,

–increased weight of knowledge work: the productivity of the food economy and the processing industry may improve significantly on the basis of the knowledge contents obtained from services, and within that from soft services in particular. This significant increase in productivity makes the traditional sectors of the economy driven back.

To make such a change effective, developments have to be started in a wide scope and at multiple levels. Here all the players of the society have responsibilities in all sectors of the economy. It is not enough to expect changes from the state or the companies only.

Public finances is one of the most significant sectors of the economy. The development status of its areas basically determines the performance of companies. Their develoment is of key importance, as there is no convergence without them.

At the same time, public finances operate an institution system, too, which determines the framework of the operation of companies. The development of that is also a primary objective. In 2010-2015, in the added value of key small, medium-size and large companies, 60 per cent of the growth was provided by foreign companies, and the share of national companies in the production of the GDP dropped by 4 per cent in this category of companies. This ratio should be modified by a renewed institution system. This institution system should make sure that the presently extensive growth - which is achieved with decreasing productivity - becomes efficient and capable of stabilising internal growth, largely on the basis of hard and soft services.

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3. Article 2. Productivity and profitability

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Boda György – Fülöp Zoltán – Révész Tamás – Thék Regina

3.1. Abstract

Hungary is an economy exposed to the advantages and disadvantages of an important regional integration, the German Central European supply chain, while its internal development is also fraught with regional tensions. Instead of gross foreign trade analyses, we can correctly see our position in this integration by focusing only on value-added production, which requires the use of international input-output models and a Hungarian territorial input-output model. This makes it clear that our higher volume production and higher productivity do not always go hand in hand with higher profitability, which devalues our national performance and slows down the convergence. The main way to address tensions remains: to increase productivity, but not at the cost of significantly reducing value-added content.

Keywords: productivity, value-added content, structural revaluation

3.2. Introduction

Even among the lucky ones, only the better ones are not left behind. With luck, you can get ahead, but only the prepared can really take advantage of the opportunity.

Hungary's economic development after the change in the political system cannot be deduced from the actions of domestic actors alone. Hungary's development is due in large part to favourable global economic developments. However, it would be good to see more precisely how much of a role we played in this. To do this, we need to map out as thoroughly as possible how our economy is interlinked with other economies.

Our country was integrated into this interconnection not as a single economic unit, but as a rather regionally fragmented economy. The positive and negative effects of the development of the world economy affect the different regions of Hungary in various ways. We also need to know where this causes problems and where it does not.

One of the most peculiar features of international development, which also affects Hungary to a considerable extent, is that the returns from development and its dissemination have become disconnected from the implemented production processes. The returns to the latter have increased only marginally even in the case of significant productivity gains, and more precisely, have not necessarily been harvested by the national manufacturers. Knowledge of this phenomenon is key to making the right national strategy decisions.

Both analyses require a regional approach. There are parts of the world economy, countries, and groups of countries, to which we are much more closely linked than to others, and this link is more strongly felt in some domestic regions than in others. This dual regionality raises several questions that can only be analysed to a limited extent on the basis of the available statistics. This is why economists and statisticians specialising in measurement are constantly striving to improve the statistical tools available. Two of these are of particular importance to us. The first is the development of the international input-output tables (IOTs), the so-called WIOT[19] tables. The other is our own development of a territorial version of the Hungarian 2020 IOT.

In this paper, we analyse the results of Hungary's development after the transition of political system on the basis of these new methodological possibilities, in addition to the traditional statistical tools. They provide a clearer, more transparent picture of how we have integrated into the world economy and of the areas of the Hungarian economy whose more rapid development could improve our position in this common international and national integration.

The structure of the study:

1. we first take account of the aspects that require the consideration and development of additional analytical options to the traditional ones,

2. we describe the developments that aim at creating analytical possibilities for these aspects,

3. present a methodology that can be used with their help, and finally

[19] WIOT:World Input-Output Table

4. on this basis, we will try to point out the sensitive issue of Hungary's integration into the world economy, namely that if we outsource development, the increase in domestic labour productivity will not sufficiently improve profitability.

3.3. Difficulties and opportunities in monitoring regional integration

Hungary's development cannot be explained without analysing the development of globalization and within it the so-called German-Eastern European integration (hereafter: GEE integration). This term is taken from relevant Austrian and IMF (International Monetary Fund) studies, which were sourced from Stehrer-Stöllinger (2013) and IMF (2013). These studies were the first to describe the emergence, specificities, and evolution of this integration in an adequate manner, providing not only an economic analysis of the process but also summarising the methodological basis for its quantification, based to a large extent on the input-output technique.

In the 1990s, the German economy significantly expanded its activities towards neighbouring countries. The main directions of German expansion were Switzerland, Austria, Slovenia, and the V4 countries. The majority of the states involved in German economic expansion joined the European Union, further strengthening the emerging integration of the GEE[20].

In parallel with German expansion, globalization has also been reflected in other integration efforts. Of these, the rise of the United States, other European Union countries, and not least China was notable, but it was the GEE integration that had the greatest impact on the development of the Hungarian economy.

The significance and magnitude of this integration process are not clear from traditional statistical observations. The problem lies on the one hand in the widening of production linkages and, as a consequence, in the 'bloating' and grossing-up of export-import relations. If we want to see clearly the role of these relationships in the development of our country, we need to describe the development of production cooperation, to net the trade flows, and in order to do this we need to rely on the latest development of input-output techniques, the so-called WIOT input-output tables, and we need to develop a

[20] With this integration, Germany's long-term foreign policy ambitions have largely been realised. True, not by military means, but by peaceful means.

territorial IOT[21] for Hungary. A good summary of this work is given in Timmer et al. (2012) and Appendix 1.

Why is the observation of integration processes distorted by the traditional statistical approach? What is this "bloat"? To get a better sense of the problem, let us consider the example of the automotive industry (see Figure *12*).

Figure 12: Difference between trade balances in gross and net external trade

Gross foreign trade

	DEU			HUN			FRA		
	E	I	I-E	E	I	I-E	E	I	I-E
DEU				50	0	-50	0	0	0
HUN	0	50	50				55	0	-55
FRA	0	0	0	0	55	55			

Trade balance on gross turnover basis (I-E)

	DEU	HUN	FRA
DEU		-50	0
HUN	50		-55
FRA	0	55	

Net foreign trade

	DEU			HUN			FRA		
	E	I	I-E	E	I	I-E	E	I	I-E
DEU				0	0	0	50	0	-50
HUN	0	0	0				5	0	-5
FRA	0	55	55	0	5	5			

Trade balance on net turnover basis (I-E)

	DEU	HUN	FRA
DEU		0	-50
HUN	0		-5
FRA	55	5	

Source: own editing based on Stehrer-Stöllinger (2013)

Suppose that Germany supplies Hungary with 50,000 units of automotive products for further processing, which Hungary assembles and then sells to France as 55,000 units. If we look at the production relations of the three countries in terms of gross turnover, there is no production relation between Germany and France, a strong production relation between Germany and Hungary, and a stronger production relation between Hungary and

[21] Since the Central Statistical Office (CSO) has not yet developed such a IOT, we had to do the task ourselves. This is described in detail in the methodological description in Appendix 2.

France than between Hungary and Germany. This can be seen in the gross external trade-related tables in Figure *12*.

Net trade is a measure of how value-added flows between countries. In the example, in fact, 50 thousand units of value-added flow from Germany to France, while 5 thousand units flow from Hungary to France, but there is no link between Hungary and Germany. This can be seen in the net external trade tables in Figure *12*. The production links in this extreme example, therefore, show a different picture based on gross flows than on net flows. Obviously, the real picture includes the net account, not just the gross. It is essential that the combined trade balances of the three-country system are the same in the gross and net accounts.

The example is important because it shows that the benefits from trade depend not on gross flows but on the value-added content that changes hands in them. It is therefore not sufficient to observe only foreign trade flows because of the expansion of production cooperatives. It is necessary to observe foreign trade, production, and the new value generated in production together. This requires the application of an accounting technique that accounts for production and foreign trade in a common system of value added[22].

The example analysed in Figure *12* already points to the solution. To net, the value-added content of exports and imports must be calculated. However, the value-added content is not only interesting for the analysis of trade relations. As it is the basis of GDP, it is a basic indicator of economic growth and is very important in its own right.

We want to capture the profitability highlighted in the title of this paper by means of value added. Its content is sectoral outputs minus external sectoral uses. Since external uses are the outputs of others, after deducting them we arrive at the sector's own net output, which is a major source of its income[23].

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[22] The problem has also been noticed by Hungarian researchers. For example, we quote Andrea Szalavetz: "Trade statistics, which record the gross value of industry and goods crossing borders from a product perspective, thus give a rather misleading picture of where and how much value is produced in the world economy, i.e. how much value is added at a given place in a given production phase compared to the previous phase, and how the resulting incomes are distributed." (Szalavetz, 2019, p. 33) "...international trade involves not products, nor even corporate functions, but tasks and activities, and it is most useful to account for these on a value-added basis." (Szalavetz, 2019, p. 45)

[23] For our calculation, we relied on the established practice of GDP balances in the SNA, which was operationalised by the Hungarian Central Statistical Office in the so-called GNI document (KSH, 2011). For all the IOTs used in our calculations, it is true that GDP equals the sum of the value added generated by the sectors and the balance of taxes and subsidies on products accounted for in the sectors' output and final

International integration is not just a mechanical interconnection of countries; it is essentially the creation of international supply chains that transcend countries. It is therefore essential to ask where value is created within a supply chain and how it is distributed between the different points of creation. For example, it is important to show how much value added is generated in Germany, Hungary, and other supply chain actors in the production of final products for the German automotive industry. This is as important as the question of the proportions of foreign trade.

The weight of the GEE integration was perceived by the Hungarian economists as mostly German predominance. Several studies, using input-output methods, have indicated that the German economy is the main driver of the Hungarian economy, and the majority of our market relations are directed towards it (Braun-Sebestyén, 2019; Braun, 2020; Braun-Kiss-Sebestyén, 2020). These studies mainly analysed the risks of dependency. However, in recent years there has also been a renewed interest in the profitability of the relationship.

In Hungarian economic thinking, there is a growing recognition that one of the biggest growth problems of the Hungarian economy is the so-called medium income trap, which in our understanding means that manufacturing activities with a high weight and productivity in production have a persistently low profitability compared to other sectors.

In the international literature, the theoretical groundwork of Gereffi et al. (2005), Wallerstein (2010), Baldwin (2016), Glawe–Wagner (2018), and the practical analytical work of Linden et al. (2009), Ali-Yrkkö et al. (2011), Antras–Chor (2013), Meng et al. (2019), Rungi–Del Prete (2020), Mudambi (2019), Stöllinger (2019) and Kordalska–Olczyk (2022) should be mentioned. In the domestic literature, we have mainly relied on the work of Andrea Szalavetz (Szalavetz, 2004, 2011, 2013, 2020). Other important studies on the topic have been published by Csath (2019, 2021).

This is a major problem not only for international but also for our internal regional relations. Our own activities are concentrated in the manufacturing sector, but this is where we have the lowest profitability. There is a lot of talk about this in the industry, but

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consumption. Thus, the value added generated by sectors is about 10-15% lower than GDP, but it is still the value added generated that is the most important source of income generation, whether we are looking at the origin of labour income or profit.

the reliable quantitative description is not yet complete. The analysis of value-added content is therefore also very important.

To be clear on the issues listed, it is necessary to calculate:

1. the breakdown of trade activity into productive and final trade,
2. the value-added contents of external and internal exports and imports,
3. the distribution of income generated in global supply chains, and
4. the productivity of income-producing activities.

The paper first summarises the methodology used, then presents the input-output tables developed for the analysis and the economic results of the calculations. Some methodological details and partial results of the calculations are given in the appendices.

3.4. What is the value added of exports, imports, and domestic production?

The task is to calculate a different kind of external trade balance[24], which shows how much value added a country or region transfers in its exports to others and how much value added it receives in its imports. As we have seen in our previous example, this can be quite different from the characteristics of gross external trade. The difference is particularly large when a country or a region adds little value to the previous work processes it receives in imports. For this reason, the value added that exchanged in foreign trade is essentially dependent on the value-added content of domestic production. The difference between gross and net external trade balances can thus be used to infer the development of production cooperation and the relationship between subordinate and superior positions of these cooperations.

The solution requires an input-output technique that accounts for production, foreign trade, and employment in a system of equations that also reflects regional aspects. The core of the system is based on the well-known accounting equations[25]:

$$\mathbf{x} = \underset{\cdot}{\mathbf{B}}\mathbf{x} + \mathbf{y} = (\mathbf{E} - \underset{\cdot}{\mathbf{B}})^{-1}\,\mathbf{y} = \mathbf{Q}\mathbf{y}$$

$$\mathbf{x}' = \mathbf{1}'\mathbf{B} + \mathbf{h}'$$

These two equations link production, external trade[26], and value added in a consistent system. They allow the general formula for value-added calculations to be carried out:

$$\mathbf{H} = \langle \underset{\cdot}{\mathbf{h}} \rangle \mathbf{Q} \langle \mathbf{y} \rangle$$

where **H** is the matrix of the final accounts of value-added, summing up the value-added content of both direct and indirect production. The best, most concise, and comprehensive description of the calculation of the total content is still provided by Augustinovics (1968). A similar interpretative book has been published by Koppány (2017).

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[24] Which, however, equals the traditional trade balance to the penny.

[25] In this equation, Ḅ is calculated from the inner square of the used IOT denoted by B using the formula B = <x>-1, where <x> denotes a diagonal matrix with the vector x on its diagonal. Similarly, the value added averages are calculated from the value added vector h with the formula ḥ = h<x>-1.

[26] The issue of managing external trade is discussed in more detail later. It is important to know that an IOT can always be specifically identified with a foreign trade management (type A or B, etc.). This will be defined in more detail later.

The sum of the columns of the matrix **H**, **H1**, shows which sectors produce the value added. And the sum of its rows, **- 1'H -** ,accounts for which final use the value added is actually generated by, or for which final use the value added is generated. The elements of **ḥ** contain the value-added averages per unit of output as row vectors (these ratios are called value-added indicators in the paper). **Q** is the Leontief inverse of the used IOT and **y** is the column vector describing the economic category whose value-added content we want to calculate. The interpretation of the Leontief inverse is also commonly used. In general, the element qij represents the total production or total output from the ith sector to one unit of final consumption of the jth sector. This is a multisectoral version of the Keynes multiplier, whose multiplication by the vector y tells us how much sectoral output (**Qy**) is needed to produce a given y final consumption. Multiplying this by the unit output **ḥ** required per unit of output gives the value added of the system (**ḥQy**)[27].

The traditional IOT, which has made significant progress in linking external trade and production statistics, is not sufficient to meet the challenge of solving this task. While it can tell us, for example, which automotive and other domestic and imported products are included in the total output of the automotive industry, it does not show how these products are used abroad. Are they used for final consumption or are they used in the production process? We also don't know which country the imports come from. But the point of production integration is precisely that foreign trade flows provide products not only for final use, i.e. consumption and accumulation, but also for production use in other sectors, i.e. for production purposes. This is a very positive process that increases overall productivity because it creates the possibility of a wider division of labour and of more detailed specialisation. The WIOT tables - the international IOTs - have been developed to illustrate this very point (see Figure *13*).

[27] Given that these connections are described in all input-output studies and textbooks, here we have only attempted to summarise the content of the procedure.

Figure 13: Scheme of international input-output tables

		Country 1 Sectors as users	Country 2 Sectors as users	…	Country n. Sectors as users	Country 1 Final use	Country 2 Final use	Country n. Final use	Output
Country 1	Sectors as outputs	**B11**	BE12 BI12		BE1 BI1n	**Y11**	YE12 YI12	YE1n YI1n	**x1**
Country 1	Sectors as outputs	BE2 BI21	**B22**		BE2n BI2n	YE2 YI21	**Y22**	YE2n YI2n	**x2**
	…								
Country n.	Sectors as outputs	BEn1 BIn1	BEn2 BIn2		**Bnn**	YEn1 YIn1	YEn YIn2	**Ynn**	**xn**
Balance of taxes and subsidies on products		p1	p2		pn	pY1	pY2	pYn	p
Value added by component		H1	H2		Hn				
Total emissions and consumption		x1	x2		Xn	vY1	vY2	vYn	

Interpretation:

Bii	The i-th country's productive use of its own outputs.	pj	Balance of taxes and subsidies on products in country j in countrv i
Yii	The i-th country's final use of its own outputs.	Hj	Value added generated in country j
BEij	Producer consumption of country j from exports of country i.	xj	Total outputs in country j
BIij	Productive imports of country j from country i.	mYj	Direct final consumption of imported materials in country j.
YEij	Final consumption of country j from exports of country i.	mYj	Balance of taxes and subsidies on products at final destination
YIij	Final imports of country j from country i.	vYj	Total final consumption for final use in country j
BEij = BIij, and YEij = YIij, as these are flows that represent exports in the output of		m, p	Total category

Source: own edit Timer et al. (2015)

The national input-output tables (IOTs) have been integrated so that the final consumption columns contain only products that are actually final consumption, and the production consumptions are allocated to the relevant sector in the relevant country in question in a detectable way. This allows us to measure the extent to which production integration is increasing across countries and sectors.

What can be seen in the WIOT tables?

- The internal production links of each country, i.e. the output needed by a country's firms for their own production. This is described by the **B** matrices (which are otherwise identical to the internal quadrants of the national IOTs).

- The final uses produced by each country itself, described by the **Y** blocks (identical to the right-hand quadrant of the national input-output tables without exports).

- Total outputs, which are contained in the x vectors. These are equal to the total output of the national IOTs.

- Also identical are the import uses, product tax, and subsidy counts and lower quadrants of the international input-output tables with the **m, p, H** vectors and matrices of the national input-output tables. These describe the value added produced in each country.

The difference is in the elaboration of the export. International IOTs break down the export vectors of traditional IOTs into countries and sectors. Exports for pure final consumption and accumulation remain in the right-hand quadrant but are allocated to countries (see blocks **Y** marked with E or I upper indexes), while exports for production are included in the internal quadrant, where they are allocated not only to countries but also to sectors (see blocks **B** marked with E or I upper indexes). The reason for the dual notation is that what is an export (E) for one country is an import (I) for another. The foreign trade turnover that forms the basis of production cooperation is the one that is additionally included in the internal quadrant.

The international IOTs according to the scheme in Figure *13* are taken as the results of the Timmer and Dietzenbacher international IOT compilation venture and the so-called FIGARO project (Full International and Global Accounts for Research in input-Output analysis). Their source is described in Appendix 1. In the course of these works, the authors have developed an international IOT for each year between 2000 and 2019. For a better overview, we have selected three years, 2000, 2014, and 2019. The Timmer-Dietzenbacher series has been prepared for the period 2000-2014. The FIGARO series covers the period 2014-2019. As the results of the two works cannot be compared on a one-to-one basis due to methodological and content differences and the different currency units, indexes were calculated only between the 2014 and the 2000 Dietzenbacher IOTs (2014 D/2000 D) and between the 2019 and the 2014 FIGARO IOTs (2019 F/2014 F).

The Hungarian territorial IOT allows for a similar analysis between Hungarian regions and Hungarian sectors (see Figure *14*). Here, the role of countries is taken over by regions.

- Here, the **B** matrixes describe the internal production linkages of each region by sector. They represent the deliveries of firms in a given region to the production purposes of that region.

- The own final uses of each region are given by the Y blocks.

- Vectors **z** describe the exports of each region that go abroad rather than to other regions.

- The **m** vectors capture imports into the region. In this way, the territorial IOT distinguishes between trade with the rest of the world and trade between regions.

- Here again, the total output of each region is represented by the **x** vectors.

- The corresponding vectors and matrices in the bottom panel describe the imports, taxes, and subsidies on products consumed by each region and the value added generated.

In Hungary, the CSO does not produce regional IOTs. The gap has to be filled by the experts themselves. In Appendix 2, we summarise the most important work known by us in this field and describe the estimation methodology we have used to prepare our own regional IOT for 2020. We also describe a number of other features of our territorial IOT.

Figure 14: Scheme of the Hungarian input-output table

		Region 1	Region 2		Region n	Region 1		Region 2			Region n.		Output
		Sectors as users	Sectors as users	…	Sectors as users	Fina use	External export	Fina use	External export	…	Fina use	External export	
Region 1	Sectors as outputs	**B11**	BE12 BI12		BE1n BI1n	**Y11**	z11	YE12 YI12	z12		YE1n YI1n	z1n	x1
Region 2	Sectors as outputs	BE21 BI21	**B22**		BE2n BI2n	YE21 YI21	z21	**Y22**	z22		YE2n YI2n	z2n	x2
	…												
Region n	Sectors as outputs	BEn1 BIn1	BEn2 BIn2		**Bnn**	YEn1 YIn1	zn1	YEn2 YIn2	zn2		**Ynn**	znn	xn
Use of imports		m1	m2		mn	mY1	mZ1	mY2	mZ2		mYn	mZn	m
Balance of taxes and subsidies on …		p1	p2		pn	pY1	PZ1	pY2	pZ2		pYn	pZn	p
Value added by components		H1	H2		Hn								
Total outputs and consumptions		x1	x2		Xn	vY1	vZ1	vY2	vZ2		vYn	vZn	

Interpretation: zij Exports and re-exports of each region abroad
mij The impot of each region from abroad

Source: own development

In this form, the IOTs provide the right data content for analysing external trade flows, production, and value-added. However, we would like to examine all this together with productivity developments. Therefore, as a complement to these IOTs, we have added an employment vector to allow the calculation of productivity. Productivity is defined as the value of output generated per person. The development of the employment vectors is summarised in Appendix 4.

The vectors **ḥ**, **Q**, and **y** and matrices needed to calculate the value-added content can be derived from the presented IOTs. The general formula for the calculations:

$$\mathbf{H}^{ij} = \mathbf{ḥ}^{i}\mathbf{Q}\mathbf{y}^{j} \qquad /4/$$

In the international IOTs $\underset{\cdot}{\mathbf{h}}^{\mathbf{i}}$ contains the value-added coefficients of a country or a country's sectors. The final consumption of a country or a country's sectors is contained by $\mathbf{y}^{\mathbf{j}}$. If the two vectors are specified precisely, the economic interpretation of the value-added calculations can be defined.

To make our calculations more transparent, we are using Stehrer's (2012) very illustrative 3×3 example of three countries' relations to show our key steps[28]:

$$\begin{vmatrix} x^1 \\ x^2 \\ x^3 \end{vmatrix} = \begin{vmatrix} \underset{\cdot}{B}^{11} & \underset{\cdot}{B}^{12} & \underset{\cdot}{B}^{13} \\ \underset{\cdot}{B}^{21} & \underset{\cdot}{B}^{22} & \underset{\cdot}{B}^{23} \\ \underset{\cdot}{B}^{31} & \underset{\cdot}{B}^{32} & \underset{\cdot}{B}^{33} \end{vmatrix} \begin{vmatrix} x^1 \\ x^2 \\ x^3 \end{vmatrix} + \begin{vmatrix} y^1 \\ y^2 \\ y^3 \end{vmatrix} = \begin{vmatrix} Q^{11} & Q^{12} & Q^{13} \\ Q^{21} & Q^{22} & Q^{23} \\ Q^{31} & Q^{32} & Q^{33} \end{vmatrix} \left(\begin{matrix} y^{11} \\ y^{21} \\ y^{31} \end{matrix} + \begin{matrix} y^{12} \\ y^{22} \\ y^{32} \end{matrix} + \begin{matrix} y^{13} \\ y^{23} \\ y^{33} \end{matrix} \right) \qquad /5/$$

The $\underset{\cdot}{\mathbf{B}}^{\mathrm{ij}}$ matrixes are computed from either the international or the Hungarian territorial IOT $\mathbf{B}_{\mathrm{ij}}$ blocks by dividing them by the corresponding production data[29].

Example 5 provides a general element of the value-added calculations:

$$H^{12} = \begin{vmatrix} \underset{\cdot}{h}^1 & 0 & 0 \end{vmatrix} \begin{vmatrix} Q^{11} & Q^{12} & Q^{13} \\ Q^{21} & Q^{22} & Q^{23} \\ Q^{31} & Q^{32} & Q^{33} \end{vmatrix} \left(\begin{matrix} 0 \\ 0 \\ 0 \end{matrix} + \begin{matrix} y^{12} \\ y^{22} \\ y^{32} \end{matrix} + \begin{matrix} 0 \\ 0 \\ 0 \end{matrix} \right) \qquad /6/$$

The $\underset{\cdot}{\mathbf{h}}$ data are obtained by normalising the international or Hungarian territorial IOT 1'H data to production [30].

Formula 6 derives the value-added components of a country from the international IOT, as well as the final consumption that went from each of the three countries to the final consumption of the two countries[31]. The result of the multiplication is the value added

[28] Interpreting each block:
- $\mathbf{x}^{\mathrm{i}}$ is the total output (production) of the i-th country or region.
- $\mathbf{B}^{\mathrm{ij}}$ is the total final consumption of the jth country or region from the ith country or region. $\mathbf{y}^{\mathrm{i}}$ is the total final consumption of the ith country or region by sector.
- $\mathbf{Q}^{\mathrm{ij}}$ is the corresponding block of the Leontief inverse. Describes the production (total output) required for the sectoral final consumption of the jth country from the sectors of the ith country, broken down by sector.

[29] $\underset{\cdot}{\mathbf{B}}^{\mathrm{ij}} = \mathbf{B}\mathrm{ij}<\mathbf{x}\mathrm{j}>^{-1}$

[30] $\underset{\cdot}{\mathbf{h}}' = \mathbf{1}'\mathbf{H}\mathrm{j}<\mathbf{x}\mathrm{j}>^{-1}$

[31] In what follows, the interpretation is given for countries only. By implication, what is said about countries also applies to regions.

exported by country 1 to the final consumption of country 2. This can be seen by performing the steps in equation 6:

$$H^{12} = \begin{vmatrix} \underset{.}{h}^1 & 0 & 0 \end{vmatrix} \begin{vmatrix} Q^{11}y^{12} & + & Q^{12}y^{22} & + & Q^{13}y^{32} \\ Q^{21}y^{12} & + & Q^{22}y^{22} & + & Q^{23y32} \\ Q^{31}y^{12} & + & Q^{32}y^{22} & + & Q^{33}y^{32} \end{vmatrix}$$

$$H^{12} = \underset{.}{h}^1Q^{11}y^{12} + \underset{.}{h}^1Q^{12}y^{22} + \underset{.}{h}^1Q^{13}y^{32} \qquad /7/$$

From the result of equation 7, we can understand that country 1 exports value added to country 2 through three channels of production linkages. Through its own production linkages to final consumption supplied by itself ($\mathbf{\underset{.}{h}}^1\mathbf{Q}^{11}\mathbf{y}^{12}$) and through the production linkages of the other two countries to final consumption supplied by the other two countries ($\mathbf{\underset{.}{h}}^1\mathbf{Q}^{12}\mathbf{y}^{22}$; $\mathbf{\underset{.}{h}}^1\mathbf{Q}^{13}\mathbf{y}^{32}$). The expansion of production cooperation thus implies that countries are in export-import linkages even if they do not have direct export-import linkages. H^{12} takes on a value even if y^{12} is possibly zero.

If all possible combinations of $\mathbf{\underset{.}{h}Qy}$ are calculated according to equation 6, the value added produced by the three countries together is divided:

$HÉ^{11} = \underset{.}{h}^1Qy^1$	The value added content of country 1's own final consumption of its output.
$HÉ^{12} = \underset{.}{h}^1Qy^2$	The content of value added exported by country 1 to the final consumption of country 2.
$HÉ^{13} = \underset{.}{h}^1Qy^3$	Value added content of country 1 exported to final consumption of country 3.
$HÉ^{21} = \underset{.}{h}^2Qy^1$	Value added content of country 2 exported to the final consumption of country 1.
$HÉ^{22} = \underset{.}{h}^2Qy^2$	The value added content of country 2's own final consumption of its output.
$HÉ^{23} = \underset{.}{h}^2Qy^3$	Value added content of country 2 exported to final consumption of country 3.
$HÉ^{31} = \underset{.}{h}^3Qy^1$	Value added content of country 3 exported to final consumption of country 1.
$HÉ^{32} = \underset{.}{h}^3Qy^2$	Value added content of country 3 exported to the final consumption of country 2.
$HÉ^{33} = \underset{.}{h}^3Qy^3$	The value added content of country 3's own final consumption of its output.
HÉ	Value added jointly produced by country 3

The combined value added of the three countries can be arranged into a matrix (Figure *15*). In the matrix, only the formulas for calculating the primary items are given.

Figure 15: Breakdown of value added for internal use and external trade flows

		For own use	Import			Total
			Country 1	Country 2	Country 3	
Country 1	Own	$\underset{\cdot}{h}^{1}Qy^{1}$				
	Exports by country			$\underset{\cdot}{h}^{1}Qy^{2}$		
					$\underset{\cdot}{h}^{1}Qy^{3}$	
	Total exports					
Country 2	Own	$\underset{\cdot}{h}^{2}Qy^{2}$				
	Exports by country		$\underset{\cdot}{h}^{2}Qy^{1}$			
					$\underset{\cdot}{h}^{2}Qy^{3}$	
	Total exports					
Country 3	Own	$\underset{\cdot}{h}^{3}Qy^{3}$				
	Exports by country		$\underset{\cdot}{h}^{3}Qy^{1}$			
				$\underset{\cdot}{h}^{3}Qy^{2}$		
	Total exports					
Total						AV

Source: own development

Based on the results of the derivation and the comparison of Figure *12* and Figure *13*, it can be seen that the same content calculation methodology can be applied to the Hungarian regional IOT. Countries are equivalent to regions and, like countries, regions have their own value-added and regional trade in which value-added contents are exchanged.

These calculations give a more realistic view of a country's importance in international trade or the role a region plays in a country's internal trade relations. The value-added content indicates that the importance of countries or regions with a lower value-added content of the work supplied is more likely to be reduced in a given trade flow relation.

3.5. Trends in productivity and profitability in the world economy and in Hungary

Hungary's development after the transition has been boosted significantly by the opportunity to join the GEE integration[32] supply chains as a key partner. This integration, together with the Pacific integrations, is one of the most successful foreign trade integrations in the world (Landesmann-Stöllinger, 2019)[33]. Hungary benefited well in these successes. It has been given an opportunity and has been able to take advantage of it (Table *14*). In addition to the GEE integration, it has also managed to build significant integration links with other trading partners, notably other countries of the European Union, the US, and China. However, this opportunity came at a price. This should be mentioned alongside the results[34].

World export growth was very rapid, especially between 2000 and 2014. After 2014, growth slowed but continued[35]. Hungary and the Visegrad countries were able to increase their weight in this growth. This is a major achievement at a time when China's spectacular growth has rearranged the shares. Indeed, China's exports have grown from 4% in 2000 to 15% in 2019, and this has pulled back the shares of the previously leading exporters. The export shares of Germany, the US, and the developed countries have fallen, while those of the GEE integration and the V4 have increased.

[32] Its members, in order of GDP per capita, are Germany (DEU), Switzerland (CHE), Austria (AUT), Slovenia (SVN), the Czech Republic (CZE), Slovakia (SVK), Poland (POL) and Hungary (HUN).
[33] The data in *Table 14* show that the GEE integration has been able to increase its share of world exports, while the other EU countries, the US, and the developed countries have not.
[34] The selection of countries and country groupings was made with the interests of our analysis in mind, one of the main objectives of which is to better understand our situation within the GEE integration.
[35] In *Table 14*, the growth should only be viewed between columns marked D or F. WIOT tables D are in dollars and F in euros.

Table 14: Export turnover of the world and Hungary in 2000-2019 based on WIOT tables

		World export structure by country				Structure of world manufacturing exports			
		2000 D	2014 D	2014 F	2019 F	2000 D	2014 D	2014 F	2019 F
1	DEU	9,5%	9,7%	8,6%	8,1%	11,5%	12,1%	10,8%	9,9%
2	AUT	1,2%	1,2%	1,1%	1,1%	1,3%	1,4%	1,3%	1,3%
3	CHE	1,9%	2,0%	2,6%	2,6%	1,4%	1,7%	2,3%	2,2%
4	SVN	-	-	-	-	-	-	-	-
5	AUT - CHE - SVN	3,1%	3,2%	3,7%	3,7%	2,7%	3,0%	3,6%	3,5%
6	HUN	-	0,7%	0,6%	0,7%	-	0,8%	0,8%	0,9%
7	CZE	-	0,9%	0,9%	0,9%	-	1,2%	1,2%	1,3%
8	SVK	-	-	-	-	-	0,6%	0,7%	0,7%
9	POL	0,7%	1,4%	1,3%	1,6%	0,8%	1,5%	1,5%	1,8%
10	V4	0,7%	3,0%	2,8%	3,2%	0,8%	4,1%	4,2%	4,6%
11	GEEI	13,3%	16,0%	15,1%	15,0%	15,0%	19,2%	18,7%	18,0%
12	MEDI	6,6%	5,9%	5,8%	5,8%	6,8%	6,8%	6,7%	6,5%
13	Other EU countries	13,7%	12,8%	12,9%	13,2%	13,5%	10,6%	10,5%	10,7%
14	EU	33,7%	34,7%	33,8%	33,9%	35,3%	36,5%	35,9%	35,2%
15	USA	15,0%	11,1%	13,3%	13,5%	14,2%	9,6%	10,7%	10,3%
16	Other developed countries	20,0%	13,8%	13,1%	12,5%	20,3%	11,8%	13,1%	12,7%
17	CHN	4,2%	13,9%	14,2%	14,5%	4,8%	18,4%	22,5%	23,1%
18	Developing	25,9%	25,8%	24,9%	25,1%	24,1%	23,5%	17,6%	18,4%
19	World sum	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

		Sectoral structure of world exports				Sectoral structure of Hungarian exports			
		2000 D	2014 D	2014 F	2019 F	2000 D	2014 D	2014 F	2019 F
1	Raw materials industry	7%	9%	8%	7%	-	-	-	-
2	Processing industry	67%	62%	57%	56%	73%	83%	74%	74%
3	Energy, water management	-	-	4%	-	-	-	3%	-
4	Hard infrastructure	12%	12%	14%	14%	14%	10%	11%	10%
5	Hospitality and business Services	7%	7%	10%	10%	-	-	4%	4%
6	Information Technology and Science	5%	6%	6%	7%	5%	3%	5%	6%
7	Total	100%	100%	100%	100%	100%	100%	100%	100%

Comments: Data below 1% are not displayed.

Country identifiers: DEU = Germany, AUT = Austria, Che = Switzerland, SVN = Slovenia, HUN = Hungary, Cze = Czech Republic, SVK = Slovakia, POL = Poland, V4 = Visegrad countries, GEEI = German Eastern European Integration, MEDI = Mediterranean countries, CHN = China.

2000 D 2000 Dietzenbacher WIOT
2014 D 2014 Dietzenbacher WIOT
2014 F 2014 Figaro WIOT
2019 F 2019 Figaro WIOT

Source: own calculation based on WIOT tables.

The problems of the Hungarian export structure can be seen in the sectoral structure of exports. While the share of manufacturing in world exports has declined significantly, the share of manufacturing in Hungarian exports and those of the V4 countries has reached peak levels.

However, this was only partly due to their own performance. As summarised by Baldwin (2016) and Gereffi et al. (2005), developed countries have outsourced their manufacturing industries to China, some of the V4 and developing countries, where they have become a dominant part of the production and export structure, while developed countries have begun to shift to the development and export of business services, information technology, and science. The combined weight of these latter sectors in the export structure of the V4 countries is lower and growing less (see Rodrik, 2016). This also indicates that different processes are unfolding behind the spectacular growth. Without proper efficiency analyses, the full picture is incomplete. An analysis of the productivity and income efficiency relations behind structural changes suggests the accumulation of a number of tensions.

Foreign trade flows do not unfold for their own sake. Their role is to exploit comparative advantages and thus make national production more efficient. A more accurate picture of the situation of the world economy, including Hungary, can be obtained by analysing not only the transformation of foreign trade structures but also the changes in the structure of production[36]. Table *15* does just that: for 2000 and 2019, it explicitly shows the structure of production, the structure of the value-added it generates, and the structure of the workforce needed to realise it.

Table 15: Structural and efficiency indicators of production, value-added, and employment in 2000 and 2019

		National economy total									
		Production structure		Value-added		Staff structure		Value-added content		Productivity	
		xi/xΣ		hi/hΣ		li/lΣ		hi/xi		li/xi	
		%		%		%		%		$/fő	€/fő
		2 000	2 019	2 000	2 019	2 000	2 019	2 000	2 019	2 000	2 019
1	USA	29,8%	20,9%	31,9%	24,8%	7,8%	9,0%	55,6%	57,7%	123 407	219 510
2	DEU	5,6%	4,1%	5,6%	4,3%	2,1%	2,3%	52,6%	50,2%	86 726	166 951
3	AUT	0,5%	0,5%	0,6%	0,5%	0,2%	0,2%	54,3%	49,2%	89 003	194 752
4	CHE	0,8%	0,9%	0,8%	0,8%	0,2%	0,2%	50,9%	47,6%	131 165	334 094
5	HUN	0,2%	0,2%	0,1%	0,2%	0,2%	0,2%	44,0%	44,8%	23 269	71 726
6	POL	0,5%	0,7%	0,5%	0,6%	0,8%	0,8%	49,0%	45,2%	22 669	82 239
7	CZE	0,2%	0,3%	0,2%	0,3%	0,3%	0,3%	43,1%	42,0%	28 354	113 098
8	SVK	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	41,2%	40,8%	23 821	97 072
9	SVN	0,1%	0,1%	0,1%	0,1%	0,0%	0,1%	48,1%	48,0%	42 602	107 951
10	Other EU countries	8,2%	9,5%	8,1%	10,0%	4,8%	5,5%	51,4%	51,2%	54 259	164 038
11	CHN	5,2%	24,3%	3,7%	17,0%	37,2%	46,1%	37,2%	34,1%	4 521	49 860
12	Other developed countri	22,3%	11,5%	22,9%	11,9%	5,7%	5,5%	53,2%	50,1%	126 240	199 577
13	MEDI	6,1%	4,2%	5,9%	4,3%	2,6%	2,6%	50,3%	49,9%	74 660	150 286
14	Other countries	20,3%	22,7%	19,4%	25,1%	38,0%	26,9%	49,6%	54,0%	17 239	79 961
15	Total	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	51,9%	48,7%	32 195	94 800
16	Developed GEEI	7,0%	5,5%	7,1%	5,6%	2,5%	2,9%	52,5%	49,7%	89 749	182 477
17	V4	1,0%	1,3%	0,9%	1,2%	1,3%	1,5%	46,3%	43,9%	23 924	87 555

Source: own calculation based on 2000 D and 2019 F WIOT

Production is not for its own sake but for income. It is to a country's advantage to have a larger share in the income structure than in the production structure. In this case, its activity is more profitable than that of countries with a smaller share in the profitability

[36] As a reminder, production always refers to total outputs.

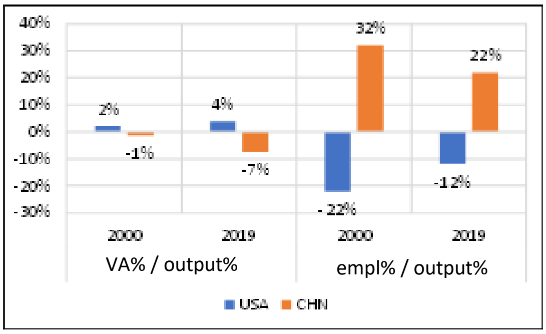
structure than in the production structure. It shares more of the total income generated within a given value chain than its share of production. The reverse, however, is preferable in the employment structure. If it has a smaller share in the employment structure than in the production structure, its productivity is better than that of others[37].

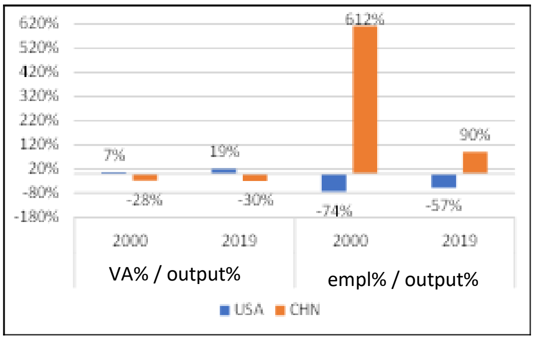
Let's compare the development of the United States and China in this respect. The US share of the production structure has fallen spectacularly, by almost 10%. China's has increased even more spectacularly, by almost 20%. But in the value-added structure, the US lost only 7% and China gained only 13%. This is definitely an efficiency disadvantage for China. The US share in the value-added structure in 2000 was 2% higher than in the production structure, and in 2019 by 4%. In 2000, China had a 1% smaller share in the income structure than in the production structure, but in 2019 it had 7% less. This efficiency gap is also reflected in the value-added content, which increased by almost 2% in the US and decreased by 3% in China. This happened despite the fact that productivity in China grew six times faster than in the US. China has been unable to translate productivity efficiency gains into income generation because of the depressed price of cheap assembly labour. There is a disconnect between productivity and income generation efficiency in China. The evolution of volumes has brought the two countries closer together, but this has not translated into a similar degree of income. Income developments have muted the convergence in volumes. Figure *16* shows two versions of what has been described.

[37] If China's share in the value added structure is smaller than in the production structure, then $hCHN/h\Sigma < xCHN/x\Sigma$. If, on the other hand, the US share is larger in the value added structure than in the production structure, then $hUSA/h\Sigma > xUSA/x\Sigma$. By doing the appropriate divisions, it is true that $(hCHN/h\Sigma) / (xCHN/x\Sigma) < 1$ and $(hUSA/h\Sigma) / (xUSA/x\Sigma) > 1$. Then $(hCHN/h\Sigma) / (xCHN/x\Sigma) < (hUSA/h\Sigma) / (xUSA/x\Sigma)$. Rearranging this, $HCHN/xCHN * x\Sigma/h\Sigma < hUSA/xUSA * x\Sigma/h\Sigma$. From this, it can be shown that $HCHN/xCHN < hUSA/xUSA$, i.e. the profitability of US production is higher. The same can be derived for productivity.

Figure 16: Differences in production, income, and employment structures in USA and China in 2000 and in 2019

Figure a. **Figure b.**

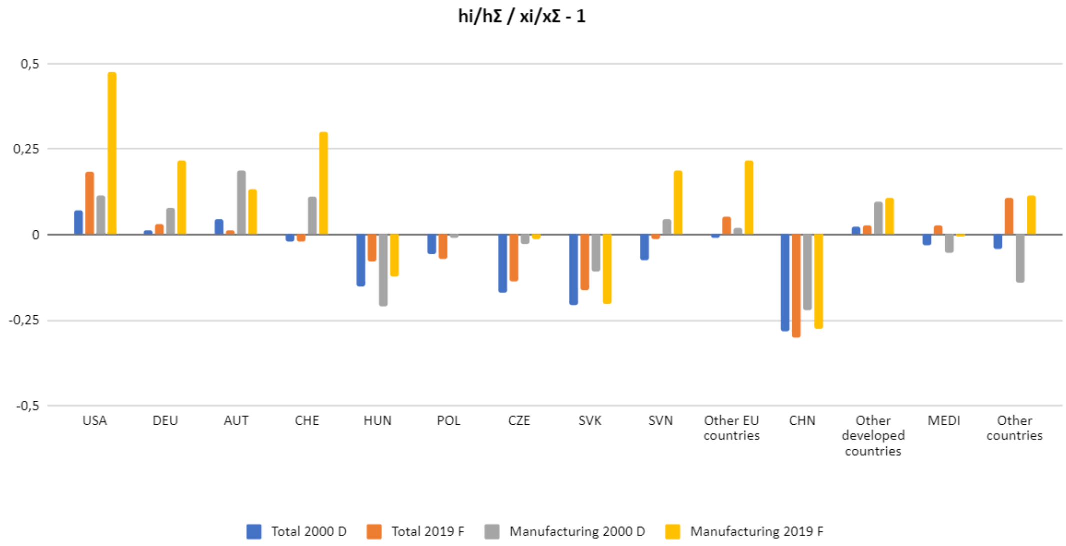




Source: own edit based on the WIOT tables 2000 D and 2019 F

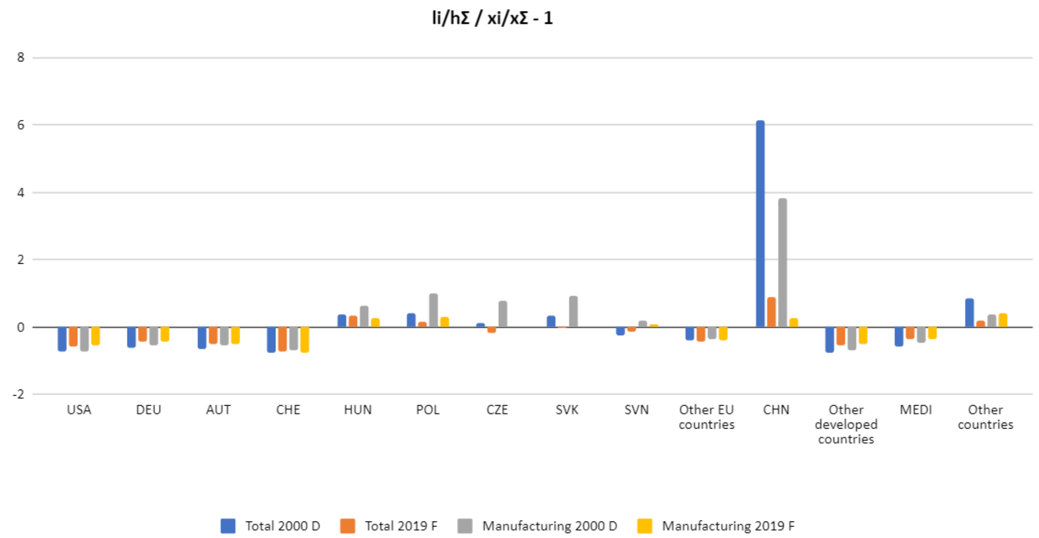
The above-described change in the economic relations between the United States and China has taken place in essentially the same way as in all developed countries and developing countries engaged in assembly activities. It is difficult to quantify this change on the basis of Table *15* because many of the countries, including Hungary, have very low shares in the world economy as a whole. Differences are often only noticeable to the third decimal place. However, if we measure the deviations from the production structure not as absolute differences, but - as we did in Figure *16*/b - by means of divisions (see Figure *17* and Figure *18*), we can prove our claim. (It is important to note that in the case of divisions, we need to subtract 1 from the indexes to arrive at Figure *16*.) The percentage deviations from production structures show a similar situation as in Figure *16*. Moreover, these graphs not only show the changes in the national aggregates, but also highlight the fact that changes in manufacturing productivity and manufacturing value-added are predominantly behind the changes. They have clearly changed in favour of developed countries.

Figure 17: Weights in the value-added structure and in the output (production) structure in 2000 and 2019



Source: own calculations based on WIOT tables

Figure 18: Weights in the employment structure and in the output (production) structure in 2000 and 2019



Source: own calculations based on WIOT tables

It is also clear from the data that the role of changes in value added content is greater than that of changes in productivity. The changes in the correlation coefficients of the group in Figure *19* support this. The data reveal a basic law that higher profitability is a reward for higher productivity countries, but this changes when the productivity of lower productivity countries is developed by more advanced countries. The price of this is paid by the lower productivity countries, with income losses. Their productivity gains have not increased their value added. This is partly behind the decline in the correlation coefficient (see R2 indicators).

Figure 19: Development of the value-added ratio as a function of productivity in 2000 and in 2019

Figure a.

2000

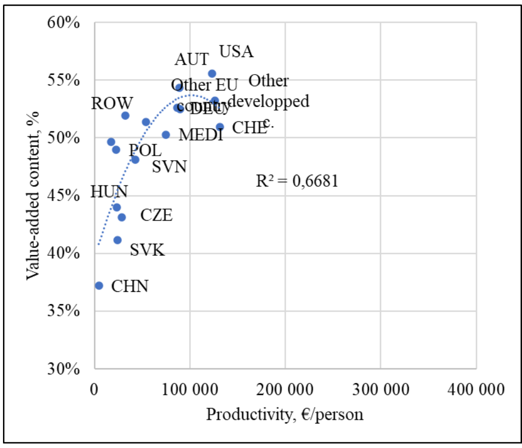
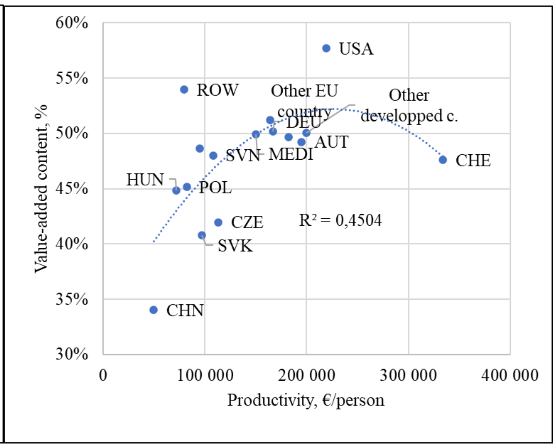


Figure b.

2019



Source: own calculations based on WIOT tables

The development of the international division of labour described above has significantly transformed the structure of Hungarian production and foreign trade both nationally and regionally (Table *16*). Manufacturing exports, mainly exported by rural regions, account for around 60% of the sectoral structure of national exports. The weight of Budapest in manufacturing exports is low[38]. The weight of developed regions in manufacturing exports is the highest, reflecting the financial background of their development. This process is of course also translated into the structure of production.

[38] The weight of Budapest would probably be further reduced if the so-called "location problem" could be properly addressed. This is that many manufacturing plants are registered in Budapest, even though production takes place in the countryside.

Table 16: Structure of foreign trade and total output in 2020 based on the Hungarian territorial input-output table[39]

		Export structure by region	Structure of manufacturing exports by region	Structure of import consumption by region	Structure of import use in the manufacturing industry by region	Structure of total output by region
1	Budapest	27%	10%	20%	22%	31%
2	Central Transdanubia	14%	20%	16%	15%	12%
3	Western Transdanubia	15%	21%	17%	15%	12%
4	Pest	11%	9%	10%	9%	10%
5	Northern Hungary	10%	14%	11%	12%	9%
6	Northern Great Plain	9%	11%	10%	11%	10%
7	Southern Great Plain	10%	12%	11%	11%	10%
8	Southern Transdanubia	4%	4%	4%	6%	6%
9	Regions total	100%	100%	100%	100%	100%
10	Budapest	27%	10%	20%	22%	31%
11	Developed regions	29%	41%	34%	29%	24%
12	Underdeveloped regions	44%	50%	46%	48%	45%

		Sectoral structure of exports	Sectoral structure of import material use	Sectoral structure of total output	Sectoral structure of total output in Budapest	Sectoral structure of total output in developed regions	Sectoral structure of total output in underdeveloped regions
1	Raw materials industry	3%	2%	4%	0%	4%	7%
2	Manufacturing	61%	67%	36%	12%	59%	40%
3	Energy, water management	4%	5%	4%	5%	2%	4%
4	Construction	2%	5%	7%	5%	6%	8%
5	Hard infrastructure	12%	9%	14%	19%	10%	14%
6	Hotel and business services	8%	4%	15%	26%	8%	11%
7	Information Technology, Science	7%	3%	6%	14%	2%	4%
8	Education	0%	0%	3%	3%	2%	3%
9	Health	1%	2%	4%	4%	3%	4%
10	Other social Services	2%	2%	8%	12%	4%	6%
11	Total	100%	100%	100%	100%	100%	100%

Comments:
Developed regions: central and western Transdanubia
Underdeveloped regions: all except Budapest.

Source: own calculations based on Hungarian territorial IOT

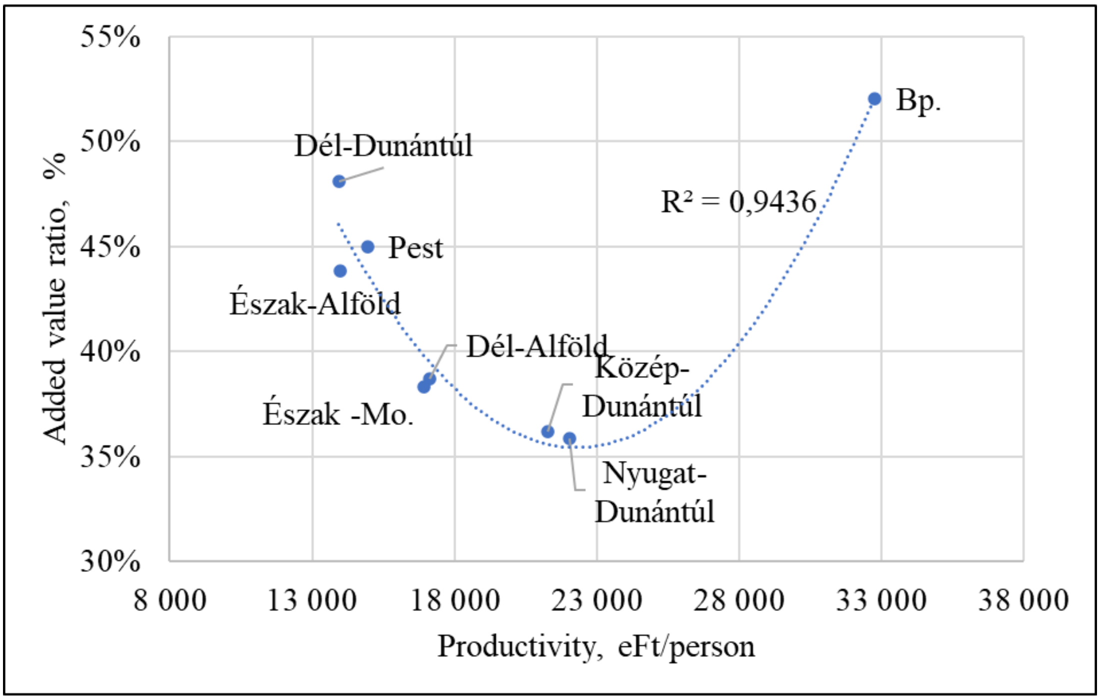
Can we consider the production structure as one that has developed as healthy? Rural regions are dominated by manufacturing, with a weight of between 30-60%. In Budapest only 12%. In contrast, in rural areas, the direct use of information and scientific services is minimal, while in Budapest it is higher than the use of manufacturing (14%). Since the different ratios between Budapest and rural areas indicate a one-sided orientation of rural areas towards manufacturing, we need to look at what this implies for income generation.

Value-added production, both in the GEE integration and in the world economy as a whole, reflects the economic power relations between the participants. The value-added content of the output of the more advanced countries - the value added per unit of output - exceeds that of the emerging countries, including Hungary, and this, as we have seen, can be disconnected from productivity differences between countries. In our rural regions, mainly because of the presence of multinational companies, the situation is similar: the highest productivity is combined with the lowest value added. There are also factors at

[39] In *Table 16*, the order of the regions reflects a certain order of efficiency. GDP per capita is highest in Budapest, which is why Budapest is first, followed by Central and Western Transdanubia. In these two regions, GDP per capita is lower than in Budapest but higher than in the other regions. In the latter, the indicator is smaller but similar in magnitude.

work in regional linkages that can deviate profitability from the main law in Figure *19*, which is that if a country or region is more productive, it tends to have a higher value-added content. One of the best examples of this is Hungary, described in Figure *20*.

Figure 20: Value-added content as a function of productivity in Hungary in 2020



Source: own calculations based on Hungarian territorial IOT

In Hungary, the main rule is very peculiar. If we combine the countryside into a single aggregate, we can show that rural areas have both lower productivity and lower value-added ratios. Budapest has higher productivity and a higher value-added ratio. This is therefore consistent with the main rule. However, the downward slope of the parabolic trend needs to be explained, as it clearly indicates that the value-added ratio in some rural regions does not follow the main rule: the higher the productivity, the lower the value-added ratio. Paradoxically, the most developed and also the most productive rural regions have the lowest added-value ratio.

The reasons for this paradox are as follows. The share of foreign capital in the manufacturing industry is high. Foreigners equip the labour used with greater and more advanced material and knowledge capital. Productivity is therefore higher compared to regions with a lower share of foreign capital. At the same time, Hungarian labour employed in manufacturing with this equipment adds little domestic value added (only low-value assembly work) to the high-value goods that are imported. Hence the striking result is that the manufacturing sector with the highest productivity has the lowest domestic value-added content.

Budapest has a significantly lower share of the manufacturing industry. This is why the value-added content of the capital city's value creation is not decreasing. In rural areas, quite the opposite is true. The share of manufacturing is high, and the higher the share, the more the value-added decreases.

A further characteristic of the Hungarian economic structure is that it is domestically "internally autarkic" and dependent on the world economy, subordinated to it. If we look at the sub-groups in Figure *21*, we can see that domestic producers have significant production links with the rest of the world rather than with each other. While they are open to the world market, domestically they are more self-sufficient.

It may seem strange that while Hungary is one of the most open economies in the world in terms of export/GDP and import/GDP ratios, we are talking about autarky in its internal relations. However, this is true in a country where assembly companies mainly assemble imported parts and have a meager share of national - non-domestic - suppliers. As a result, the level of mutual supply between regions is very low. This is why we have used the term "internal autarky".

The low value-added content has a serious impact on our real share of world economic participation. As an important development in integration relations, Hungary has become increasingly involved in international production cooperation, especially in manufacturing cooperation[40]. In the period under review, exports for production grew faster, but later final product exports also accelerated, especially in the case of developed countries. According to the WIOT tables, the ratio between the two product groups is now 50-50%[41].

The increasing weight of exports of intermediate goods in the weight of exports measured in terms of gross turnover shows a higher than real weight of exports in countries where relatively little value added is incorporated into exported products compared to previous,

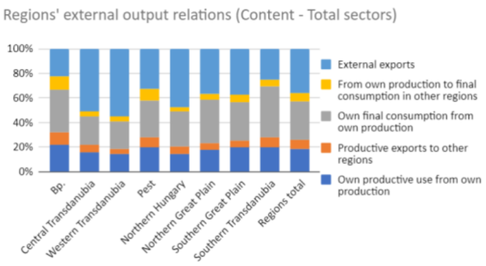
[40] Based on the WIOT tables, exports of the V4 countries can also be broken down into exports for productive purposes (intermediate goods) and exports of goods produced for final use (final goods).
[41] The phenomenon is discussed in many studies, including most of the ones we have mentioned, through a system of forward linkages and backward linkages indicators. A more detailed discussion of them requires a much deeper input-output analytical background.

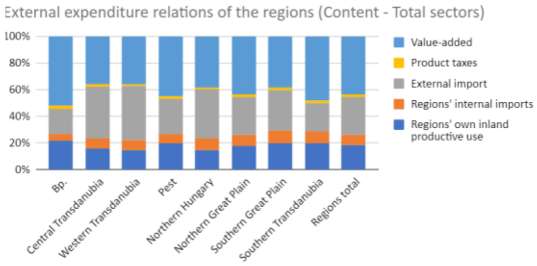
mainly imported, products. See the dark histograms of Hungary and the V4 countries "hanging off" the horizontal axis in Figure *22*! As a counter-image of this, the weight of imports is greater when also measured in terms of their value added. These results clearly show that our weight in the world economy is much smaller in terms of net exports than in terms of 'inflated' gross exports. Among the countries surveyed, this depreciation is most significant for Hungary (more than 20%).

Figure 21: Structure of inputs and outputs in each region in 2020

In the national economy as a whole

Figure a ***Figure b***

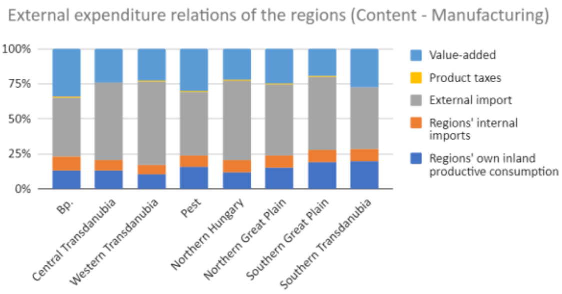


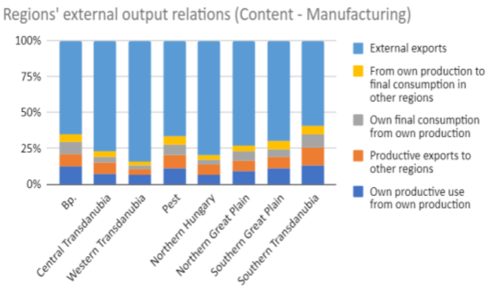


Note: The general interpretation of the jth column is: the proportion of the jth region's purchases from itself, from other regions or abroad, and the proportion of the jth region's exports to itself, to other regions, abroad or for final consumption.

In the processing industry

Figure c. ***Figure d.***



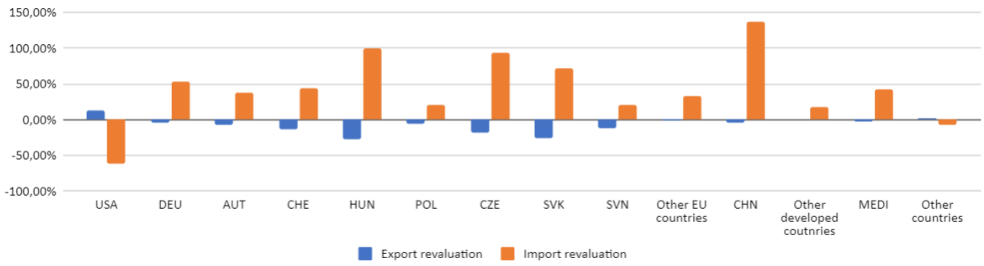


Note: The general interpretation of the jth column is the same as in Figure *21*/a-/b, but only for the manufacturing sectors in each region.

Source: own development

In interpreting export depreciation, we must recognise that each of the indicators of depreciation is a comparison of a gross turnover figure y and its corresponding total content figure **ḥQy**, where **Q** is a Keynesian multiplier of production over unity and **ḥ** is a value-added content in the range 30-60%, according to equation 4. In the world export structure, those countries are valued that produce with a sectoral structure with significant interdependence - because they have a high production multiplier - and those with high value-added. Of the two modifying factors, the value-added content is the more important. Countries with looser sectoral linkages have a lower production multiplier. Moreover, if these countries can only realise a lower value-added content in their supply chains, they are devalued. Hungary is one of the latter countries highlighted in the study.

Figure 22: Change in the structure of world trade flows based on value-added contents – 2019 F



Source: own calculations based on WIOT tables

We have to explain the increased value of import shares. They are significantly higher for the more advanced GEE integration countries on the basis of value-added content than on the basis of gross turnover. The value added of imports is weighted by the value-added content of different countries. The US and developed countries have the highest value-added content. Since these countries are suppliers to all other countries or groups of countries, they supply higher value-added products, which increases the value-added content of imports. Our claims are supported in more detail in Appendix 3.

This is particularly evident in Hungary's regional relations (see Figure *23*). Here too, the rule holds that regions with a higher value-added content are valued upwards in interregional trade and those with a lower value-added content are valued downwards. However, in contrast to foreign processes, domestically intra-regional imports are mostly valued up and down in a similar way as exports. This is because the value-added of domestic regions is low - unlike in developed countries - and therefore internal imports also adjust downwards the value-added of internal imports of regions. The mechanism for this is also explained in detail in Appendix 3.

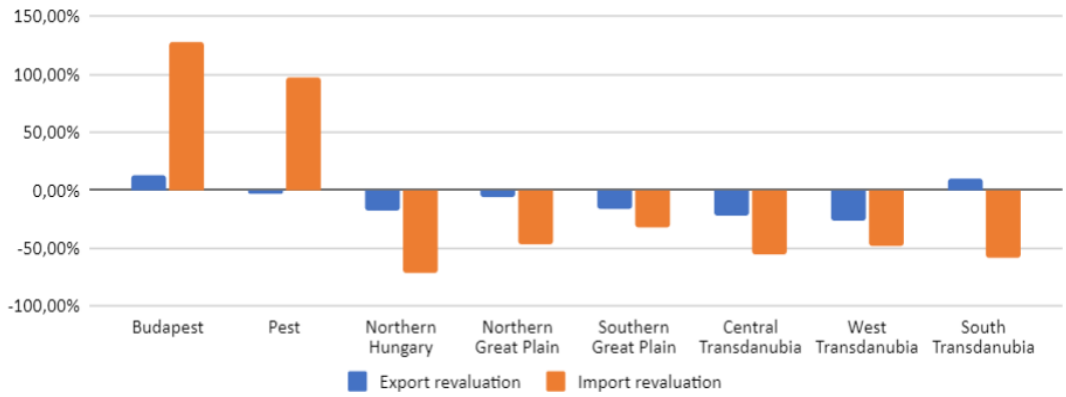
Thus, the main message of our calculations based on the territorial IOTs is that

- economies with a one-sided economic structure or with low interconnectedness of production and
- with low value-added

devalue its export performance by the value-added content of its exports. Inadequate knowledge of this can lead to biased value judgments. The devaluations range from 20 to

30%, and Hungary is the country with the highest devaluation among the selected countries. This also implies income depreciation, which has a negative impact on the balance of payments.

Figure 23: Change in the structure of Hungarian internal trade flows based on value-added content – 2020 HUN



Source: own calculations based on Hungarian territorial IOT

The change in the shares does not only affect Hungary. The weight of Germany and Austria in net exports is also decreasing compared to the United States and China[42], but the decrease is much smaller (10-20%) than in the V4 countries, due to the much higher degree of internal linkages between their sectors and the much higher value added in their supply chains.

In Hungary, the phenomenon occurs in the same way between Budapest and the countryside as it does in the global economy between the more developed countries and Hungary. Budapest's importance in terms of the value-added content of domestic exports is increasing, while that of rural regions is decreasing. Domestically, the lower value-added content of the middle-income trap and the autarkic production links are also behind this phenomenon. The question arises whether, if the most developed Budapest did not get rich from manufacturing, the dominance of manufacturing is a permanent or temporary goal.

[42] Careful calculations are needed here to show how much this is a distinctive feature of Chinese development and how much it is an important step in their escape from the middle-income trap. As our study is only about the Hungarian economy, we will not analyse the Chinese data in any more depth than this.

3.6. Summary

Based on the calculations made, we can see that if a society "outsources" developments and the sale of products resulting from these developments, then the incomes realised will grow less than its productivity. This slows down the growth of the capital resources available for economic and social development, which can prevent convergence with countries that can achieve profitability in line with their productivity growth. This process leads to devaluation.

We can see the significant progress that has been made in the emerging countries - including Hungary - that have had a chance in the model described[43]. China's development is particularly impressive. However, it is certain that the catching-up of developed countries, if it happens, will not be achieved by emerging countries in this model.

In the current growth model of the world economy, the important law of "no free lunch" applies. If someone cannot undertake the riskiest and most investment-intensive activities - either because they cannot or because they could but for whatever reason they pass them on to others - they will have to settle for lower profitability. Opportunity has not come free to emerging countries. They had to pay the price.

Of course, the direct consequence of this in capitalism is that the competitive advantage gained can become a permanent, monopolistic competitive advantage, forcing those who are left behind for one reason or another into a trap. Thus, among the reasons, not only the dilemma 'to take up - not to take up' must be addressed, but also the conditions of take-up itself. And the tensions in world politics around China's development indicate that this issue is increasingly becoming a central issue in strategic thinking, and it is far from certain that the growth model and the growth opportunity it presents will be sustained. However, whether it survives or not, taking the risks of development and sales cannot be postponed, as only this will ensure a match between productivity growth and income generation, which in any case raises the question of going beyond and upgrading the "assembly model".

[43] Let us not forget that the global economic change we have analysed has not helped the development of all countries, for example Russia.

We are convinced that this is not only in the interest of the "assembling countries", but also a matter of European cooperation. If Europe does not want to be at a disadvantage against China, it must ensure its rise with a periphery that is capable of development, not a periphery that is falling behind. This calls for a rethink of the model described for European development. Our factual description has sought to provide, among other things, the appropriate analysis to do so.

We consider it a valuable contribution to further reflection on the topic to show that the problems of the model described are not only related to the developed countries and Hungary but also to the economic relations between Budapest and the countryside. This indicates that those who interpret the problems of the "assembly model" only as a question of power relations between countries come to the wrong conclusion. Conversely, the power imbalances of the 'assembly model' should be addressed in domestic 'center-rural' relations, not only in international relations.

We do not want our calculations to be the basis for some one-sided conspiracy theories that, well, it has been proven that foreign capital has clearly exploited the Hungarian economy and developing countries. Among other reasons, we have consistently carried out a parallel domestic and international analysis to reduce the possibility of such one-sided interpretations. Nevertheless, exploitation as such is certainly present in the model, but its forms and extent need to be analysed within a framework that is consistent with the role of investment ventures. Any one-sidedness in this respect is harmful.

We also see other risks. If there is a disconnect between productivity and profitability in the cooperation between national and multinational capital, there will be a temptation for those who capture this lower level of profitability to see it as a cheap way to enrich themselves, with less risk and relatively less investment. It is already apparent that important partial results can be achieved along this path, but it will not solve society's problems as a whole. However, those who get rich by this route will see it as the only way to salvation and will want to preserve it rather than make it more efficient. In practice, this brings back on the agenda the almost 400-year-old problem of either the second serfdom described by Engels-Acemoglou-Robinson (Acemoglu-Robinson, 2013) or the development path that István Bibó and Jenő Szűcs called the Central-Eastern European divergent development path, which deviated from the main stream of Western Europe

(Bibó, 1948; Szűcs, 1981). We do not want to give help to any anti-Westernism. The breakdown of progression barriers should rather be sought within borders.

In our view, the way in which nationally owned Hungarian companies can acquire higher-value jobs within supply chains, whether in innovative development or in the manufacturing process, is crucial for future development. If the regional tensions involved are managed well, they can make progress in the integration(s) that determine development, as well as accelerate the country's own internal development. The main way to manage tensions is to raise productivity, but not at the cost of reducing value added. In the long run, we cannot afford the luxury of a permanent disconnect between productivity and value-added without consequences. Convergent development requires that this gap be closed.

Strategic clarity requires significant methodological improvements. The possibility of focusing statistical observations on the value-added content of activities in value chains rather than on gross statistical observations needs to be improved. The measurement of GDP and trade linkages should be used to measure real national output more accurately. This is an important prerequisite for influencing the production linkages that are emerging in the context of globalisation towards a win-win relationship.

Upgrading within existing value chains is also a very important development direction, as is exploring the possibilities of moving up and exploring the possibilities of organising new value chains ourselves. There are strong business accumulation conditions for this, which can be improved through the development of education and training systems to ensure continuous learning.

Finally, the scope for regional statistical monitoring must be broadened. Globalisation is an effective economic driver, but the balanced development of national producers is not its first. This remains a national task in its own right, which cannot be tackled effectively without a solid basis.

Appendix 1: WIOT and FIGARO global multi-regional IOT

The development of the WIOT and its complementary data[44], collectively called WIOD[45], was initiated by the European Commission in 2009 in its 7th Framework Programme. The work was carried out by a research team led by the University of Groningen. The latest 2016 edition of the database links 56 sectors from 43 countries (28 EU + 15 non-EU) + the rest of the world for the period 2000-2014. Its system is compatible with the latest UN sectoral classification structure (ISIC Rev. 4) and the System of National Accounts (SNA08). It is a very detailed database. It includes data in current prices in $, at constant prices of the previous year, as well as international resource and consumption tables, national IOTs calculated from international tables and original national input data in the countries' own currencies. It provides employment, capital stock, gross output and value added data at current and constant prices in national currencies, broken down by 56 sectors (Timmer et al. 2015, 2016). The database can be downloaded from the University of Groningen website (rug.nl) (Groningen Growth and Development Centre - WIOD - World Input-Output Database), where further methodological and technical descriptions can be found.

The FIGARO database was developed in 2021 in cooperation between Eurostat and the Joint Research Centre of the European Commission, and further expanded in 2022. It is planned to add data from two years earlier on an annual basis. The current version contains estimated global multi-regional activity and organisational IOTs at current prices, converted into euro at official annual average exchange rates, for 45 countries (27 EU countries + 18 key trading partners) + the rest of the world and 64 sectors of Eurostat's IOTs for the period 2010-2020. The IOT time series are available in CSV format, which can be expanded into a matrix format on the europa.eu website (Eurostat - ESA supply, use, and input-output tables - Database). Further methodological and technical information can be found on the europa.eu website of the FIGARO project: Eurostat – Products Eurostat News – integrated global accounts for economic modelling – FIGARO.

[44] These are the Socio-Economic Accounts.
[45] World Input-Output Database

Appendix 2: Estimation of the 2020 Hungarian county IOTs and development of a multi-regional IOT model

According to Szabó (2021), the studies of Csepinszky and his colleagues (1973, 1976), which report on the compilation of the type B IOT of Vas county based on data from 1968 and 1972, can be considered among the pioneering works in Hungary aimed at estimating county IOTs. The authors used as primary sources balance sheet reports of enterprises and cooperatives and available statistical data. In addition, field surveys were carried out for the larger enterprises, and estimates based on national ratios were made. Later, Rechnitzer (1981) also estimated the county IOT for the counties of the South Transdanubian region primarily by collecting enterprise data.

For all counties of Hungary, only for 2010 and only for 37 sectors have been produced the estimates of the multiregional IOT (more precisely, multi-regional IOT), which are consistent with the national IOT, as reported in Szabó's (2021) doctoral thesis.

In the course of our work, we first separately prepared the IOTs of Hungary's 19 counties and the capital, which were consistent with Hungary's base price[46], organisationally classified[47], so-called type B[48], 64-sector IOTs for 2020. They were then linked. Thus, an inter-regional and a multi-regional IOT model were quantified.

The main statistical datasets used for the quantification were the national accounts in the CSO's Stadat and Information Database, the 2020 IOT and their background tables[49], the output, exports, and employment data[50] for industry by county and sector, and **the county and sectoral breakdown of output and value-added for 2015, separately obtained from the CSO.**

To use an analogy, each cell of the national IOT was divided into 20 counties and then placed on top of each other. This transformed the two-dimensional table into a three-dimensional one, and a one-storey building into 20 level one, where each level ('layer') is the IOT for that county.

[46] The base price is essentially the producer price, with the modification that the transport and trade margins are deducted from the selling price of the product and recorded as the base price output of the transport and trade sectors respectively.
[47] Organisational classification means that each production unit is counted in the sector of its enterprise.
[48] A separate line showing imports as complementary to the domestic product.
[49] Supply and consumption tables, import matrix and "Balance of taxes and subsidies on products" table.
[50] "Focus on the counties" issues.

Since data on inter-county trade flows are not available (especially not at such a detailed level, broken down by sector and partner county), we have used one of the few methods available in the international literature, Kronenberg's (2007) CHARM (Cross-Hauling Adjusted Regionalization Method), one of the best known methods, to estimate inter-regional intra-sector trade. (See also Kronenberg (2009) and Többen - Kronenberg (2014).)

We have also used a gravity model to express the distance sensitivity of trade (Black, 1972; Dusek, 2016), (Jahn, 2017; Thissen et al., 2014; Yamada, 2015; Szabó, 2021). The raw estimation results of this were matched and refined using the RAS and the INSD two-way matrix adjustment methods.

The main steps in the estimation of the county IOTs are outlined below (the categories estimated in each step are indicated in italics):

- A key element of the estimation was the disaggregation of the *annual value added* in 2020 and within that the individual value-added components into 64 sectors from the data available in the KSH Stadat system by county and for 11 branches.

- These county and sectoral value-added estimates ($\mathbf{h^r = 1H}$) are also used as the basis for the *county-by-county* ($\mathbf{x^r}$) estimates of *sectoral outputs* in 2020, taking into account the 2015 county and sectoral value-added shares and the evolution of sectoral value-added shares (calculated from the 2020 national value-added shares) between 2015 and 2020.

- The county intermediate consumption matrixes (domestic components of $\mathbf{X^r}$ and import components of $\mathbf{m^r}$) were calculated by modifying the input coefficients calculated from the national IOT by a proportion (column-wise, i.e. a uniform proportion per product) consistent with the estimated value added share of the sector in the county (or the "material share" calculated from it, supplemented to 100%, i.e. the value of user-price intermediate consumption divided by outputs).

- The net product tax share of *intermediate consumption and final consumption* (marked with $\mathbf{p^r}$ for intermediate consumption, $\mathbf{b^r}$ for domestic final consumption and t'^{r}_{z} for exports) by county (direct tax burden) was first estimated by multiplying the implicit tax rates calculated from the corresponding elements (due to missing data on changes in stocks, for this category from sectoral values of intermediate consumption and the corresponding net taxes on products) of the 2020 "Balance of taxes and subsidies on products" matrix and the "Use matrix at basic prices" table of the CSO by the corresponding estimated uses (current, intermediate, and final consumption), and then adjusting these estimates to the corresponding element (for a particular user) of the 2020 IOT net product tax item. In a similar way, the *import component of final consumption by province* ($\mathbf{d^r}$, $u^r{}_z$) was estimated.

- *Exports by sector and by county* ($\mathbf{z^r}$) were estimated as the product of the industrial sectors' outputs and the 2020 export sales shares calculated from the CSO's county industrial statistics. For agriculture, forestry and fishing, and most services sectors, exports were allocated to counties in proportion to their share of the sectoral group's share of the sectoral group's value added in 2020 in the national IOT. For other sectors, we estimated the county exports from a previous database from 2010 and using the national export sales shares for the sector.

- The county and sectoral breakdown (Yr) of domestic final uses (excluding inter-county turnover) was calculated using the county shares of output and the share ratios calculated from the 2010 database already cited by dividing the corresponding final use data of the national IOT.

- Net intercounty exports (cr) were calculated on a residual basis, specifically from sectoral product balances as the difference between county output and total (other) consumption of domestic products.

Appendix 3: Itemised breakdown of revaluation of trade flows

From the territorial IOTs - either from the WIOT tables or from the Hungarian territorial IOT - the export headcount is calculated

$$\langle \underset{\cdot}{\mathbf{h}} \rangle \mathbf{Q} \langle \mathbf{e} \rangle \qquad /F.1./$$

using the formula, the detailed content of which in a 3×3 case is as follows:

$$\begin{bmatrix} \underset{\cdot}{h}^1 & 0 & 0 \\ 0 & \underset{\cdot}{h}^2 & 0 \\ 0 & 0 & \underset{\cdot}{h}^3 \end{bmatrix} * \begin{bmatrix} q^{11} & q^{12} & q^{13} \\ q^{21} & q^{22} & q^{23} \\ q^{31} & q^{32} & q^{33} \end{bmatrix} * < \begin{bmatrix} 0 & e^{12} & e^{13} \\ e^{21} & 0 & e^{23} \\ e^{31} & e^{32} & 0 \end{bmatrix} * \mathbf{1} > \qquad /F.2./$$

To the left of the territorial Leontief inverse is the diagonal matrix of value-added contents, and to the right the final export matrix of the territorial system, excluding exports for production. Productive exports are included in the corresponding blocks of the Q matrix. Since in this system the exports of one country are the imports of another, the sum of the columns of the export matrix represents the final exports of the countries, while the sum of the rows represents the final imports. These final exports do not include each country's output for its own internal use. Therefore, the main diagonal is zero.

The formation of the total value-added content of exports is shown in derivation F.3, while the value-added content of imports is derived in equation F.4.

The value-added content of final exports:

$$
\begin{aligned}
h^{1} q^{11} e^{1} + h^{1} q^{12} e^{2} + h^{1} q^{13} e^{3} &= h^{1} (q^{11} e^{1} + q^{12} e^{2} + q^{13} e^{3}) \\
h^{2} q^{21} e^{1} + h^{2} q^{22} e^{2} + h^{2} q^{23} e^{3} &= h^{2} (q^{21} e^{1} + q^{22} e^{2} + q^{23} e^{3}) \\
h^{3} q^{31} e^{1} + h^{3} q^{23} e^{2} + h^{3} q^{33} e^{3} &= h^{3} (q^{31} e^{1} + q^{23} e^{2} + q^{33} e^{3})
\end{aligned}
\qquad \text{/F.3./}
$$

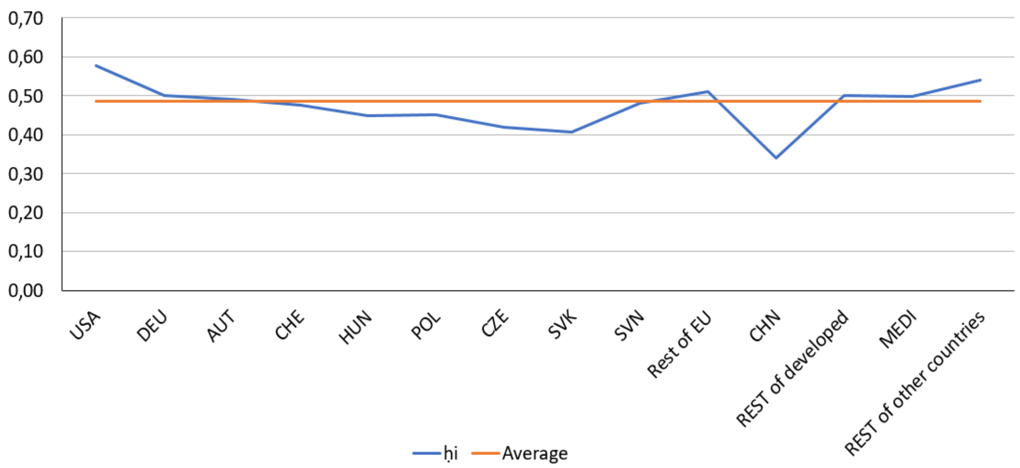
The value-added content of final imports:

$$
\begin{aligned}
h^{1} q^{11} e^{1} + h^{2} q^{21} e^{1} + h^{3} q^{31} e^{1} &= e^{1} (h^{1} q^{11} + h^{2} q^{21} + h^{3} q^{31}) \\
h^{1} q^{12} e^{2} + h^{2} q^{22} e^{2} + h^{3} q^{23} e^{2} &= e^{2} (h^{1} q^{12} + h^{2} q^{22} + h^{3} q^{23}) \\
h^{1} q^{13} e^{3} + h^{2} q^{23} e^{3} + h^{3} q^{33} e^{3} &= e^{3} (h^{1} q^{13} + h^{2} q^{23} + h^{3} q^{33})
\end{aligned}
\qquad \text{/F.4./}
$$

The fundamental difference between the two derivations is the approach to value-added content. The size of the value-added content of final exports depends crucially on the value-added content of the country involved, while the value-added content of final imports is calculated by weighting the value-added content of each country.

The value-added content of each country is highly dispersed (Figure *24*).

Figure 24: Dispersion of value-added content around the average – 2019 F



Source: WIOT

The Visegrad countries' and China's final exports are depreciating because their value-added content is below average. The more developed countries of the GEEI have a higher value-added content than the Visegrad countries and China, but lower than the US and developed countries. Therefore, their export performance is also depreciating, but to a much lesser extent than the previous group of countries.

To understand the import appreciation, a detailed knowledge of the structure of the Q<e> matrix is necessary (Table *17*), since the value added of each country in its imports is weighted by the columns of this matrix.

Table 17: Input structure of production needed for export of final use – 2019 F

	USA	DEU	AUT	CHE	HUN	POL	CZE	SVK	SVN	Other EU	CHN	Other developed countries	MEDI	Other countries
USA	98%	2%	1%	3%	1%	1%	1%	1%		2%		3%	1%	2%
DEU		83%	7%	3%	7%	4%	6%	6%	4%	2%			2%	
AUT			75%		2%			1%	2%					
CHE			1%	77%					2%					
HUN					63%			2%						
POL					2%	78%	2%	2%						
CZE					2%		70%	4%						
SVK					1%		1%	66%						
SVN									71%					
Other EU		5%	4%	5%	7%	4%	4%	4%	4%	85%			4%	2%
CHN		2%	2%	2%	3%	3%	5%	3%	2%	1%	92%	3%	2%	4%
Other developed countries		1%		1%	1%	1%	1%	2%		2%	2%	88%		2%
MEDI		2%	2%	2%	3%	2%	2%	3%	5%	2%			84%	
Other countries		3%	4%	5%	6%	5%	4%	5%	6%	4%	3%	4%	5%	89%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: own calculations based on WIOT

Note: only items greater than 1% are included.

The table shows that where we see an appreciation in imports, the share of imports from countries with higher value added is high.

The revaluation processes in Hungarian regional trade can be understood along the same lines. When considering these, it should be remembered that here we are not talking about the regions' foreign relations, but only about their trade with other internal regions.

The internal exports of regions with higher value added are appreciating, while the internal exports of regions with low value added are depreciating. As we can see, the magnitude of the depreciation is proportionate to the weight of manufacturing.

Here, the revaluation of imports is not opposite to the revaluation of exports, as in the case of external relations. This is due to the very strong internal autarky, as shown in Table *18*. For this reason, the revaluations are subject to inter-regional orders of magnitude in value added content.

Table 18: Input structure of production required for the internal final use export of regions – 2020 HUN

	Budapest	Pest	Northern Hungary	Northern Great Plain	Southern Great Plain	Central Transdanubia	Western Transdanubia	Southern Transdanubia
Budapest	94%	5%	6%	6%	6%	6%	5%	5%
Pest	1%	91%	1%	1%	1%	1%	1%	1%
Northern Hungary			89%					
Northern Great Plain				90%				
Southern Great Plain	1%				89%			
Central Transdanubia	1%					90%	1%	
West Transdanubia							91%	
South Transdanubia								89%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Hungarian territorial IOT

Note: only items greater than 1% are included.

Appendix 4: WIOD SEA and Ilostat employment databases

The employment data used for this research are drawn from two sources. The calculations were performed using sectoral employment databases (ISIC level 2) for the years 2000, 2014 and 2019. Country groups other than the priority countries, for which data are not available from the same source for the years under study, are also included in the analysis.

Where employment data were provided by the compilers of the IOTs, they were used. Thus, data for 2000 and 2014 are taken from the Socio Economic Accounts table[51], a supplementary database published by the World Input-Output Database (WIOD) November 2016 Release.

Employment data for 2019 are from the labour force statistics published by Ilostat.

For the priority countries, all data are available to perform the calculations. Among the country groups, the countries of the EU, Developed countries and Mediterranean country aggregates are also fully matched, but for the group of Developing countries, the aggregate elements in 2019 are slightly different compared to 2000 and 2014.

[51] https://www.rug.nl/ggdc/valuechain/wiod/wiod-2016-release?lang=en

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4. Article 3. Evolvement of global value chain positions in the Central – Eastern European countries – A new dimension in catching up?

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4.1. Abstract

The paper examines the evolvements in the global value chain positions of the Central – Eastern European (CEE) countries. This approach enables us to reveal both economic and sector level structural changes of the economic catching up process.
To study the structural patterns, we developed a modified smile curve framework that combines value added ratio and upstreamness index. Data were derived from the WIOD database from 2000 to 2014.

By undergoing a significant catch-up in the last decades, CEE countries have shown considerably different patterns in their evolvements of GVC positions.
Regarding the economy level, we concluded that leading economies can be described by a "U"-shaped smile curve over the period., There are two further dominant patterns that have become widespread among the CEE countries. Until 2014 the most common structure is marked by "/" shape that reflects an upstream-weak economy (eg. BGR 2000; HUN 2000; LVA 2014). The second most common structure is marked by an inverted "U" shape ("^" shape) that signs a manufacturing-heavy economy (eg. EST 2000; POL 2000; HUN 2014; POL 2014). There is no significant difference in the added value ratio of the manufacturing sectors compared to the western countries. Typically, the CEE countries are shifting towards the supplier positions and sectors with less complex output resulting in the flattening and twisting of the "U" shape.

While most studies focus on a single sector or region, this study involves many sectors and many countries that provide a real global context, thus extending the the GVC-related empirical studies concerning the CEER.
To further facilitate the significant catching up process, the upstream-weak economies should develop their structure in a way that less simple and specialised production

process is done in high ratio in any sector. The heavy manufacturing should elaborate market connections and develop the connections to the customers. It alerts that a transition is required from extensive to intensive and knowledge-based developments.

4.2. Introduction

In Eastern European countries the question constantly arises as to whether the peripheral situation resulting from Soviet influence has already been dismantled and whether they have successfully emerged from the low- and middle-income trap after the transformations that have taken place. Freedom of foreign trade and technological development have paved the way for these countries to be a part of global supply chains. In a way it is common in the world to distribute the production of most components for certain products in order to maximise production efficiency. In recent years there has been a growing tendency for the path from input to output to become longer. The products of many sectors are used to a greater extent by the production of other sectors rathet than end users, and the input of a certain sector goes a long way to becoming a finished product that can be consumed or accumulated. This kind of unbundling allows influential countries to keep higher value-added activities within their borders and to cover these products from export, outsource lower value-added activities or produce the products in another country in the form of FDI (foreign direct investment). Research of Minarik et. al. (2022) shows a good example of how other activities related to the production of the automotive industry (such as transportation and warehousing activities) can increase the share of value added in an exceptionally low value-added global sector.

This study is aimed at an exploratory quantitative investigation, for which several questions can be formulated. There is a lot of literature dealing with the catching up of Eastern-European countries. The measurement of "catch-up" is usually done by a high-level, aggregated indicator, which is contributed by many factors. In the literature related to GVC (global value chain), there seems to be a gap as the relationship between the production of added value and the performance and position of sectors is not examined quantitatively. During the examination, several questions were formulated: How did the examined country group catch up with Germany and the USA? Which countries or country groups show similarities in the UMD (Upstream, Manufacturing, Downstream) structure compared to the benchmark countries? Can a significant difference be spotted in the UMD structure and a significant difference in added value in the case of the examined countries?

This article aims to fill in the gap in literature by answering the following question:: how much does the GVC position of the region contribute to the strengthening of catch-up?

Smile curve framework places these GVC analysys in a system and measures whether a given activity or sector is closer to inputs or outputs and how value-added production develops. The horizontal dimension of the smile curve, the downstreamness index, at the industry level is able to condense inter-sectoral relationships, accumulation, and material-to-end-use ratios into a single indicator in a complex way. In the vertical direction, the value-added content of the output is displayed.

To be more precise, the hypothesis of the smile curve is that significantly different value-added content can be produced from development work (basic and applied research, planning, production preparation, etc.) to strongly related tasks to customers and sales (marketing, output logistics) in the value chain by the participants in the economy. This statement is mostly accepted as general truth among economists. The nowdays widely used basic theorem and measurement can be related to Shih, Stan (1992), Mudambi (2008), Antràs, P., Chor, D., Fally, T., & Hillberry, R. (2012) and Antràs–Chor's (2013) work. The original theorem was a micro level examination, which was based on the function of firms, but later researchers proved that the theorem could be used in sectoral level as well (Armando Rungi–Davide Del Prete (2017); Stöllinger, Roman (2019); Hagemejer, J.–Ghodsi, M. (2017); Boda (2020); Boda et al. (2021) and so more).

To sum up the theorem, let's simplify the statement to: those activities of which outputs, get to further processing, but do not get to final consumption or only in a slight rate, can be found in the beginning of the value chain. These sectors/functions are called Upstream (U). In the middle of the value chain can be found the production (Manufacturing; M) sectors/functions, of which inputs are provided by the Upstream sectors and the big part of their outputs are processed by the Downstream (D) sectors before those outputs are sold to final consumption to the customers.

The name smile curve derives from the relation of Upstreamness (horizontal axis) and value-added ratio (vertical axis) as shown in *Figure 25*. According to the theory, higher value-added ratio can be reached at the beginning and at the end of the value chain, which can help sectors/functions to be more profitable than others in a lower level. (When I refer to UMD, I simplify the sectors that were classified in the aforementioned three main groups.)

Many researchers have studied smile curve; hence there is a wide range of international literature on micro level, namely, corporate value chain and of global value chain research which I present in Chapter 2 (Theoretical background of smile curve and its connection to the research) in detail. In this paper I present the analysis of the smile curve based on sectoral relations balance (SRB), or in other words the world input-output table, which I accomplished using the methodology of smile curve.

During my research I examined whether the smile curve can really appear considering the CEER (Central and Esatren-European Countries and Russia) countries, and the USA and Germany as benchmarks. To evaluate the sectors in each country, I use the methodology of Antràs, P., Chor, D., Fally, T., & Hillberry, R. (2012) and Antràs–Chor (2013). To get the most reliable results, I studied whether there are any better methods. Furthermore, I compared my results to the most commonly examined countries and the UMD classification methodologies, which can be found in international literature, and came to similar result, but those findings are not presented in this study.

As for CEER countries, I only examined the ones whose data can be driven from the WIOD (World Input-Output Database), and who are located in the central or eastern part of Europe and have post-communist past. These countries are: BGR Bulgaria; CZE Czech Republic; EST Estonia; HUN Hungary; LTU Lithuania; LVA Latvia; POL Poland; ROU Romania; RUS Russia; SVK Slovakia. When I refer to CEER countries or CEER country group in this study, I always mean the group of these countries. For benchmark I use the data of USA and Germany (DEU). I have chosen these two countries as benchmark, because Germany is a well-developed country and has the biggest influence in the region on the examined countries, and USA is one of the leading economies and has a very strong and often studied economy.

4.3. . Literature review

4.3.1. Theoretical background of GVC

Global value chain got in the centre of the business thinking decades ago. Studying value chains and corporate competitive edge, Porter (Porter, 1985) pointed out that the functions of the value chain should be analysed separately because each of them provide different added value for the saleable products and services. The corporate level interpretation used by Porter reached another level of economy organisation within a short time. Extending the thread to global trade relations, the base of the examination is formed by where sectors are placed in value chains. Technological development and the reduction of transactional costs caused a dramatic change in production tasks and in international division of labour (Krugman et al., 1995), therefore the relevance of national economy and global analyses increased beside the corporate level interpretation. This paper also deals with global relations in sector level.

In the globalised world the same NACE-coded[52] sectors vary very much across countries. Sometimes they produce final outputs or intermediate outputs for different sectors, or even for the same sector in the same or different countries. There are several reasons behind it. One of it is the specialisation of firms. Lot of enterprises just clear their processes and leave some elements, because they cannot do it efficiently enough. In this case they simply buy certain parts from another company. In case the company is profitable enough, it can outsource some processes, or even might create or join to a joint venture.

Baldwin was also thinking about global value chain when he created the model of the attainment of globalisation in his study. Baldwin (2015) says that due to the changes of trade activity, the majority of EU companies are capable of outsourcing tasks which were categorised as non-tradable before. In addition, he led the following aspect into the common knowledge: bigger companies plan the labour required by the production by using partly domestic labour and their knowledge, and at the same time calculating with labour from different places of the world[53]. It turned out that those parts of tasks that

[52] Nomenclature générale des activités économiques dans les Communautés Européennes – NACE (Nomenclature of Economic Activities)

[53] He meant both the mobility of labour including telework with digital assets, and the outsourcing of certain processes of the value chain for other participants.

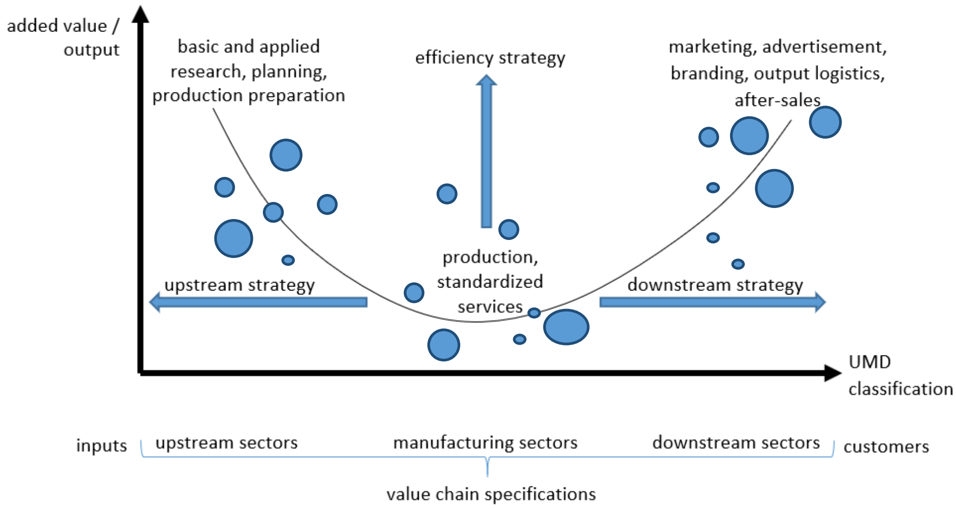
required high qualification were easily outsourceable but some professions, which were not outsourceable at all or were hardly outsourceable, remained (Baldwin, 2006).

This phenomenon is an extensively researched area among CEER countries, and the result is not consensual. Some researchers claim that this saved the countries in modern times by the foreign direct investments, some researchers claims that those caused more harm than benefits, because the ratio of value-added in output stayed low. To examine the smile curve of each country can bring us one step closer to understanding. In the value-added production of most CEER countries, the foreign-owned capital plays an important role (Sass M., 2021).

Related to the smile curve the most popular articles are Rungi and Del Prete's (Rungi and Del Prete 2017), Mudambi's (Mudambi, 2008) and Antràs–Chor's (Antràs–Chor, 2013) studies, which provided insight of the theoretical context. They can be considered as the basic literature of the topic.

Armando Rungi and Davide Del Prete's study from 2017 is strongly related to Baldwin's. The authors also studied the distribution of the genesis of added value along the global value chain. In certain sectors there is a significant difference in the distribution of added value per production unit. This effect is called smile curve by the literature as the sectors organised in three categories (upstream, production and downstream; or pre-production, production, and post-production (Mudambi, 2008)), the curve in the coordinate system will be a parabola similar to a smile. (See *Figure 25*) Sectors on the edges from among the participating ones in the analysis can 'smile' since they have higher added value per output unit. These are the sectors that should be reasonably strived after.

Figure 25: The explanation of smile curve theorem



Source: Own collaboration according to Boda et al. (2021) based on Armando Rungi–Davide Del Prete (2017). The first variant of the figure was published by Boda (2020, pp. 15).

Note: Blue bubbles, spots represent different sectors and specialised activities

Figure 25 deepens the visualisation of Mudambi's and Stöllinger's original smile curve figure. It specifies how value-added creation (y axis) becomes measurable by the rate of added value and output. It can be calculated either for companies or sectors. It also displays which sectors stand typically closer to inputs[54] and to their production, and also which sectors stand closer to the customers (market). Furthermore, strategic opportunities are also named about which direction the sectors can move. The common interpretation of strategy can be seen at corporate level, but sectoral strategic lines can also take shape in case the stake-holder companies are ran along similar policies. The increase of value-added ratio is a fundamental purpose of all companies and sectors since high benefit can be secured by high value-added content. Of course, an increase of value-added ratio can be successfully reached by several methods, such as efficiency increasing investments. For example, based on the smile curve framework, reducing or outsourcing of the functions are found in the middle of the smile curve, and concentration of resources to upstream and/or downstream direc-tions can also be efficiency increasing. In case a sector increases its input and production preparation

[54] Input: input materials, products and services that participate in value creation.

rate, it will move towards an upstream strategy direction such as, increasing the rate of R&D (Research and Development), taking on new basic research, examinations, discoveries. In case a sector moves rather to-wards the customers, it will run along a downstream strategy, for example, its products and services move to final consumption increasing marketing, sales motivating, and sales related functions. However, in case it stays in the middle but wants to increase its value-added ratio in output, it can work along an efficiency increasing strategy by the development and modernisation of manufacturing tasks. We should note that the bubbles in *Figure 25* indicate that sectors can vary around the two dimensions. Therefore, it is not true that a sector must always be on the curve.

A certain sector can be examined by its relative position along the curve, accordingly in which section it falls along x axis, also by the rate of added value and output in a certain year. Derivations from the other sectors need to be examined during determining the relative position to ensure the comparability among different countries. Further conclusions can be drawn during the analysis by taking the time factor into consideration. If the relative position is determined for two time periods, the direction of dislocation along x and y axis will display to which part (front/middle/end) of the value chain the certain sector is oriented and whether the strategy change has caused efficiency increase or decrease. Therefore, smile curve framework can also be validated by sectoral dynamics. For instance, if the company moves from production to up-stream in line with increasing value-added ratio, or reversed, or if it moves from downstream to production in line with decreasing value-added ratio, the smile curve framework becomes confirmed. Hence, the direction of increase strategy can be concluded by taking the timelines into consideration, namely, whether the sector turns upsteramed, downstreamed, bound in the middle, or with no movement along the value chain still increasing its efficiency. This kind of method is not appropriate for determining the purposefulness since sectors can be dislocated towards any direction by several external environmental factors.

4.3.2. CEER countries' economies in GVCs

Examining CEER countries and comparing them to chosen benchmark countries can be done by examining the position of their upstream, manufacturing, and downstream sector-groups.

The name 'smile curve' refers to the whole framework displayed in *Figure 25*, so it includes both the vertical y axis dimension (rate of added value and output) and the horizontal x axis (sector position in value chain). Sector classification to the right categories might also be set by defining the criteria of UMD extremum by drawing vertical lines. Classification of the UMD categories has a detailed methodology which is mainly discussed in the methodological chapter. In this paper the classification is also part of the smile curve framework.

It is important to call attention to the value chain in firm level that describes the relation of classical value adding processes within the company (Porter, 1985), however, *Figure 25* describes a value chain which can be extended to intercorporate relation (Bowersox & Closs, 1996). A supply chain belonging to global value chain can be reviewed at sector level with the national economy SRB used in the analysis.

It is generally accepted that value chain-links, geographically spread far from each other, and are able to run as independent companies – specialised to a certain task of the value chain – according to where further tasks are done by completely separate companies regardless of any proprietorial or locational aspects, thanks to information technology and assets. (Jones & Kierzkowski, 1990, 2001) Thus, outsourced operation related transactional costs are reduced. To make the specialisation profitable, either the outsourcing of certain sectoral functions, or the sale of sectoral outputs for separate economic parties are needed along with different wage levels of different countries. Profit might increase, if much more savings are reached by reducing wage costs than transactional costs[55]. All the above contributed to the development of smile curve framework, since studies of segmented manufacturing and of conspicuous differences in the added value producing capabilities among similar sectors of different countries

[55] This statement is only one reason highlighted mainly because of Hungary, however other reasons might also take place beyond wage arbitrage, such as R&D intensity encouraging relocation of which California is a good example.

become increasingly significant. (Stöllinger, 2019) Based on the theory, it is presumable that significant differences will occur during the ex-amination of sectors among the examined countries, since there are ’upstreamer’ and ’downstreamer’ functions even inside a certain sector, whose functions became outsourcable much easier on international level, thanks to globalisation and to the ever-decreasing transactional costs.

Rungi and Del Prete’s study from 2017 and Mudambi’s study from 2008 describes how they perform the sector classification to upstream, manufacturing, and downstream categories (this will take place in the methodological chapter).

The authors also used other authors’ previous results to their figure. Shih, Stan’s (1992) observation also appears in the U formed curve seen in the figure. The added value per production unit or per core activity service is the lowest especially in manufacturing, however it is much higher in the other two functions. It is important to mention that production and output indicators also involve basic commodity capacity, therefore in sectors where basic material demand is high, the value-added ratio of output is naturally lower than in sectors where there is no basic material or only a small amount, since added value already contains the outcomes rid from basic material values. These were deduced in a calculable form on corporate level by Koppány and Kovács (2011) in their study[56]. Two transitory categories can be mentioned before added value: the material free production value which is the gross production value reduced with material cost and with resorted services, and also the net production value which is the material free production value reduced with depreciation. And the added value can be calculated as the sum of labour costs, depreciation, and pre-tax profit. (Koppány & Kovács, 2011) Added value can also be deduced from adding capitalised value of self-manufactured assets to sales revenue and by deducting material expenses. Sectoral added value can be calculated by summing up the added values of the sector’s participants. This way we can get a bottom-up built computative system.

[56] „gross production value indicator takes into consideration only yields issued during the company’s own manufacturing function. These yields are on one hand the produced and sold (revenue), on the other hand the produced but not yet sold (+capitalised value of self-manufactured assets) products. Another option might be that a part of the sold products got produced in earlier periods, so their value is not part of the production value of a given time. In this case capitalised value of self-manufactured assets gets minus sign so it corrects properly the revenue. Cost of goods sold and value of transmitted services mean also negative correction since none of them are parts of either the sold goods or the subcontractor’s further billed capacity of the production value generated by the given company.” (Koppány & Kovács, 2011, pp. 39) (originally written in Hungarian)

The decreasing of production value is also explained by Prahalad and Hamel's (1990) core competence theory, i.e. companies primarily deal with tasks they know the best and they outsource the rest[57]. In case outsourcing gets to a place where they are more competent in the given task, the sum efficiency will probably increase. But it might decrease the measured added value (absolute value) because if a company had managed the transport on its own before but now it is outsourced, the value-added content of this action will not appear in that company but in another one, since the output will belong to the other one and the added value will appear there. These actions call attention to focusing on the value-added content of output in the first place and not on its absolute quantity, strengthening the importance of observation dimension by Shih, Stan (1992).

Several methodological descriptions of company UMD classifications are available in the literature. The sectoral relations balance (SRB – input-output table) can serve as a basis. Its reason is that it numerically defines the sectoral relations in inputs, outputs and consumption, furthermore, it has bound and solid methodology on which UMD analysis can be layed. International comparison is helped by the countries' surveying along the same logic which is reliable likewise.

For the sake of the whole picture, I reviewed a wide range of literature on smile curve, in which computational methodologies were included. I rated the relevant studies according to which level UMD classifications (micro, meso, macro) were used, or to which fields were covered by the analyses or by the authors, and to what kind of database they used and who else's methodology or theory was adapted to their own work. It is summarised in Table *19*:

[57] Development of IT made the measure of outsourcing and the range of outsourcable actions far wider. However, according to Baldwin's theory certain processes might be outsourced at an increasingly higher rate while apparently they stay within the company and don't get to another chain-link.

Table 19: Review of smile curve methodologies

Author, citation	Analysis time-base	Field coverage	Analysis unit	Analy-sis level	Database	Referred methodologies
ANTRÀS, Pol–CHOR, Davin (2013). Organizing the global value chain.	2000-2010	U.S.	U.S. intrafirm imports in total U.S. imports in the manufacturing industries	micro/ meso	U.S. Input Output tables, U.S. Census Bureau's Related Party Trade Database, NAICS	Acemoglu, Antràs, and Helpman (2007) Antràs (2003, 2005) Antràs and Helpman (2004, 2008) Antràs, Chor, Fally, and Hillberry (2012) Leontief Inverse Matrix Broda and Weinstein (2006)
HAGEMEJER, J.–GHODSI, M. (2017). Up or Down the Value Chain? A Comparative Analysis of the GVC Position of the Economies of the New EU Member States.	1995-2011	EU, OECD, Rest of the World (ROW)	41 regions, 35 sectors (considering the world a closed economy)	meso	WIOD	Miller and Temurshoev 2015: Closed economy approach Chor, Manova and Yu (2014) Antràs *et al*. (2012)
RUNGI, Armando–DEL PRETE, Davide (2017). The "Smile Curve": where value is added along supply chains.	2015	EU15	2 million companies	micro	Orbis	Antràs and Chor (2013) Sturgeon (2008) Mudambi (2008)
CIEŚLIK, Ewa–BIEGAŃSKA, Jadwig–ŚRODA-MURAWSKA, Stefania (2016). The intensification of foreign trade in post-socialist countries and their role in global value chains.	2000-2009	Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia	National economy of mentioned countries	macro	OECD, WTO databases	Hummels *et al*. (2001),
Łukasz AMBROZIAK (2018). The CEECs in global value chains: the role of Germany.	1995-2011	Germany + Czech Republic, Hungary, Poland, Slovakia, Slovenia, Estonia, Lithuania, Latvia, Bulgaria, Romania	Central and Eastern European countries (CEECs)	macro	WIOD	Stehrer (2013)
Current study	2000-2014	CEER countries from WIOD and DEU and USA	Sectors and aggregates of examined countries	macro/ meso	WIOD	Antràs *et al*. (2012) Antràs–Chor (2013) Mudambi (2008) Rungi–Del Prete (2017)

Source: own elaboration based on the above-mentioned literatures.

The above-mentioned studies examine the smile curve and GVC from different perspective, region, or time period, and they have less focus on the combined methodology part with the WIOD based measure-ments of the upstreamness. In this paper the indicators are combined, and the grouping of the sectors to UMD categories are done by an exact methodology. This gives the chance, that via a complex methodolo-gy, simplified and understandable results can be presented to country groups or sectoral groups. This study gives an exploratory overview among the chosen countries, and country groups, moreover it is compared to the benchmark countries.

4.4. Research methodology

Further parts of methodological description involve the necessary methodologies of smile curve calculation (including UMD analysis) and the detailed description of input data.

4.4.1. Classification of the sectors according to their positions in the value chain

During the UMD methodologies overview I adapted Antràs–Chor procedure since their methodology is defined in sectoral level, which plays a central role in my research, and further charted literatures also refer to the authors as providers of core methodology. I find the highlighted methodology detailed, usable and mathematically verifiable and, based on available data, applicable in my research. Hagemejer and Ghodsi (2017) also base their analysis on Antràs–Chor (2013) methodology, by which EU and OECD countries are covered involving countries of my research as well. Cieślik–Biegańska–Środa–Murawska (2016) methodolo-gy is at macro level, so it handles whole national economies which do not fit to my research, that is why I dismissed it. Beyond applying Antràs–Chor methodology as a basis. The above mentioned two studies use WIOD database which I also operate with during my research.

Antràs–Chor procedure calculates an indicator based on sectoral relations balance (SRB – input-output table) for each sector correlating direct finished goods production (aggregate direct use) of a certain sector to the whole production beyond finished goods production, namely, total production use. This indicator can be deduced by a formula as well.

The authors interpret this indicator as the following: „The higher is this indicator for a given industry, the more intensive is its use as a direct input for final use production". (Antràs & Chor, 2013, pp. 26) Thus, the higher the indicator is, the more downstream the sector is. The higher the finished product rate is, the more downstream the sector is. And the lower the rate is, the more upstream the sector is.

The currently available database enables the examination between 2000 and 2014. 15 years is a long pe-riod. Examining the phenomenon is enabled by attempts on setting the world input-output tables. Out of these I use the results of the so called WIOT[58] (World Input-Output Table or better known as WIOD). This table assembles input-output tables of the majority of the world. (Particular input-output tables – SRBs – of 43+1 countries[59] can be deduced at current rate, in USD, yearly between 2000 and 2014[60].) In these input-output tables the followings are displayed:

- added value,
- all the output or production, and
- factorisation of all the output to:
  - producer consumption, final consumption, gross accumulation, and export, and
  - domestic and import material consumption, taxes, and subsidies, and added value.

Smile curve is deductible out of these data, if we accept the upstream-manufacturing-downstream com-putational methodology after Antràs–Chor downstreamness calculation procedure for the horizontal axis, and the value-added ratio of output as vertical axis.

Computational methodology of smile curve (including UMD classification) was already described on a theoretical level in the previous chapter, but the methodology chapter cannot be complete without presenting the most determining detailed methodologies. Formulas and their indicators are necessary to be described. For this I present Antràs–Chor (2013) primer methodology in detail. Hagemejer–Ghodsi (2017) also took Antràs–Chor (2013) methodology as a basis and applied it during empiric calculations from WIOD database.

4.4.2. Adaptation of Antràs–Chor's (2013) methodology

This subchapter contains the methodological description and highlights based on ANTRÀS, Pol and CHOR, Davin (2013): Organizing the global value chain. Depicted

[58] http://www.wiod.org/home
[59] List of country codes used in WIOD is found in the appendix.
[60] As it is a deep structural analysis measuring the trend of very slow processes, year 2014 cannot be considered as obsolete due to the time consumption of database.

formulas and texts are inserted from the referred work, except the ones with another source label.

Upstreamness and Downstreamness

Novelty of the model is that with mathematical methods it ranks expository variables not quantified before, namely, the relative position of sectors in the value chain, and classifies them into three – not applied before – categories (UMD). Authors used simple Input-Output basic correlation to create the methodology based on index-numbers in sectoral relations balance:

$$Y_i = F_i + Z_i, \tag{1}$$

where:

Y_i − the full output of sectoral i

F_i − the sum of outputs of sector i of which outputs get to final consumption and investment

Z_i − outputs of sector i which serves as other sectors' inputs (or 'full consumption as input')

In a world where there are N sectors, the formula is expandable as follows:

$$Y_i = F_i + \underbrace{\sum_{j=1}^{N} d_{ij} F_j}_{\text{direct use of } i \text{ as input}} + \underbrace{\sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik} d_{kj} F_j + \sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N} d_{il} d_{lk} d_{kj} F_j + \cdots,}_{\text{indirect use of } i \text{ as input}} \tag{2}$$

where:

d_{ij} − a pairing of two sectors (i,j)

$1 \leq i, j \leq N - j$ show how much input was used by i to produce proper output for a onedollar[61]

We must take into consideration that the second expression on the right of Figure *26* shows the direct consumption from input *i*, namely, the whole value of input purchased by *i* from *j* which is used up for producing outputs for final consumption. The other expressions including higher-class summary reflect how much the indirect consumption of *i* is as an input, since they join to other upstream processes in the value chain, but they

[61] Money dimensions of used up data, Antràs–Chor calculated in USD.

miss out at least two manufacturing conditions on final consumption. The above mentioned can be represented as a compact matrix with superposition of sectors i:

$$Y = F + DF + D^2F + D^3F + \cdots = [I - D]^{-1}F, \qquad (3)$$

where:

Y and F $N\times1$ vectors, of which the values of entry at row i are Y_i and F_i

D − direct criteria matrix $N\times N$, of which entry at (i,j) is d_{ij}

The first index-number of downstreamness is DUse_TUse (for the sake of simple differentation of indicators I coherently refer to this indicator in the study as upstreamness indicator) which is the rate of aggregated direct consumption at row i and the total aggregated consumption as input. More precisely it is calculated as follows: entry i (e.g., value of direct consumption at row i as input for the final consumption summarised along each customer sectors at column j) of DF column vector is divided by entry of Y,F (which equals to the value of total consumption of i as input summarised along each customer sectors at column j). The higher the DUse_TUse index-number of sector i is, the more intensive the consumption of direct input for production of final consumption is, so the major part of value i joins to the manufacturing relatively far from downstream. On the other hand, the low value of DUse_TUse indicates that the largest part of contribution for manufacturing processes of input i goes indirectly, namely, rather in upstream stages.

To take it simplified, it can be stated that the higher the value of DUse_TUse indicator is, the more likely it is to be around the downstream sector, and the lower the value is, the more likely it is to be around the upstream sector.

Their analysis was complemented by another downstreamness index-number called DownMeasure (for the sake of simple differentation of indicators I coherently refer to this indicator in the study as downstreamness indicator) whose purpose is the complete use of information on indirect input data in upstream stages. Another calculation distinguishes the value of indirect consumption according to the numbers of production stages of final consumption, depending on which stage the input joins to the value chain in. We must get back to Formula 2 where the output for final consumption (first expression on the right) is weighted by 1, the input directly used up during the production of final consumption (second expression on the right) is weighted by 2, and the third expression on the right is weighted by 3 and so on. It leads to the following calculation in matrix form:

$$F + 2DF + 3D^2F + 4D^3F + \cdots = [I - D]^{-2}F. \quad (4)$$

In case of each sector *i* entrant was taken at sub *i* of $\{I\text{-}D\}^{-2}$ F, then it was normalised by Y_i. In the higher position (upstream) the input joins to the value chain, the greater weights are used. It gives the index-number of upstreamness which is, for this reason, greater than or equal to 1. (The value can take 1 only if all the output of the certain sector got to final consumption and these outputs were not used as inputs by other sectors.) To keep the sectoral DownMeasure index-number of all *i*, we have to take the reciprocal, so DownMeasure gets to interval {0,1}. The second variable possesses several desirable attributes strenghtening the measure of sector position.

The reciprocal of DownMeasure (or Down_Rec) is an indicator, of which it is statable – taking it simplified like DUse_TUse indicator – that the higher the value of indicator is, the more likely it is about downstream sector, and the lower this value is, the more likely it is about upstream sector. In my research, I named downstreamness index the Down_Rec calculated from WIOD data.

Fally and Hillberry (2012) stated that the upstreamness value of the variable (upstreamness variable) is in fact equivalent to the rate of the distance of a sector and the final demand determined in a recursive way (Fally, 2012). Fally's (2012) conclusion is based on the thought which says that sectors themselves who are purchasing many inputs from other upstream sectors are also relative upstreams. Upstreamness variable can also be called as index-number of cost-push effects or forward linkages – the measure of the increase of outputs of all the sectors in the economy as a result of a onedollar increase in added value of the sector in question – this one was highlighted in the supply branch of so-called input-output literature in Ghosh's (1958) and Miller–Blair's (2009) works as well.

Not surprisingly, sectors with low downstreamness value usually process fuel, chemicals, or metals, while sectors with higher values are the ones where goods are usually close to the end of the value chain.

4.4.3. Empirical definition

In the following section I demonstrate the authors' (Antràs–Chor) description of empirical definition by which they could uncover the share of production inside corporate trade. As a basis they applied the regres-sion examination among sectors.

$$S_{it} = \beta_1 D_i \times 1(\rho_i < \rho_{med}) + \beta_2 D_i \times 1(\rho_i > \rho_{med}) + \beta_3 1(\rho_i > \rho_{med}) + \beta_X X_{it} + \alpha_t + \varepsilon_{it}. \quad (5)$$

Dependent variable S_{it} in year t shows the share inside corporate import at sector i in the United States. They aimed to explain it in the sectoral downstreamness function D_i, such as DUse_TUse or DownMeasure were also set. Important criterion is to take into consideration the instructions of their model they distinguish downstreamness effects in sequential supplements and in other substitute occasions. They analyse D_i the interaction of indicator variables 1(ρi > ρmed) and 1(ρi < ρmed) in sectors where it is equal to 1 if common demand elasticity of purchasing sectors as input *i* is lower, ergo it is under the intersectoral median value of this variable.

The model indicates that differences among countries might be useful in prevalence[62] of integration to eliminate prepossessions which concern endogenous positioning decisions of the companies during different stages of the production. That is why they examined specifications which reveal the sectoral changes on country level:

$$S_{ict} = \beta_1 D_i \times 1(\rho_i < \rho_{med}) + \beta_2 D_i \times 1(\rho_i > \rho_{med}) + \beta_3 1(\rho_i > \rho_{med}) + \beta_X X_{it} + \alpha_{ct} + \varepsilon_{ict}. \quad (6)$$

So, this formula explains the intercorporate import. S_{ict} refers to the exporter country on yearly sectoral level such as the similar set of sectoral variables, while it controls the pegged effects of the country in a particular year, α_{ct}, and also the standard mistakes (in a conservative aspect) per sector.

[62] Prevalence is the incidence rate of a certain occurrence at a given time (or period) affecting a given population.

4.4.4. Aggregating sectors and country groups among downstreamness indicator

To examine the sectoral correlation and to check on the smile curve related applied theory I made numerous calculations and I rely on them in my methodology. I calculated the upstreamness (DUse_TUse) and downstreamness (Down_Rec) indicators of all the sectors displayed in WIOD, and also what value they have overall the sectors in the world.[63]

To check on the methodology I drew the sectors of the countries in the coordinate system based on upstreamness/downstreamness and value-added ratio, additionally classified the sectors to UMD categories based on the indicators, aggregated the values (creating UMD sector groups) and drew the curves. In case of classifying to UMD categories, sectoral relations of a certain country are also have to be taken into consideration beyond mere upstreamness and downstreamness values, which makes the classification quite complicated. It is necessary to analyse what upstreamness and downstreamness values are taken by supplier sectors and what values are taken by customer sectors, so the sectors of certain countries should be classified to UMD categories based on the whole picture of these correlations. It is too complicated during the analysis of more countries, and this is why it is suggested to apply simplifications (e.g., choosing direct cut values along upstreamness and downstreamness indicators). Based on a certain country's upstreamness and downstreamness values, all the sectors might get into manufacturing and downstream category, if sectors were classified based on cut value (e.g., India, USA). Classifications must be corrected with sectoral relations; this way UMD categories of smile curve get outlined in these countries as well.

According to the results it is noticeable that the drawn curves, based on upstreamness and downstreamness indicators and added value, clearly show the smile shape in most countries (mainly in well-developed ones such as USA, Switzerland, Germany, Austria, Belgium etc.), although with a relatively low, approximately 0.2 R^2 value. Some countries with the same figure took rather a '/' shape. Calculation to the whole world also took rather a '/' shaped curve with approximately 0.15 R^2 value. These statements are in line with Boda's (2020) ones who also used WIOD database to his research.

[63] The "World" data is from the aggregation based on the input-output tables of 43+1 (+1=Rest of the World) countries.

I got further results worth mentioning by comparing the two indicators: upstreamness and downstreamness. One of the reasons is that displaying the results continuously with both indicators requires great efforts. The other reason is that it is not fortunate when not the same order is formed based on the two index-number during classification along cut value. Its similarity with Spearman rank correlation was represented by me. Based on the results summarised to the whole world I enqueued upstreamness and downstreamness indicators so the country positions became definable. Based on computational results relatively strong connections are measurable among data from years 2000 and 2014. In case of the former ρ^2=60%, in case of the latter ρ^2 equals almost to 70%. Downstreamness variance is wider: between 0.28 and 0.91 while upstreamness variance is only between 0.24 and 0.75 (2014). Besides it is noticeable that in case of classifications with larger differences rather downstreamness indicator delivers the result would be logical according to the theory. For example, mining sector is transferred into downstream category based on upstreamness, however based on downstreamness indicator it is a strong upstream sector near the manufacturing border. Further observation is that the downstreamer a sector is, the more similar classification we get by the two indicators. There are bigger differences on the border of manufacturing and upstream. The reasons of the differences were not in focus right now but based on these examinations I found downstreamness indicator a better one in overall, but of course it was expedient to take both of them into consideration as far as possible.

In case cut value is defined along the classification based on summarised data of the world and 54 sectors get trisected, upstreamness indicator takes 0.46 as an upstream border and 0.51 as a downstream border in 2000. In 2014 U (Upstream) and M (Manufacturing) cut value is 0.42, M and D (Downstream) cut value is 0.47.

Along downstreamness U and M cut value is 0.39, M and D cut value is 0.50 based on data from year 2000. In 2014 they are 0.36 and 0.46. It is summarised in the following table. Manufacturing takes from the upper value of Upstream until the bottom value of Downstream. (See Table *20.*

Table 20: Cut value based on UMD classification of the world in 2000 and in 2014

Based on Upstreamness	**Upstream**	**Downstream**
2000	Upstream<0.46	Downstream>0.51
2014	Upstream<0.42	Downstream>0.47
Based on Downstreamness		
2000	**Upstream<0.39**	**Downstream>0.50**
2014	Upstream<0.36	Downstream>0.46

Source: own elaboration.

Cut values represent clearly how sector values move to upstream direction. The range of the two values do not change: in case of upstreamness the difference is approximately 0.05, while in case of downstream-ness it is stable 0.1, i.e. sectors moved downwards together. It is important to highlight that in this world scale examination the trisection of sectors make the calculations much simpler since this study does not focus on determining the actual numbers and types of sectors in certain categories. Still, this simplified condition called the attention to the dislocation.

Smile curve was calculated and displayed based on 43+1 countries. In the chapter below the most important conclusions are demonstrated via some of the highlighted countries.

Using the cut values of downstreamness index, all countries' sectors were summed up to sectoral groups among if the sector is considered as upstream, manufacturing or downstream. With this simplification every country or country group has three dots in each year in the smile curve coordinating system. It is not easy to choose the correct aggregation methodology, because none can ensure totally equal circumstances, but in this study, I had chosen the introduced world average cut value for the year 2000 (0,39 and 0,50). This simplification can show us how the sectors drift along the downstreamness index. I have to call the reader's attention to keep in mind that not the same sectors are put in each country to upstream, manufacturing and downstream categories, because the direct downstreamness value of each element was used in the calculation.

In case we would like to aggregate countries data for a country group, we can use two logically correct method:

- We aggregate each country's UMD sectoral group, and we calculate the weighted average.

- We aggregate each country's individual sectoral input-output data, and we recalculate the UMD sec-toral groups as we do it in each country.

In the first case it is not ensured that the same sectors are in the UMD categories from each country, but we ensure that independently from other countries, we show the weighted sum of all upstream sectors. In the second case it is a way of thinking that this geographical unit can be considered as a big country, be-cause the sectors are strongly connected. I calculated every indicator in both ways and there was not a significant difference in the final results. If we aggregate each country's UMD sectoral group, we get a bit more upstream-weighted results, so more sectors are added to upstream category and more to manufacturing.

In this study I use the second method, so I aggregate each country's individual sectoral input-output data.

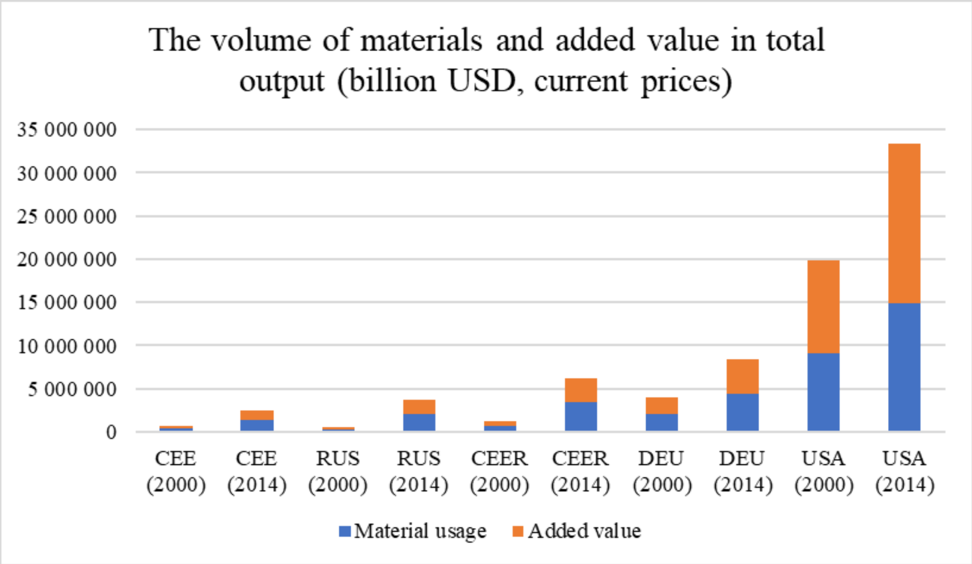
4.5. Results and discussion

The Central and Eastern European periphery and Russia (according to domestic indicators) are steadily closing the gap with developed western countries. This can be seen in the mass value added produced, as the total CEER output in 2014 is 74% of Germany's 2014 output, while the total value added of the CEER countries is 70% of the German value added. These were only 30% and 28% in 2000. Note: The distance from Germany is slightly reduced from the US, where the values are: 2000: 20%; 18%; 2014: 25%; 22%.

As Russia accounts for almost half of the value-added production of the country group, I also present this separately (CEE and RUS). There is still a gap in the value-added share compared to the benchmark countries. This gap is larger in the CEE group of countries than in the CEER group, so Russia is raising the average.

If we take value added per capita or GDP as a basis, the gap is still large, but of course it is narrowing. Perceiving the difference in population, in 2014 there were 318 million people in the US, 81 million in Germany, compared to 144 million in Russia alone, but a total of around 100 million people in the CEE countries. The CEER countries, complemented by Germany, would equal the US in terms of population, but total out-put and total value added are only roughly half that of the United States.

Figure 26: The volume of materials and added value in total output in the examined country groups (bil-lion USD, current prices, 2000; 2014)



Source: Calculated from WIOD database. The percentages shown are the ratio of material consumption to value added in production. In this way, the value-added ratio and the material consumption ratio can be read.

The catching-up process is ongoing, but structural tensions are emerging. CEER countries tend to pro-duce a higher share of inputs for other sectors than of final goods, and these inputs also pass through more sectors, involve simpler work processes, and contain less value added than in other countries. The smile curve helps visualise this.

When comparing the CEER group of countries with Germany and the USA, the difference is very striking in that the most important sectors in the CEER countries are in production and upstream, and there are few significant sectors in the downstream. Production is also high in Germany, but there are also strong sectors downstream. In contrast, the U.S. has few and proportionately small upstream sectors and a huge down-stream.

The direction of the shifts between the two years is also striking. While the sectors of the CEER country group moved upstream and focused on manufacturing and the upstream side, Germany slightly strengthened the downstream side, while the US further strengthened the downstream side and the presence of the sectors decreased on the upstream side. These are shown in Figure *27*. Given that these shifts are the result of slow processes, the changes are not conspicuous even in a 14-year period, but the direction is clear. It can be assumed that it has slowed down somewhat, but the trend continues to this day.

Figure 27: The sectoral smile curve of the CEER country group, DEU and USA; year 2000 and 2014.

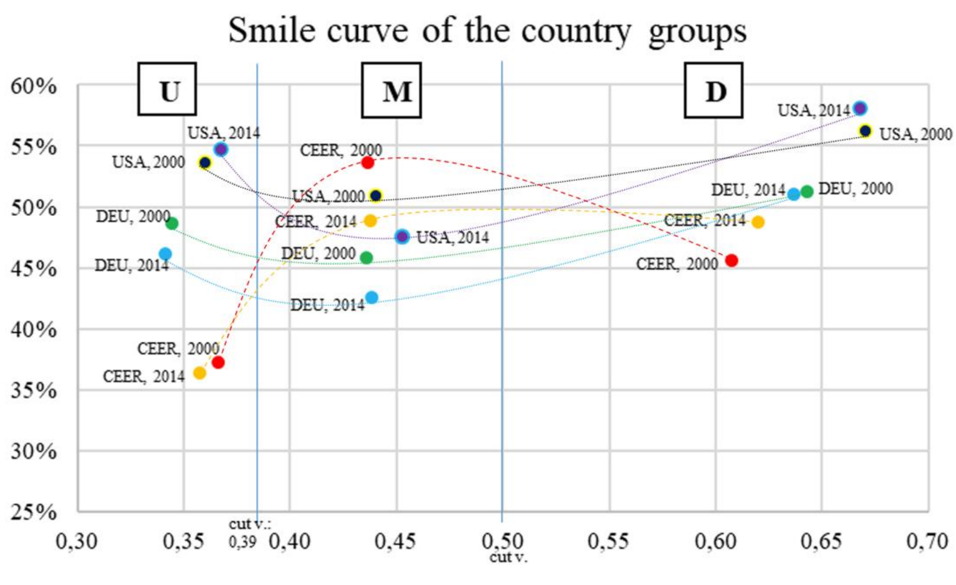
Source: own collaboration according to WIOD.

Bubbles: sectors; *X* axis: downstreamness indicator; *Y* axis: added value ratio; size of the bubbles: ratio of each sector's added value in the total added value

In the detailed bubble figure for all sectors in Figure *27*, the sectoral weight for the size of the bubble does not appear in the trend line, so the originally low R^2 values can be ignored. If the sectors are aggregated on the selected cut value menus to form the smile curve, which can be considered weighted, the true curve is obtained, which no longer includes the bias due to the outlier downstream health and education in Figure *27*, as well as the bias due to the low weight and low value-added sectors. The resulting curve for the UMD sector clusters is more in line with the real sectoral centroid trends. It is shown in Figure *28*.

In the Eastern European periphery, the income generation curve of countries does not take the classical "U" shape, but rather a "/" or "^" or an "r" shape. The curve of the CEER country group is also “^” in 2000, while in 2014 it is more “r” shaped. Thus, the share of value added in these countries in the upstream sector group fell below the originally low value-added share of production. It is about 10-15 percentage points lower than the average production profitability of the sample average smile curve. It should be noted, however, that the share of value added in the manufacturing sector group of the CEER group of countries is outstanding even compared to the benchmark countries. This means a much worse profitability position compared to countries where the profitability curve has shifted towards services in addition to the classic smile curve. Interestingly, in 2014, the CEER countries produced with a few percentage points higher value-added share in the manufacturing sectors than Germany. In the downstream sector group, there is no big difference between the individual countries, but it is also typical here, as in almost all the examined elements, that the value of the USA is the highest, followed by Germany and finally the CEER group of countries. This is illustrated in Figure *28*.

Figure 28: The smile curve of the examined country groups in year 2000 and 2014.



y axis: added value ratio; *x* axis: downstreamness value

Source: own elaboration based on WIOD.

The lack of value-added content in the CEER countries is also exacerbated by the fact that more sectors show upstream values based on the downstreamness indicator, than in the benchmark countries. Based on the aggregate sector groups, 36/**39%** of the sectors in the country group in 2000/**2014** are upstream, which produces 18/**22%** of the total value added, 36/**34%** are manufacturing sectors, which produce a high 45/**44%** of value added and 29/**27%** is the weight of downstream sectors, their value-added production accounts for 34/**37%** of total value added. For benchmark countries, these ratios are shifting downstream. These are summarised in Table *21*.

Table 21: The UMD structure of the examined country groups in year 2000 and in **2014**.

Country	**Indicator**	**Year**	**Share of U**	**Share of M**	**Share of D**	**Total**
CEER	Ratio of sectors	2000 **2014**	36% **39%**	35% **34%**	29% **26%**	100%= 56 pcs **100%= 56 pcs**
CEER	Ratio of added value	2000 **2014**	18% **22%**	45% **44%**	37% **34%**	100%= 568 522 **100%= 2 823 041**
DEU	Ratio of sectors	2000 **2014**	25% **25%**	34% **34%**	41% **41%**	100%=56 pcs **100%=56 pcs**
DEU	Ratio of added value	2000 **2014**	15% **16%**	25% **26%**	60% **58%**	100%=1 969 179 **100%= 3 992 428**
USA	Ratio of sectors	2000 **2014**	25% **23%**	32% **30%**	43% **46%**	100%=56 pcs **100%=56 pcs**
USA	Ratio of added value	2000 **2014**	13% **14%**	24% **19%**	63% **66%**	100%= 10 826 714 **100%=18 440 962**

Source: own elaboration based on WIOD (total data is in current prices in billion USD).

It can be clearly seen from the data that although in each country the downstream sector group produces half/two thirds of the value added, one third less than half of the sectors are present in this category.

The total value added according to WIOD is included in Table *21* by way of illustration, which shows that the weight of the entire CEER group of countries is close to that of Germany, but about six times lower than in the USA. (Figures are in current prices, expressed in billions of dollars.) The weights are also justified because while the value added of the CEER countries was only 29% of the German value in 2000, in 2014 it was already 70%. This is a big catch-up. If we add the production value, it already gives out 75% instead of the previous 31%. This shows that the CEER countries are trying to catch up with the Western countries at a tremendous pace, even though there have been crisis years in the given period. It should be noted that Germany is also catching up with US value-added production, rising from 18% to 22%.

The gap between the benchmark countries and the CEER countries is very significant. It is necessary to look deeper, at the level of countries, as a first step, and to look back at the theoretical framework. Table *22* provides an overview of the main set of structural indicators by country and group of countries. Figure *29* also shows visually the proportion of sectors in U-M-D groups by country. First of all, the difference is striking that in all CEER countries, with the exception of two countries (LTU, RUS), the share of upstream sectors is very high, ranging from 40-50%, while in the case of USA and Germany it is 20-25%. In addition, the share of value added is around 25-30%, while in the two western countries it is 40-50%. (Figure *30*)

Table 22: The share of UMD sectoral groups in the CEER countries and country groups, and in the bench-mark countries

2000	AV/Output				Added value structure				Output structure			
	U	M	D	Total	U	M	D	Total	U	M	D	Total
BGR	36%	41%	50%	42%	36%	27%	37%	100%	42%	27%	31%	100%
CZE	38%	34%	48%	40%	45%	21%	35%	100%	46%	25%	29%	100%
EST	36%	46%	42%	41%	36%	29%	35%	100%	40%	26%	34%	100%
HUN	34%	39%	48%	38%	49%	19%	31%	100%	56%	19%	25%	100%
LTU	47%	55%	51%	52%	5%	35%	61%	100%	5%	33%	62%	100%
LVA	35%	50%	47%	43%	27%	25%	48%	100%	34%	22%	44%	100%
POL	40%	48%	44%	44%	20%	35%	45%	100%	22%	32%	45%	100%
ROU	48%	39%	47%	45%	25%	24%	51%	100%	24%	28%	49%	100%
RUS	47%	50%	52%	51%	4%	34%	63%	100%	4%	35%	61%	100%
SVK	32%	39%	48%	37%	44%	30%	25%	100%	51%	29%	20%	100%
V4	37%	43%	45%	42%	32%	29%	39%	100%	36%	28%	36%	100%
CEE	38%	43%	46%	42%	30%	29%	41%	100%	34%	28%	38%	100%
Not V4 CEE	41%	43%	48%	45%	25%	27%	49%	100%	27%	27%	46%	100%
CEER	**37%**	**54%**	**46%**	**45%**	**18%**	**45%**	**37%**	**100%**	**22%**	**39%**	**38%**	**100%**
DEU	49%	46%	51%	49%	15%	25%	60%	100%	16%	26%	58%	100%
USA	54%	51%	56%	55%	14%	24%	63%	100%	14%	25%	61%	100%

2014	AV/Output				Added value structure				Output structure			
	U	M	D	Total	U	M	D	Total	U	M	D	Total
BGR	39%	38%	41%	39%	27%	43%	29%	100%	27%	45%	28%	100%
CZE	36%	29%	45%	36%	49%	26%	25%	100%	48%	32%	20%	100%
EST	40%	40%	41%	40%	35%	34%	31%	100%	35%	35%	30%	100%
HUN	36%	46%	39%	39%	49%	16%	35%	100%	52%	14%	34%	100%
LTU	55%	47%	50%	50%	11%	30%	60%	100%	10%	31%	59%	100%
LVA	36%	42%	48%	41%	32%	39%	29%	100%	37%	39%	25%	100%
POL	37%	46%	44%	42%	29%	27%	43%	100%	34%	25%	41%	100%
ROU	40%	38%	47%	43%	32%	11%	57%	100%	34%	13%	53%	100%
RUS	31%	48%	51%	47%	11%	36%	53%	100%	16%	36%	48%	100%
SVK	34%	33%	50%	37%	43%	26%	31%	100%	47%	30%	24%	100%
V4	36%	39%	44%	40%	38%	25%	37%	100%	41%	26%	33%	100%
CEE	37%	39%	45%	40%	35%	25%	40%	100%	38%	25%	36%	100%
Not V4 CEE	40%	40%	46%	43%	28%	23%	49%	100%	30%	25%	45%	100%
CEER	**36%**	**49%**	**49%**	**45%**	**22%**	**44%**	**34%**	**100%**	**28%**	**40%**	**32%**	**100%**
DEU	46%	43%	51%	48%	16%	26%	58%	100%	17%	29%	54%	100%
USA	55%	48%	58%	55%	14%	19%	66%	100%	15%	23%	63%	100%

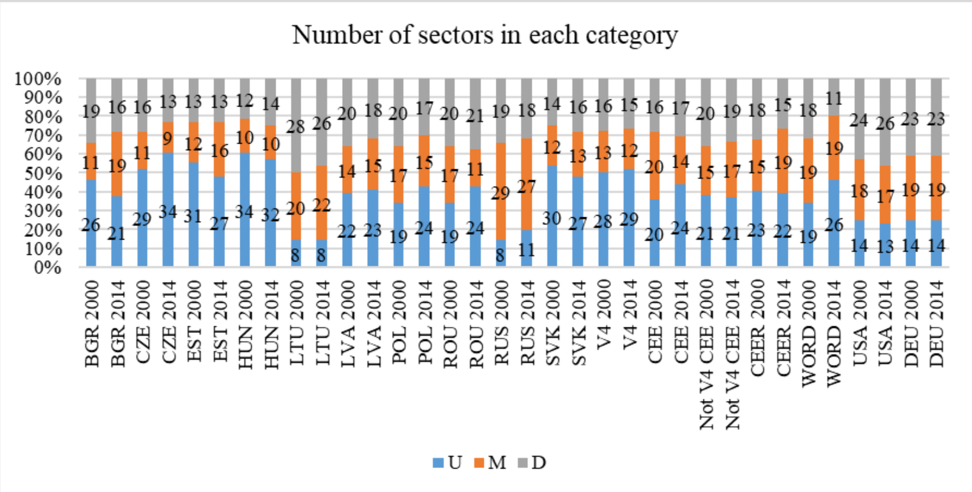
Source: own calculation from WIOD

Upstream sectors are closer to raw materials and inputs. They mostly serve other sectors with their outputs. These intermediate products are undergoing several transformations before reaching the end user. This also means that if an industry does not have its own direct access to inputs, the dependency is high, and imported material may be needed. In general, outputs are considered to be low-readiness products in terms of the final user's product. If only other sectors are served by a sector, it is difficult to choose a distinctive competitive strategy, as the end-user often does not even know which company a manufactured part comes from. In this case, the cost-directed strategy remains, and a situation may arise where relatively expensive inputs must be produced (cheaply), which can be sold at a slightly lower price, and thus the value-added ratio will be inherently low. It predicts that if mostly the product of the industry goes through more participants production process, the added value in one participant might be low. This is not a problem in itself, as high volumes can still generate significant profits, but it is important to point out that much more capital and input must be used to generate the same amount of profit than where the share of added value is higher. An example is the automotive suppliers, which are very popular among the V4 countries. Many small and large companies perform automotive supplier tasks, which are present in several sectors (e.g. plastics, metalworking, textiles and leather, etc.). These sectors mainly source their raw materials from imports and almost 100% of their customers are – at best, directly – from large car manufacturers and, at worst, from other manufacturers who, after minor modifications, are the supplier of the product to the car manufacturer. Based on these, the companies in the example slip into upstream sectors and can only operate with a depressed share of value added. Even though they are literally manufacturing, they are so upstream in the supply chain that they appear as upstream operators. (Upstreamness and downstreamness value can indicate this as well.) Countries that engage in these supplier activities on a massive scale are likely to have a dominant upstream side and have a lower value-added share. Countries that have chosen this, tend to have a high proportion here as well. This kind of upstream shift can also be observed in a number of sectors. In several countries, the number of sectors entering the upstream group increased from 2000 to 2014, but in the CEER countries the number of countries, where it increased and where it decreased, was relatively balanced, but the group remained stagnant on average, compared with 19 increased to 26 in the world average. The manufacturing group typically includes fewer sectors in CEER countries than in the world average or benchmark countries. The only notable exception is Russia, where there are very few upstream sectors (8; 11) and many manufacturing sectors (29; 27), with an average number of downstream sectors. The aggregate of the country group data already balances this somehow and gives a more realistic picture than looking at it individually. Lithuania has a similar structure, but with the highest share of downstream sectors, with a very high share (28; 26).

The Russian outlier structure suggests that the country is set up with a few, relatively strong, upstream sectors to serve a myriad of manufacturing sectors. Some of these serve end-users, or export, and a significant number of other sectors, yet focusing on the middle and end of the supply chain. This could even mean that, under the current Russian-Ukrainian war and economic restrictions, Russia is significantly less dependent on exports than average and is highly self-sufficient. This does not mean low dependence in all areas, as upstream inputs are likely to become scarce relatively quickly.

In the downstream group, it is striking that most CEER countries have 18-15 downstream sectors, which is not even a significant difference from the world average, but the benchmark countries are well above 20.

Figure 29: The number of sectors in each examined country's UMD sectoral group



Source: own elaboration based on WIOD.

The development of the value-added ratio has already been mentioned several times. Details can be found in Figure *29* and the table in the appendix. In this paragraph, I will highlight some more outstanding values and concluding remarks.

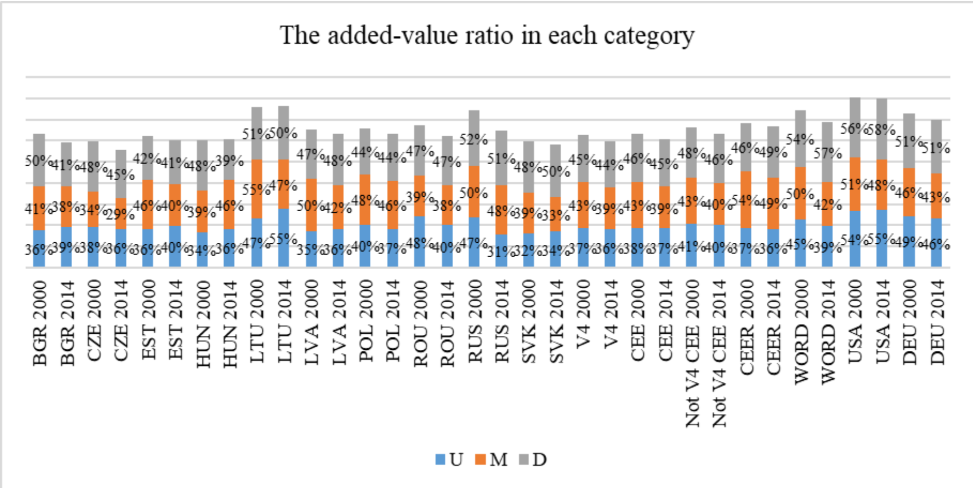
The *y* axis of the smile curve is the share of value added, so for the shape of the smile to emerge, both the upstreamness group and the downstreamness group must have a higher value-added share than the production. It should be noted that overall, the goal is not the shape of the smile, but to keep these points high. Rather, the problem is that CEER countries often lag benchmark countries. On the downstream side, this is not a problem, it is fulfilled everywhere with one exception (POL 2000).

However, the "U" shape emerges only in the following cases: CZE 2000, 2014; LTU 2000; ROU 2000, 2014; and benchmark countries USA 2014; GER 2000, 2014.

Russia is considered outstanding, especially in 2000, when the share of value added in all three groups reached 45%. It took on a similar structure in this respect to the USA or Germany, which is also outstanding because the manufacturing sector group did not expect such a high share of value added to appear in the middle of the curve.

BGR 2014, CZE 2014, EST 2014, HUN 2014, LTU 2014, SVK 2014. are extremely low. It is noticeable that both, the results of 2014 and mainly the decline of the manufacturing sector group's performance have decreased, partly due to the downturn of the downstream group. Interestingly, three of the V4 countries were included, while Poland performed better and was able to strengthen the downstream group.

Figure 30: The added-value ratio in each examined country's UMD sectoral group



Source: own elaboration based on WIOD.

Based on the data, it can be concluded that if the CEER countries want to maintain the pace of catching up with the same structure, they will have to increase their production to a much greater extent than the benchmark countries, as they have a higher added value amount but not ratio. This cannot be considered as an upgrade process. This would be a degressive increase, as there is no interference between the structure of the economy and the structure of production, but it carries out the same processes only to a greater extent. There is another way. Referring to the arrows in Figure *25*, there are several ways to increase added value. On the one hand sectors downstream could be strengthened, as CEER countries are currently moving in a "/" or "r" curve, suggesting that if a sector moves downstream, the value-added content will increase significantly. On the other hand, it would be worth examining in the future how the structure of the upstream sectors could be adjusted to a level like that of the benchmark countries, so that the value-added content would increase.

If we only assume that the 2014 German value-added ratio would be achieved in the upstream sector, it alone would increase the total value added produced in the country group by 6%. If the US structure were adapted, this would be an increase of 11%.

Under the bold assumption that the group adapts the US production structure in its entirety, value added would increase by 17% (Table *23*) but it would not be negligible if the German structure could be adapted, as it would increase by 2%. The German structure increases less than expected because the value-added share in the manufacturing sector, which otherwise has the highest output overall, is much lower in Germany than in the CEER countries (the US is also 1% lower), and therefore there would be a decline in this group.

In this simplified modelling, there is an upgrade situation. The aim of Table *23* is there just to demonstrate drastically how much the structure matters.

Table 23: Simplified modelling of the transition to a US value-added production structure for the CEER group of countries

Country	Indicator	U	M	D	Total
CEER	Output	1 715 435	2 515 962	1 987 719	6 219 116
CEER	Added value	624 497	1 229 144	969 400	**2 823 041**
CEER	AV/Output	36%	49%	49%	45%
CEER->USA	AV/Output	55%	48%	58%	55%
CEER->USA	Added value	937 878	1 196 200	1 155 645	**3 289 722**
CEER (theoretical)	AV/Output	55%	48%	58%	53%
CEER (theoretical)	Growth of AV	150%	97%	119%	**117%**
DEU	Output	1 424 679	2 405 133	4 528 783	8 358 595
DEU	Added value	657 248	1 024 531	2 310 649	**3 992 428**
DEU	AV/Output	46%	43%	51%	48%
USA	Output	4 886 364	7 510 984	20 981 343	33 378 692
USA	Added value	2 671 515	3 571 056	12 198 392	**18 440 962**
USA	AV/Output	55%	48%	58%	55%

Source: own collaboration based on WIOD data

The analyses also show that the structure of Germany has weakened somewhat compared to the US. One of the reasons for this is that, except for the unchanged group of downstream sectors, both other groups of sectors have shifted upstream, and the share of value added has decreased significantly. This kind of strategy, and the accompanying slowdown, is causing and will continue to cause several economic tensions in the future.

The simplified modelling (Table *23*) also shows that a shift from a 36% to a 55% value added ratio in the case of strengthening the upstream sector group would increase the value added generated to 150%, even with unchanged production. On the other hand, it is also striking that if the share of value added in production decreases by 1 percentage point, the value added produced by production decreases by 3%, resulting in a 1% decrease in the value added of the whole group of countries.

The assumed structural change has several limitations, such as limitations on infrastructure and tangible assets, but it would also require a transformation in knowledge capital and market acceptance, which also involves a significant political factor. Their examination is not the subject of the study.

This simple, excessive modelling demonstrates well why we must pay attention to the GVC positions and study more this field of production.

4.6. Conclusions

The Eastern European periphery is trying to catch up with the developed western countries at a rapid pace, which is partly successful. The value-added production of the CEER group of countries accounted for only 30% of Germany in 2000, but in 2014 it was already 70%. It should be noted that this was achieved without a significant change in the population and a deterioration in the share of value added (1% points), so the production volume had to be significantly increased. However, structural differences between groups of industries make it difficult to catch up quickly. A significant difference in the smile curve is found on the upstream side. In the manufacturing sector, the CEER countries achieved an even higher share of value added than Germany, and even managed to exceed the level of the USA by 1 percentage point. The lag in the downstream sector group is smaller than in the upstream, but perceptible. In contrast, the share of value added in the upstream group lags by 12-17 percentage points, and a larger share of sectors fall into this category in the CEER countries than in the benchmark countries.

In relation with added value analysis of UMD categories it can be generally stated that in developed countries, downstream sectors usually accomplish more efficiently than manufacturing and upstream sectors. High value-added ratio indicates that sectors in this sector group have the most powerful negotiation position to influence prices – in some cases they can create a monopolistic situation during the sales function. The opposite of it all can be found in case of sectors stuck in the middle of value chain.

Smile curve framework and theory seems to be proven true according to the results of analysing several developed and strong countries' economy, though the expected U curve is not outlined in other countries and in world economy aggregate. Analysis can be deepened by more detailed examinations of particular sectors (specific company size in the actual sector, detailed analysis of particular financial indicators, examinations of functions) to get deeper knowledge on the reasons for sectoral efficiency differences among countries and of different UMD classifications.

As result I can tell that the CEER countries have more upstream sectors (39%), than USA (23%) or Germany (25%). In the weight of the manufacturing sectoral group there is not a huge different. In the downstream sectoral group USA has more than 40% of its sectors, but the CEER countries just approximately 27%.

Within the CEER country groups only, a few countries have similar structure and results as the benchmark countries. The strongest (if we considered the size as well) is Russia, and next is Lithuania and Latvia, but the latters are small countries. Poland and Romania have big potential, according to their structure. The other V4 countries seem to change their structure in a trap position because of the input-dependent and input-producing heavy, low value-added economic structure.

The CEER countries are presumably aiming to build a stronger economy. To do so, they need not only to catch up but also to overtake the benchmark countries. This is more difficult to achieve through degressive growth than by improving the structure of production, although it is also a multi-factorial and complex task involving economic and political factors. Szalavetz (2022) claims that the electrification of the Hungarian automotive industry does not give many opportunities for upgrading. Although it requires innovative tasks, but the time pressure and the environment will not let the local companies take advantage of it. This micro level example highlights well the problems of the countries GVC location.

Assuming that a higher value-added content can be extracted from the current production due to the more efficient structure, the CEER countries would have approached the level of German value added in 2014 with the US structure.

It can be concluded from the analysis that if we look at the performance of the three main units of analysis, it would be the US, DEU, CEER respectively, confirming that the more downstream the country is, the more successful its economic structure is.

The timeline from 2000 to 2014 is long enough to see the changes clearly, but 2014 was a long time ago, so it can be said that the directions described with this study are still valid. I hope that in the future a new update of the WIOD will be available, and we can see a pre-COVID year eg. 2019 or year 2022, to make the same examination and see the new trends. The catching-up process with the benchmark countries is striking, but it is important to underline that CEER countries could easily find themselves in a trap situation, if they continue to focus on sectors with lower value added. This could leave countries in an income trap, as the only way to continue catching up is to increase production further to allow GDP grow. The examined database does not express the ownership of production factors, so it is not suitable for separating companies operating in a country according to owner. It means that it is also not suitable for separating the value added in different sectors whether it is owned by a local or a foreign party. The examination covers only the geographically bounded location. In the future it can be a next research topic, that this should be shared among ownerships as well.

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APPENDIX

List of country codes according to WIOD

AUS	Australia	IRL	Ireland
AUT	Austria	ITA	Italy
BEL	Belgium	JPN	Japan
BGR	**Bulgaria**	KOR	Korea
BRA	Brazil	**LTU**	**Lithuania**
CAN	Canada	LUX	Luxemburg
CHE	Switzerland	**LVA**	**Latvia**
CHN	China	MEX	Mexico
CYP	Cyprus	MLT	Malta
CZE	**Czech Republic**	NLD	Netherlands
DEU	**Germany**	NOR	Norway
DNK	Denmark	**POL**	**Poland**
ESP	Spain	PRT	Portugal
EST	**Estonia**	**ROU**	**Romania**
FIN	Finland	ROW	Rest of the World
FRA	France	**RUS**	**Russia**
GBR	United Kingdom	**SVK**	**Slovakia**
GRC	Greece	SVN	Slovenia
HRV	Croatia	SWE	Sweden
HUN	**Hungary**	TUR	Turkey
IDN	Indonesia	TWN	Taiwan
IND	India	**USA**	**United States of America**

Sectoral data of CEER country group and DEU and USA; 2000

2000		CEER			DEU			USA		
num	name	Downstreamness	AV/Output	Ratio in total AV	Downstreamness	AV/Output	Ratio in total AV	Downstreamness	AV/Output	Ratio in total AV
1	Crop	0,47	46%	5,6%	0,51	46%	1,0%	0,42	37%	0,7%
2	Forestry	0,33	50%	0,3%	0,38	53%	0,1%	0,32	57%	0,2%
3	Fishing	0,52	34%	0,0%	0,65	54%	0,0%	0,32	57%	0,1%
4	Mining	0,44	49%	3,8%	0,38	40%	0,3%	0,32	51%	1,1%
5	Food	0,60	26%	3,6%	0,68	28%	1,9%	0,63	30%	1,6%
6	Textil	0,58	37%	1,2%	0,66	32%	0,5%	0,55	33%	0,5%
7	Wood	0,41	35%	0,7%	0,43	36%	0,4%	0,38	30%	0,3%
8	Paper	0,36	34%	0,7%	0,38	31%	0,5%	0,35	38%	0,6%
9	Printing	0,34	37%	0,3%	0,34	47%	0,6%	0,38	41%	0,4%
10	Coke	0,38	29%	1,5%	0,44	13%	0,3%	0,44	23%	0,5%
11	Chemicals	0,37	30%	1,3%	0,43	34%	1,8%	0,42	42%	1,3%
12	Pharmaceutical	0,62	44%	0,2%	0,71	48%	0,7%	0,41	42%	0,5%
13	Rubber	0,36	32%	0,7%	0,45	39%	1,1%	0,40	37%	0,6%
14	Mineral	0,39	39%	1,2%	0,43	41%	0,9%	0,39	45%	0,4%
15	Basic metals	0,38	31%	2,4%	0,37	28%	0,9%	0,32	30%	0,5%
16	Fabricated metal	0,36	35%	0,8%	0,43	44%	2,0%	0,37	46%	1,2%
17	Computer	0,40	28%	0,8%	0,59	40%	1,6%	0,51	43%	2,2%
18	Electrical eq	0,41	30%	0,6%	0,52	41%	1,8%	0,48	37%	0,4%
19	Machinery	0,51	37%	1,2%	0,64	41%	3,2%	0,57	39%	1,1%
20	Motor v.	0,52	25%	1,6%	0,59	26%	3,0%	0,58	29%	1,3%
21	Other transport	0,54	32%	0,2%	0,60	36%	0,4%	0,64	44%	0,7%
22	Furniture	0,57	40%	1,1%	0,73	43%	0,9%	0,65	49%	0,9%
23	Repair machinery	0,37	41%	0,4%	0,46	37%	0,5%	0,59	66%	0,1%
24	Electricity, gas	0,37	39%	3,2%	0,43	49%	1,6%	0,44	50%	1,7%
25	Water	0,44	53%	0,2%	0,44	64%	0,3%	0,44	50%	0,0%
26	Sewerage	0,38	47%	0,3%	0,43	48%	0,7%	0,33	50%	0,3%
27	Construction	0,62	43%	6,6%	0,62	43%	5,1%	0,81	51%	4,5%
28	Motor Retail	0,44	61%	1,6%	0,54	68%	1,7%	0,68	72%	2,1%
29	Wholesale Trade	0,44	61%	11,0%	0,44	54%	4,0%	0,50	71%	6,1%
30	Retail trade	0,45	64%	6,7%	0,71	61%	4,5%	0,82	69%	5,3%
31	Land transp	0,44	53%	4,4%	0,35	48%	1,8%	0,43	51%	1,5%
32	Water transport	0,37	40%	0,2%	0,61	41%	0,2%	0,68	29%	0,1%
33	Air transport	0,46	41%	0,4%	0,55	33%	0,3%	0,59	45%	0,5%
34	Warehousing	0,35	47%	1,7%	0,31	36%	1,2%	0,36	67%	0,5%
35	Postal	0,35	59%	0,3%	0,36	62%	0,7%	0,36	57%	0,4%
36	Accommodation	0,61	49%	1,4%	0,79	49%	1,6%	0,66	56%	2,8%
37	Publishing	0,46	41%	0,3%	0,47	44%	0,6%	0,58	46%	1,1%
38	Video, TV	0,43	40%	0,3%	0,42	47%	0,7%	0,51	49%	1,0%
39	Telecomm	0,44	54%	2,1%	0,46	57%	1,6%	0,46	49%	2,3%
40	Programming	0,39	57%	0,5%	0,44	62%	1,6%	0,51	49%	1,3%
41	Financial	0,43	62%	2,6%	0,41	51%	2,8%	0,41	58%	3,2%
42	Insurance	0,48	31%	0,2%	0,50	38%	1,0%	0,55	55%	2,8%
43	Auxiliary finance	0,42	52%	0,2%	0,32	50%	0,6%	0,42	37%	1,3%
44	Real estate	0,56	64%	5,7%	0,56	73%	11,0%	0,66	73%	10,7%
45	Legal	0,33	54%	0,8%	0,33	67%	3,3%	0,39	66%	3,6%
46	Architectural	0,38	48%	0,6%	0,42	66%	1,5%	0,43	60%	1,6%
47	R+D	0,45	64%	0,3%	0,44	66%	0,7%	0,44	60%	0,8%
48	Marketing	0,30	39%	0,4%	0,35	58%	0,8%	0,44	60%	0,7%
49	Other scientific	0,35	49%	0,4%	0,39	52%	0,5%	0,43	60%	0,3%
50	Admin	0,40	57%	2,8%	0,33	58%	4,0%	0,38	62%	3,8%
51	Social security	0,74	59%	5,9%	0,79	73%	6,5%	0,81	68%	12,9%
52	Education	0,86	71%	3,5%	0,84	82%	4,3%	0,78	60%	0,8%
53	Health	0,91	57%	2,9%	0,94	68%	6,2%	0,96	61%	5,8%
54	Other service	0,57	52%	2,0%	0,61	66%	4,0%	0,61	66%	2,8%

Source: own calculation from WIOD

Sectoral data of CEER country group and DEU and USA; 2014

2014		CEER			DEU			USA		
num	name	Downstreamness	AV/Output	Ratio in total AV	Downstreamness	AV/Output	Ratio in total AV	Downstreamness	AV/Output	Ratio in total AV
1	Crop	0,49	43%	3,1%	0,48	33%	0,6%	0,41	41%	1,0%
2	Forestry	0,33	47%	0,2%	0,37	44%	0,1%	0,34	72%	0,1%
3	Fishing	0,62	50%	0,0%	0,53	52%	0,0%	0,34	72%	0,1%
4	Mining	0,40	64%	6,6%	0,33	42%	0,2%	0,36	68%	2,6%
5	Food	0,63	24%	2,5%	0,66	23%	1,6%	0,58	25%	1,4%
6	Textil	0,59	40%	0,6%	0,69	34%	0,3%	0,61	30%	0,2%
7	Wood	0,41	33%	0,5%	0,42	27%	0,2%	0,37	29%	0,2%
8	Paper	0,38	31%	0,5%	0,39	28%	0,4%	0,37	29%	0,3%
9	Printing	0,33	39%	0,1%	0,35	40%	0,3%	0,40	45%	0,2%
10	Coke	0,36	24%	2,4%	0,44	6%	0,2%	0,47	21%	1,0%
11	Chemicals	0,36	27%	1,1%	0,45	31%	1,6%	0,43	44%	1,5%
12	Pharmaceutical	0,62	43%	0,2%	0,68	51%	0,9%	0,43	44%	0,5%
13	Rubber	0,37	27%	0,8%	0,48	36%	1,0%	0,41	32%	0,4%
14	Mineral	0,39	35%	0,8%	0,43	37%	0,6%	0,39	40%	0,3%
15	Basic metals	0,34	26%	1,8%	0,37	21%	0,8%	0,30	21%	0,3%
16	Fabricated metal	0,37	35%	0,9%	0,44	42%	2,0%	0,38	39%	0,8%
17	Computer	0,41	24%	0,8%	0,58	47%	1,3%	0,53	69%	1,5%
18	Electrical eq	0,43	28%	0,5%	0,55	42%	1,7%	0,49	43%	0,3%
19	Machinery	0,49	32%	1,2%	0,64	39%	3,5%	0,55	37%	0,9%
20	Motor v.	0,47	18%	1,5%	0,66	31%	4,0%	0,59	24%	0,8%
21	Other transport	0,54	34%	0,2%	0,60	33%	0,5%	0,64	36%	0,7%
22	Furniture	0,58	33%	0,6%	0,79	46%	0,9%	0,64	44%	0,6%
23	Repair machinery	0,35	46%	0,4%	0,40	40%	0,6%	0,64	59%	0,1%
24	Electricity, gas	0,34	30%	2,9%	0,40	38%	1,9%	0,51	67%	1,6%
25	Water	0,42	55%	0,2%	0,48	60%	0,2%	0,50	67%	0,1%
26	Sewerage	0,38	39%	0,3%	0,38	45%	0,8%	0,34	47%	0,2%
27	Construction	0,60	40%	6,7%	0,54	44%	4,6%	0,75	55%	3,8%
28	Motor Retail	0,43	65%	2,1%	0,47	68%	1,5%	0,71	68%	1,5%
29	Wholesale Trade	0,43	54%	9,3%	0,47	58%	4,5%	0,51	66%	6,0%
30	Retail trade	0,45	62%	6,1%	0,59	53%	3,2%	0,83	63%	4,7%
31	Land transp	0,42	45%	4,1%	0,35	50%	1,8%	0,44	47%	1,4%
32	Water transport	0,38	41%	0,1%	0,63	30%	0,3%	0,52	29%	0,1%
33	Air transport	0,45	21%	0,2%	0,58	25%	0,2%	0,57	45%	0,5%
34	Warehousing	0,38	46%	1,9%	0,31	38%	1,8%	0,36	54%	0,6%
35	Postal	0,32	55%	0,2%	0,35	47%	0,5%	0,36	52%	0,3%
36	Accommodation	0,57	47%	1,2%	0,77	47%	1,5%	0,68	55%	2,8%
37	Publishing	0,46	52%	0,2%	0,43	47%	0,6%	0,59	64%	1,2%
38	Video, TV	0,40	45%	0,2%	0,52	56%	0,7%	0,54	62%	1,2%
39	Telecomm	0,41	53%	1,7%	0,41	41%	1,0%	0,53	50%	1,9%
40	Programming	0,41	58%	0,9%	0,40	61%	2,6%	0,48	60%	1,9%
41	Financial	0,45	66%	4,1%	0,42	46%	2,5%	0,47	69%	2,8%
42	Insurance	0,45	32%	0,2%	0,48	35%	1,0%	0,49	49%	2,8%
43	Auxiliary finance	0,34	53%	0,2%	0,31	45%	0,6%	0,46	51%	1,4%
44	Real estate	0,53	66%	6,2%	0,53	76%	11,1%	0,66	74%	11,9%
45	Legal	0,32	56%	0,9%	0,32	59%	3,0%	0,39	61%	4,0%
46	Architectural	0,35	49%	0,5%	0,41	60%	1,5%	0,45	58%	1,5%
47	R+D	0,64	66%	0,2%	0,83	65%	0,8%	0,45	58%	0,8%
48	Marketing	0,30	42%	0,3%	0,37	57%	0,5%	0,45	58%	0,8%
49	Other scientific	0,33	45%	0,2%	0,40	54%	0,5%	0,45	58%	0,3%
50	Admin	0,38	57%	5,6%	0,34	61%	4,9%	0,39	62%	3,9%
51	Social security	0,63	57%	6,3%	0,64	66%	6,2%	0,84	66%	13,1%
52	Education	0,85	72%	3,7%	0,83	77%	4,5%	0,79	60%	1,1%
53	Health	0,90	59%	4,1%	0,95	69%	7,5%	0,96	59%	7,1%
54	Other service	0,55	52%	2,0%	0,62	68%	3,8%	0,65	59%	2,6%

Source: own calculation from WIOD

The main indicators calculated for the CEER countries and the benchmark countries. Year 2000's downstreamness cut value was used for categorising into U-M-D sectoral groups. CEER countries number of sectors is divided by the number of countries (by 10) for the better displayability.

2000	U	U	U	M	M	M	D	D	D
	average downstreamness	number of sectors	AV/output	average downstreamness	number of sectors	AV/output	average downstreamness	number of sectors	AV/output
BGR	0,33	26	36%	0,45	11	41%	0,68	19	50%
CZE	0,34	29	38%	0,45	11	34%	0,61	16	48%
EST	0,31	31	36%	0,44	12	46%	0,66	13	42%
HUN	0,32	34	34%	0,46	10	39%	0,63	12	48%
LTU	0,37	8	47%	0,44	20	55%	0,64	28	51%
LVA	0,30	22	35%	0,43	14	50%	0,65	20	47%
POL	0,36	19	40%	0,43	17	48%	0,62	20	44%
ROU	0,34	19	48%	0,43	17	39%	0,64	20	47%
RUS	0,37	8	47%	0,45	29	50%	0,63	19	52%
SVK	0,32	30	32%	0,44	12	39%	0,69	14	48%
V4	0,34	28	37%	0,44	13	43%	0,62	16	45%
CEE	0,34	24	38%	0,44	14	43%	0,62	18	46%
Not V4 CEE	0,33	21	41%	0,44	15	43%	0,65	20	48%
CEER	0,37	20	37%	0,44	20	54%	0,61	16	46%
WORD	0,36	19	45%	0,44	19	50%	0,64	18	54%
USA	0,36	14	54%	0,44	18	51%	0,67	24	56%
DEU	0,34	14	49%	0,44	19	46%	0,64	23	51%

2014	U	U	U	M	M	M	D	D	D
	average downstreamness	number of sectors	AV/output	average downstreamness	number of sectors	AV/output	average downstreamness	number of sectors	AV/output
BGR	0,33	21	39%	0,43	19	38%	0,66	16	41%
CZE	0,32	34	36%	0,43	9	29%	0,58	13	45%
EST	0,32	27	40%	0,43	16	40%	0,65	13	41%
HUN	0,35	32	36%	0,45	10	46%	0,63	14	39%
LTU	0,38	8	55%	0,44	22	47%	0,65	26	50%
LVA	0,31	23	36%	0,45	15	42%	0,68	18	48%
POL	0,34	24	37%	0,43	15	46%	0,58	17	44%
ROU	0,34	24	40%	0,44	11	38%	0,59	21	47%
RUS	0,36	11	31%	0,44	27	48%	0,62	18	51%
SVK	0,32	27	34%	0,43	13	33%	0,62	16	50%
V4	0,33	29	36%	0,43	12	39%	0,59	15	44%
CEE	0,33	24	37%	0,43	14	39%	0,60	17	45%
Not V4 CEE	0,34	21	40%	0,44	17	40%	0,61	19	46%
CEER	0,36	22	36%	0,44	19	49%	0,62	15	49%
WORD	0,33	26	39%	0,44	19	42%	0,67	11	57%
USA	0,37	13	55%	0,45	17	48%	0,67	26	58%
DEU	0,34	14	46%	0,44	19	43%	0,64	23	51%

Source: own elaboration based on WIOD

5. Study 4. International analysis of the IT sector based on GVCs

5.1. Introduction

Nowadays, many studies deal with digitalisation from different aspects. They often link the topic with IT as a driving force.

A closer look at the role of IT in today's world shows that the impact of its development goes far beyond the availability of increasingly modern devices and tools at increasingly affordable prices for end-users. The role of IT in the value chain can be explored in more depth, as IT has become more and more embedded in all sectors. (Tseng, Wu, & Nguyen, 2011) The increase in the efficiency of information flows has transformed supply chains:

- Some of the activities that previously could not be outsourced have become outsourced.
- Communication has been simplified and accelerated, thereby making the value chain more flexible.
- The chain of activities has become more transparent, significantly reducing uncertainty about the business environment.
- Disruptions in the value chain due to performance problems of individual actors have become easy to identify, allowing these problems to be addressed more quickly, thus increasing the efficiency of the value chain as a whole.
- IT has also made the delivery of some services cheaper and easier, as well as the management/monitoring/control of remote activities.

IT is therefore present in every sector, its importance is constantly increasing. However, an important question is the extent to which individual sectors (or even, at a micro level, individual companies) have IT development, operation, etc. under their own control. This issue was examined by Brown (Brown, 2003), who divided the degree of IT centralisation at the company level into four categories (centralised, decentralised, "federal" and personalised). The choice was mainly related to two factors, namely the strategic importance of IT within the company and the availability of the necessary competence within the company. The first criterion can also be extended to the sectoral level.

Examining IT as a separate unit thus raises a problem, which I have solved by using the TEÁOR codes (the Hungarian activity classification) used in the international IOT (input-output table), the method of which I explain in the methodological chapter. In this study, I refer to the IT sector as the **group of sectors** comprising **IT services** (J62_63).

The sector's role in the global supply chain is well described by looking at the proportion of goods produced by the IT sector that are used for final use (consumption or accumulation) and the proportion that constitutes the input of other sectors. I have examined this mainly on the basis of the **IOT** and using the **"smile curve"** methodology.

By comparing the positions of IT in the supply chain across countries, we can see which groups of countries have a similar strategic role in the national economy. In addition, the efficiency of the sector can also be measured by country, as the analysis shows the ratio of output to value added. If the IT sector is stuck in the middle of the smile curve, it is poorly positioned and it is heavily dependent on other sectors, both on the supplier and customer side.[64] If it is at either end of the chain, it is also likely to be better positioned in the global value chain. Digitalisation has a clear link with IT, as it is integrated into the products and services of other sectors. If a country's IT sector only serves this kind of integration, it is pushed to the middle of the curve, neither serving the core development to a large extent, nor directly serving the end user.

As an introduction, I will give a brief historical overview of the IT sector, since it should be mentioned that the sector had a big boom about two decades ago, in the early 2000s, which ended with the "dotcom bubble burst". This is the phenomenon of the soaring value of companies on the internet soaring on the stock market and achieving huge share prices, followed by the "bubble burst", i.e. the collapse of the stock market. The sometimes significantly overvalued technology stocks, with P/Es[65] in the 50-60 range, have been pointed out by several analysts, but many have indicated that the high liquidity could lead

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[64] This statement is often criticised at the company level, as it may be a conscious decision to put a company in this situation, as it is mainly a B2B role and wants to operate as a supplier in a stable partnership. As a sector is made up of the totality of the companies in it, there is a chance that the vast majority of players will make this choice, but this is still a reflection of the overall role of the sector and does not contradict the fact that if there is a strong bargaining power on both the supplier and the buyer side, profitability is reduced.

[65] P/E = P/EPS = Price/Earning Per Share = Share price divided by earnings per share. P/E (price/earnings) is one of the most commonly used indicators in fundamental analysis. It is calculated using EPS, i.e. the market price divided by the EPS of the share. This indicator expresses the multiple of the earnings power of the stock compared to the price to be paid for the share. So EPS shows how much income 1 share has generated for the company. If we divide it by the market price, we get how many times the market price is equal to the annualised earnings. Source: elemzeskozpont.hu/pe-mutato-hasznalata-tozsden

to further rises. Warren Buffett did not favour the stock of the tech sector, and many now unlisted star investors criticised him for this, but Buffett was later proved right as the value of the stocks fell. (AdmiralMarkets (2020)) The lesson of the case is that the IT sector, a popular sector that has been a strong driver of global development, bringing new solutions, has had a huge run-up but a downturn has become inevitable, which many companies have not survived. Many of the IT companies we know today have seen their stock market values soar once again, such as Google (Alphabet) or Facebook. This fact is somewhat reminiscent of the blowing up of the bubble in 2000. Further analysis of the dotcom bubble is not part of this paper, but it is important to note in analysing the IT sector.

Nowadays, IT is once again a major focus, since, in the context of digitalisation, the sector's output has become part of our everyday lives in some direct or indirect form through various tools and platforms. Both in our private lives (e-government, smart devices and smart homes, teleworking, various online communications, etc.) and in our corporate lives. In addition to process automation, digitalisation and robotisation, including software robots and various learning algorithms and artificial intelligence, are gaining ground. The majority of these are from the IT sector, at least the software (and development) part. The hardware part often comes from an engineering or other manufacturing sector, for which the sector uses IT sector outputs as inputs. It is not difficult to imagine this process, but without knowledge of the IT sector and its links, we are in the dark, so I will analyse it in detail in my paper.

5.2. Global value chain and smile curve frameworks for sector-level analysis in the literature

In the following section, I present the results of my literature research on the value chain and the smile curve, and the theoretical background to the sector-specific aspects of the topic.

The issue of global value chains has been the focus of much research for decades. Among the first to study value chains, Porter (1985) points out that different activities in the value chain add different amounts of value to the final products and should therefore be studied separately. Porter's research was conducted at the firm level, but as a result of technological advances and the reduction of transaction costs, the relevance of understanding value chains at the national economy level – across firms and sectors – has increased alongside the firm level. Globalisation processes have also significantly increased the importance of international relations compared to national economic relations in terms of production tasks and division of labour (Krugman et al., 1995). This paper also discusses global relations at the sectoral level, focusing on the IT sector.

In his research, Baldwin shows that a significant proportion of EU companies are able to outsource work that was previously classified as "non-tradable". (Baldwin, 2015). He has also introduced the view that larger companies are planning the workforce they need for production by using some of the domestic workforce and their skills, and at the same time are also considering labour from other parts of the world.[66] It turned out that a part of tasks that required high qualification were easily outsourceable but some professions which were not outsourceable at all or were hardly outsourceable remained (Baldwin, 2006). A skill-based analysis of the global division of labour can make an important contribution to the international study of the origin of value added. Indeed, in countries where a sector employs a higher-than-average skilled labour force, a higher value added content can be expected.

Baldwin's study thus examines the interconnectedness of value chains across countries and the organisation of work at the macro level. Work organisation is easily linked to labour productivity, but cross-country business operations often move capital, so it is also linked to capital productivity. This is directly related to my later studies, where I will also

[66] He meant both the mobility of labour including telework with digital assets, and the outsourcing of certain processes of the value chain for other participants.

look at the role of IT from the labour and utilisation side. It would be a logical step for companies to outsource the low value-added (almost manufacturing) parts of the IT sector and keep mainly the higher value-added tasks. The different levels of outsourcing mentioned above may cause the IT sector to be positioned differently along the smile curve in different countries. In this case, the IT sector in one country may be seen as a different link in the international value chain from the IT sector in another country.

This question has been examined in other literatures. In their analysis, Nölke and Vliegnhardt (2009) show that while Central and Eastern Europe has in many aspects successfully taken advantage of the opportunity offered by the developed countries, at the same time it has been in a situation of dependency (DME) on donor countries, which has not solved their social problems and has only achieved partial results, which have been the basis for a number of other crisis phenomena. The latter line of thought is not discussed in this article, but it should be pointed out.

The IT sector is also becoming increasingly outsourced in the area of software development and operation. There is a long history of outsourcing the manufacture of IT hardware devices, with most telecoms' equipment being made in the Far East. Baldwin's article contributes to the exploration of the larger global context, both in terms of labour and value chain linkages.

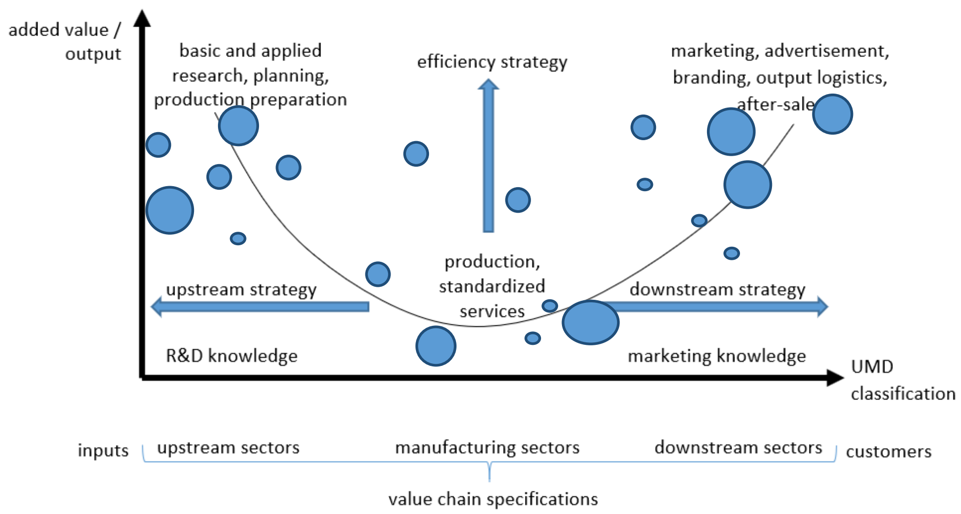
Examples of highlighting a sector, such as IT in this case, can be found in the literature. The article by Folfas and Udvari (2019) examines the chemical industry. Instead of gross output, the authors have also examined the value-added content of the sector, as this approach is free of double counting and other distortions. Using input-output analysis, it was found that the countries studied (Poland and Hungary) have a relatively low value-added content, as they rely to a large extent on inputs from richer countries rather than on domestic, high value-added semi-finished products. The outline of the study is very similar to the structure I have developed. A key element in my study is to understand the sector and place the origin and proportion of value added along the smile curve in the countries studied. This raises the issue of location along the global value chain. Hagemejer and Ghodsi (2017) investigate in a comparative and descriptive way the position of the new European Union members in the global supply chain and whether it is possible to move downwards or upwards from different starting points.

The underlying assumption of the smile curve framework is that economic actors in the value chain are able to produce different value-added content, from preparatory work to tasks closely linked to buying and selling. The smile curve therefore examines the relationship between position in the value chain and value added content (value added per unit of output).

At the beginning of the supply chain are those activities whose outputs are mostly further processed and have little or no final use. These sectors or activities are called Upstream. At the centre of the supply chain are the Manufacturing sectors or activities whose inputs are supplied by the Upstream sectors and the majority of their outputs are processed by the Downstream sectors before being sold and ultimately used by consumers.

Figure 31: Reinterpretation of smile curve

Figure 25 The explanation of smile curve theorem



Note: Blue bubbles, spots are representing different sectors and specialised activities

Source: Article 3 Figure 25.

To plot the smile curve, two pieces of data are needed for each sector. The value-added content and the quantified value of the position in the value chain. Based on the theory, a higher added value content can be achieved at the beginning and end of the value chain than in the middle – the smiley curve got its name from the U shape of the figure that can be drawn in this way.

5.3. Methodology

5.3.1. Smile curve

To plot the smile curve, two sets of indicators need to be calculated for each sector. The first one is the Upstreamness/Downstreamness indicator, which shows the position of the sector in the value chain (*x*-axis), the other one is the value-added content of the sector, which is the ratio of value added to output (*y*-axis). For the review of UMD methodologies, I adapted the Antràs–Chor approach, as the authors' methodology is interpreted at the sectoral level, and the literature further reviewed also refers to the authors as the basic methodology. For each sector, the Antràs–Chor method calculates an indicator based on the IOT, which relates the total direct use of the sector to the total production of the sector over and above the production of the final product, in other words the total production use.

Based on the procedure, I used two different methodologies in my research: I did most of the calculations based on both the Upstreamness and Downstreamness indicators. I will not discuss the mathematical derivation of these indicators in this paper. The detailed derivation for these two indicators can be found in Fülöp (2021).

5.3.2. Identification of IT sector

To carry out the calculations, I had to select the sector that was closest to my research objectives and could be described by statistical codes. To summarise, since there is no **sector called IT**, for the purposes of the analysis I will refer to the **Information Technology Services sector (62) and the Information Services sector (63)**. The English equivalent in the **WIOD** database is **„J62_J63 Computer programming, consultancy and related activities; information service activities".**

5.3.3. Examinations

My tests use the 2000 and 2014 WIOD databases:

- I analysed the position of the IT sector in the value chain by country and aggregated.
- I calculated the value-added content of the sector by country and aggregated.

- I analysed the most significant economic linkages of the sector, namely which sectors are the main suppliers of inputs to the IT sector and which sectors are the main processors of its outputs.
- I examined the proportion of domestic and international links.
- I examined the ratio between final and intermediate consumption.
- I examined the shifts between the two dates along value added content, IT weight within country, and country weight/world total IT value added indicators.

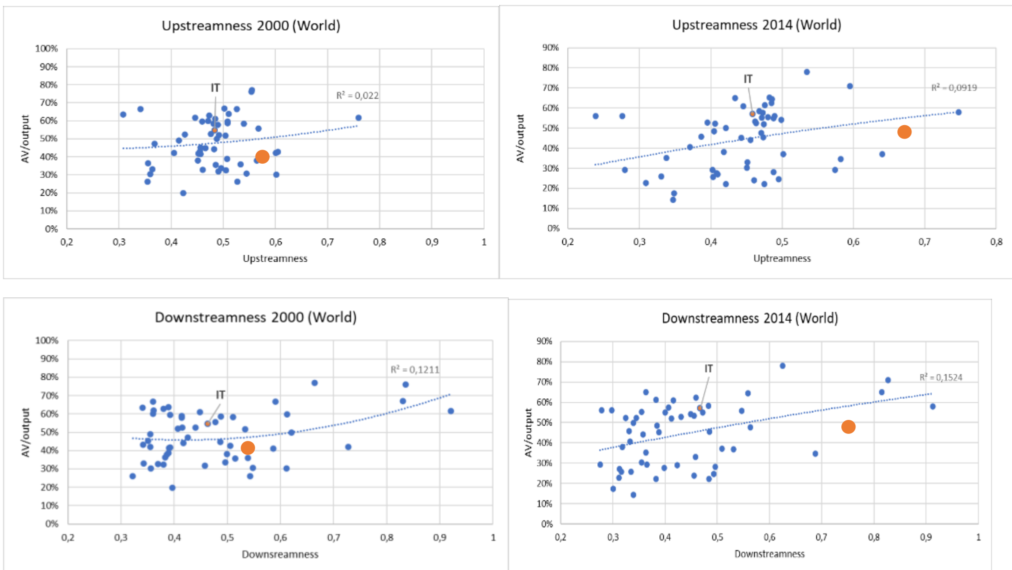
5.4. Results

5.4.1. IT sector's position in the value chain

To examine the position of the IT sector ("Computer programming, consultancy and related activities; information service activities") in relation to other sectors, I aggregated the sectoral scores of all the countries surveyed to obtain an aggregate smile curve for the world's countries. Thus, taking the aggregated values of each country by sector, I calculated the Upstreamness/Downstreamness indicator, which measures the position of the sector in the value chain (its distance from the final users) and the value-added content of the sector for all countries.

The analysis was carried out for 2000 and 2014, calculating both Upstreamness and Downstreamness indicators, the results of which are shown in Figure *32*.

Figure 32: IT sector position aggregated along the smile curve (2000 and 2014)



The IT sector is positioned in the middle of the supply chain according to the Upstreamness methodology in both years under review, which means that its inputs are supplied by the Upstream sectors and the bulk of its outputs are processed by the Downstream sectors before being sold and ultimately used by consumers. Based on the Downstreamness indicator, there is a downstream shift in the IT sector between the two points in time, with a higher proportion of its outputs going to final consumption.

5.4.2. Input-output analysis of the IT sector

In addition to determining the position of the sector in the value chain, it is important to identify which sectors supply the inputs to the IT sector and which sectors purchase the largest share of its outputs, in order to better understand the sectoral inter-linkages and interdependencies. The input-output analysis is based on data for 2014. The main direct suppliers and customers of IT are listed in *Table 24* Green indicates the sectors that are among the top nine sectors in terms of both input services and output consumption.

Table 24: The IT sector's most important economic links

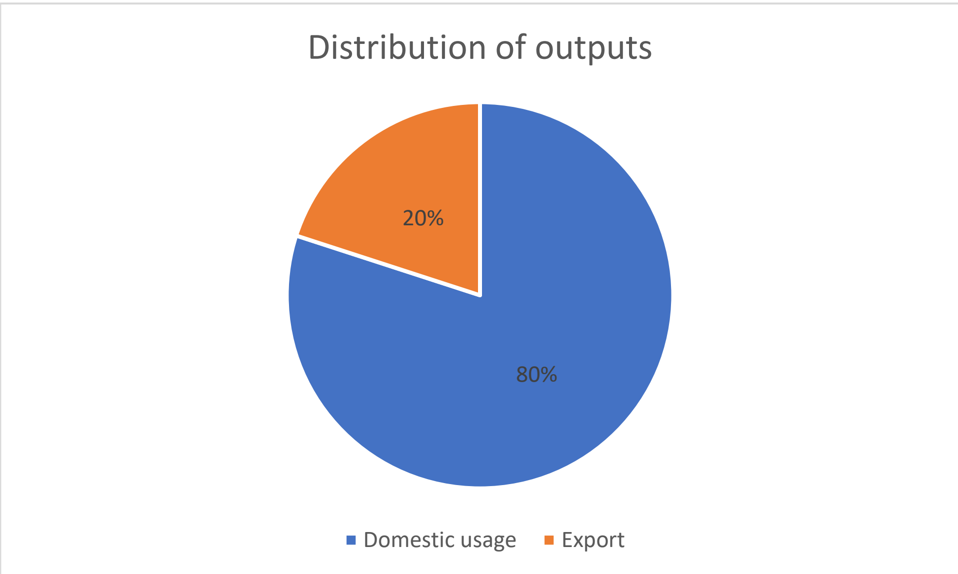
Distribution of input resources in the IT sector			Distribution of IT sector output consumption		
Sector name	Input (million USD, current price)	Input (%)	Sector name	Output (million USD, current price)	Output (%)
Wholesale trade (except of motor vehicles and motorcycles)	38 525	4,3%	Wholesale trade (except of motor vehicles and motorcycles)	45 833	4,2%
Manufacture of computer, electronic and optical products	61 027	6,8%	Manufacture of computer, electronic and optical products	37 919	3,5%
Telecommunications	50 044	5,6%	Telecommunications	36 722	3,4%
Information technology and information services	162 521	18,2%	Information technology and information services	162 521	15,0%
Financial intermediation, except insurance and pension funding	32 679	3,7%	Financial intermediation, except insurance and pension funding	80 580	7,4%
Legal, accounting, book-keeping and auditing activities; tax consultancy	61 790	6,9%	Legal, accounting, book-keeping and auditing activities; tax consultancy	61 021	5,6%
Administrative and support service activities	114 267	12,8%	Administrative and support service activities	47 020	4,3%
Other professional, scientific and technical activities, animal health and welfare activities	32 717	3,7%	Other professional, scientific and technical activities, animal health and welfare activities	110 501	10,2%
Real estate activities	41 941	4,7%	Real estate activities	36 075	3,3%
Other 47 sectors	297 233	33,3%	Other 47 sectors	465 777	43,1%

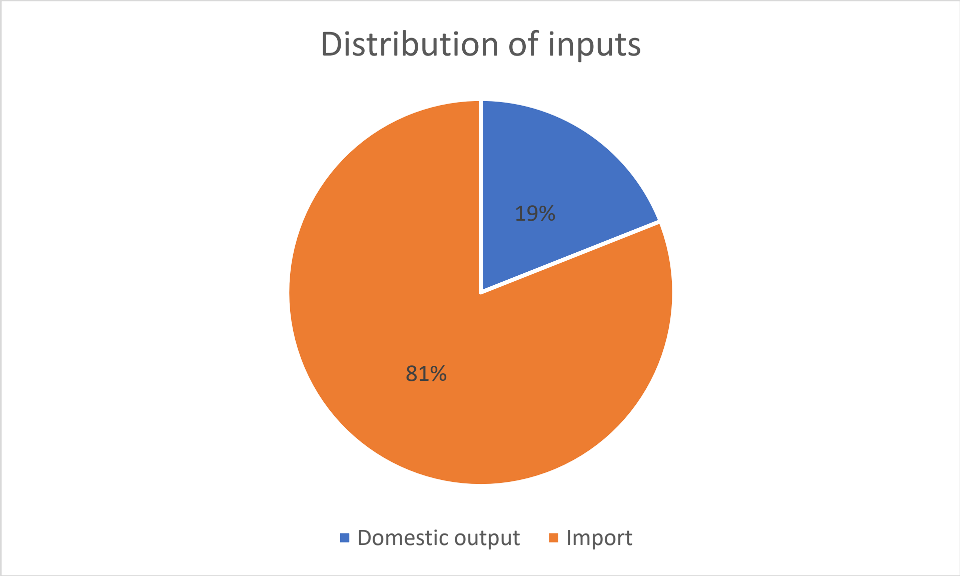
Looking at the sectors included in the table, the following conclusions can be drawn:

- Both input providers and output users in the IT sector are a small group of sectors. For input providers, 16% of sectors supply 67% of inputs. For outputs, 16% of sectors use 57% of outputs.
- In terms of both inputs and outputs, the information technology and information services, namely the IT sector itself, represents the most significant "link". For most sectors it is true that they use the largest share of "own" inputs for further production.
- Sectors closely linked to the IT sector have a high added value content. With the exception of the 'Computer, electronic and optical products manufacturing' sector, which is included in the table as a major supplier, all sectors have a higher than average value added content. Ranking the 56 sectors by value added content, the 12 sectors in the table include the most efficient sectors 1, 4, 5, 6, 8 and 9.
- The IT sector is mainly closely linked to service sectors. Another exception is the 'Computer, electronic and optical products manufacturing' sector.

I also looked at the proportion of domestic inputs and imports used by the IT sector and the proportion of its output used for domestic intermediate consumption or export. The results are illustrated in Figure *33* (based on 2014 data).

Figure 33: Share of domestic and foreign sectoral contacts (2014)





Source own collaboration

In terms of both consumption and output, it is true that around 80% of the IT sector remains within national borders. This rate can be considered as average when taking into account the other sectors (which are around 84% for both consumption and output).

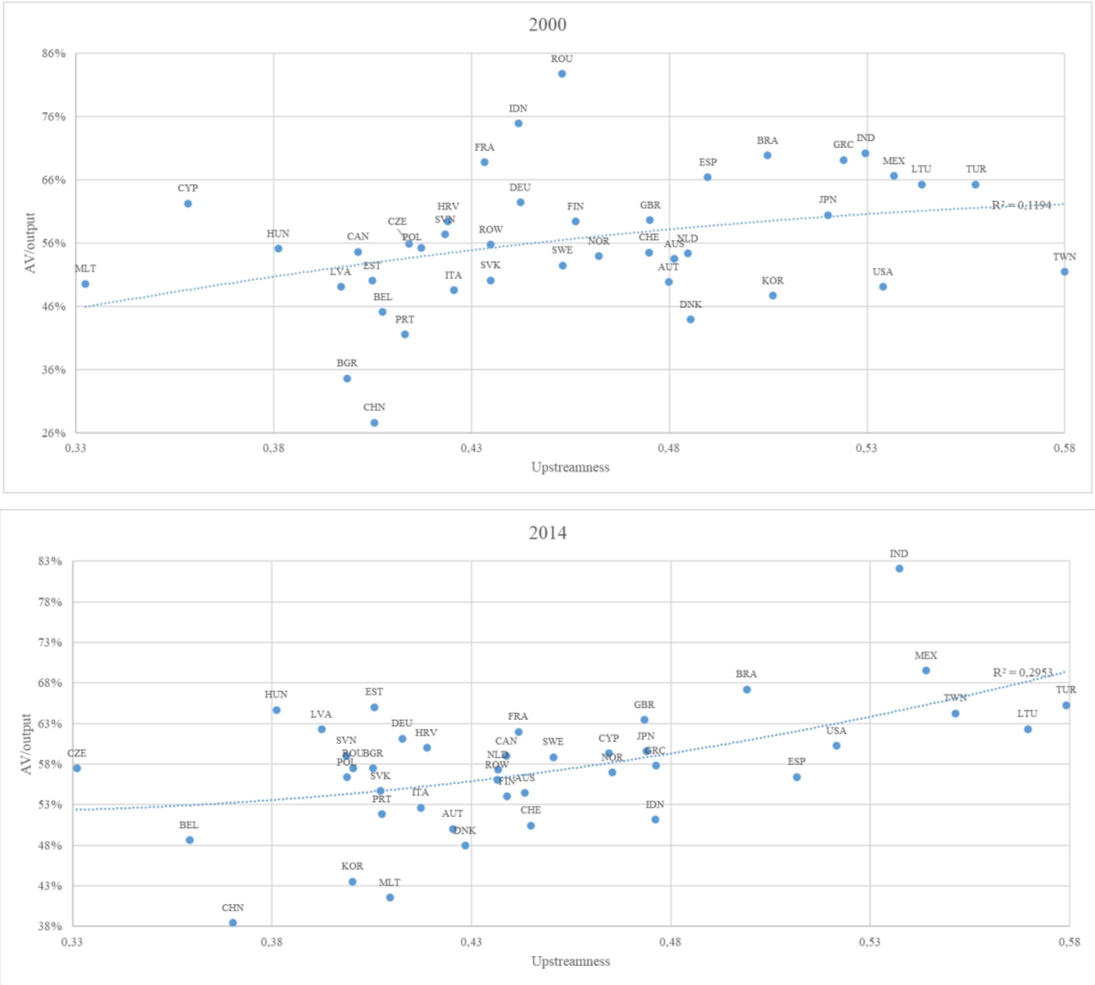
The ratio of intermediate consumption to final consumption is around 50-50% for the IT sector, which is also average for the other sectors, but with a much higher variance between sectors than for domestic-foreign sales (minimum intermediate consumption ratio 6%, maximum 96%).

5.4.3. Comparison of the "IT positions" of the countries surveyed

I have looked at the IT sector in detail for each country. In this subsection, I will examine the sector not in relation to other sectors, but by focusing on the differences in the position of the sector between countries.

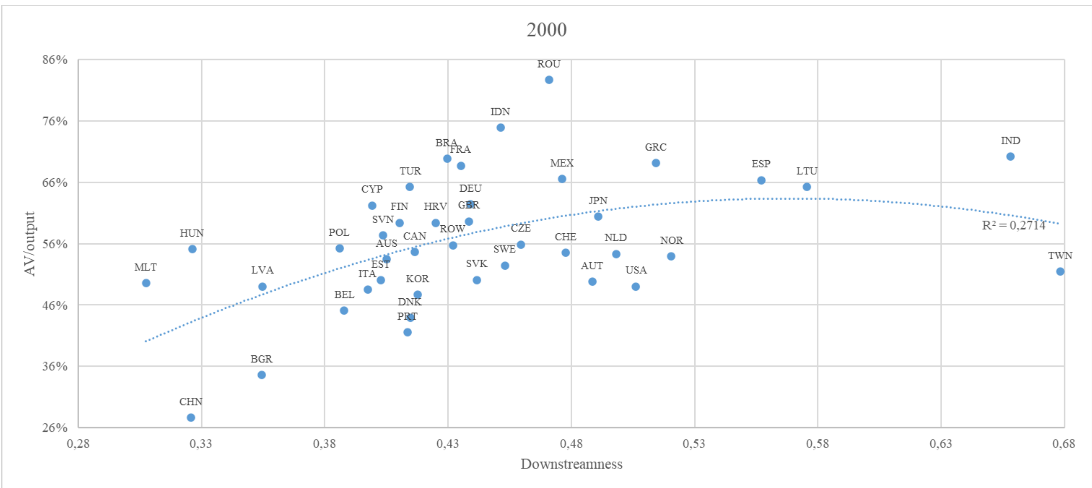
In a first step, I analysed the countries' IT sectors by plotting the classic smile curve. I calculated the Upstreamness/Downstreamness index of the IT sector for each country and the value-added content of the sector per country. This analysis clearly shows how different the same named sector is from country to country. The results based on the Upstreamness indicator are shown in Figure *34* and the results based on the Downstreamness indicator are shown in Figure *35*. Explanations of the country labelling are given in the Annex.

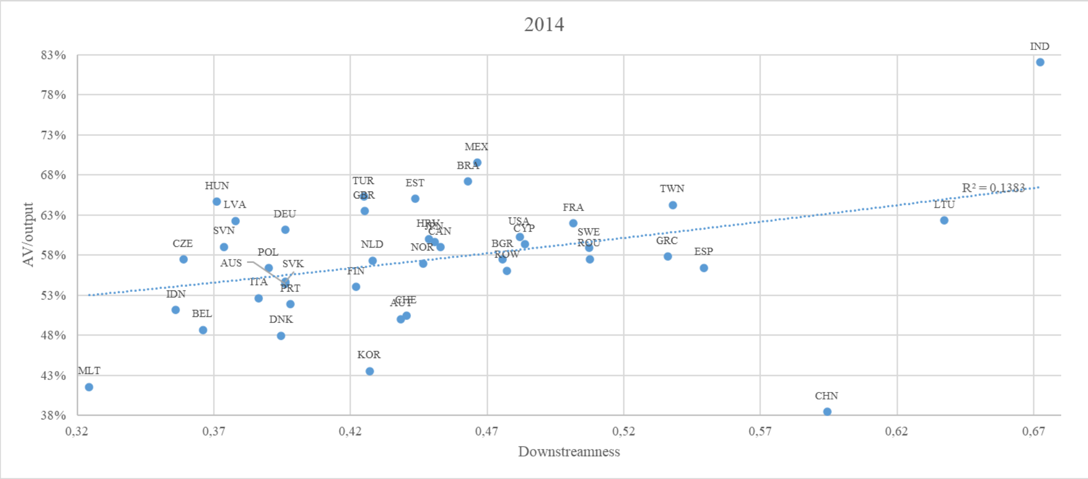
Figure 34: IT position of countries by Upstreamness index (2000 and 2014)



Source: own calculation and edit based on WIOD

Figure 35: IT position of countries by Downstreamness index (2000 and 2014)





Source: own calculation and edit based on WIOD

According to the smile curve theory, sectors at the beginning and end of the value chain are able to create more value-added content than those in the middle of the value chain. The theory applies to sectoral positions within a country (or aggregated to a group of countries), but interestingly, the analysis for 2014 gives similar results to the overall sectoral analysis for the whole world in the previous research, that is, value added content increases progressively from the upstream to the downstream classifications.

The strategic position of the sector varies considerably from country to country. This can be seen from the very large variation between countries on both the upstreamness and downstreamness scales. For both indicators, the IT sector accounts for about half of the total upstreamness and downstreamness domains.

Based on the upstreamness and downstreamness indicators calculated for the IT sector and the "artificial cut value" scores, I plotted the country sectors on the smile curve and assigned them to UMD categories for both years. To determine the cut value, I examined all sectors in several countries and plotted the UMD curve and decided to sort it by the aggregated values for the whole world. (Article 3 and methodological introduction, Fülöp, 2023)

For the sake of transparency, I have also divided the value-added ratio into three categories. Low, medium and high value-added content. The cut value in this case is 50% and 60%. This means that I have divided countries into the three categories in roughly the same ratio. Note that the world aggregate would have a cut value of 35% and 55% if I also wanted to follow the rule of division into three parts.

Based on the categories thus created, a 3x3 matrix can be created for both survey years, providing a clear overview of the countries' positions. Here, too, a decision has to be made, since similar but not the same tables are created, depending on whether I classify the sectors according to upstreamness or downstreamness indicators and whether I use the cut value for 2000 based on the corresponding world values or whether I use the cut value for 2014. I have carried out all the possible classification methods mentioned above and although there is a lot of overlap, it is not possible to summarise them in a single figure, therefore I will not attempt it.

In 2000 and 2014, the number of countries in the high value-added range is the same, but with some changes. More countries slip back into the medium range, and some move up into the high range. There is no crossover between low and high based on the time periods examined. The low value-added range is basically in the upstream and manufacturing categories, with some countries "stuck" in the downstream sectors, but still with low value-added (e.g. IRL, CHN). Six countries have managed to move and achieve higher added value content. These can also be clearly seen in the following tables. (Table 25, Table 26, Table 27)

Table 25: Classification of countries' IT sectors by UMD and value added share, Downstreamness indicator cut value 2014; 2000; 2014

2000; **2014**	**U**	**M**	**D**
High AV	x	BRA; CYP; DEU; FRA; IDN; TUR **DEU; EST; GBR; HUN; LVA; TUR**	ESP; GRC; IND; JPN; LTU; MEX; ROU **BRA; FRA; IND; LTU; MEX; TWN; USA**
Medium AV	HUN **CZE; IDN**	AUS; CAN; CZE; EST; FIN; GBR; HRV; POL; ROW; SVK; SVN; SWE **AUS; AUT; CAN; CHE; FIN; HRV; ITA; JPN; NLD; NOR; POL; PRT; SVK; SVN**	CHE; NLD; NOR; TWN **BGR; CYP; ESP; GRC; ROU; ROW; SWE**
Low AV	BGR; CHN; LUX; LVA; MLT **LUX; MLT**	BEL; DNK; IRL; ITA; KOR; PRT **BEL; DNK; KOR**	AUT; RUS; USA **CHN; IRL; RUS**

Source: own calculation and edit based on WIOD. Note: value added data for RUS are insufficient, therefore its low classification is not confirmed!

A simplification of the data presented in Table 25 (showing only the number of countries included in each section) is illustrated in Table 26 and in Table 27.

Table 26: Number of countries per UMD and value added ratio category in 2000, based on downstreamness index 0.36 and cut value 0.46

2000, (pcs)	**U**	**M**	**D**	**sum**
High AV	0	6	7	13
Medium AV	1	12	4	17
Low AV	5	6	3	14
sum	6	24	14	44

Source: own calculation and edit based on WIOD. Note: value added data for RUS are insufficient, therefore its low classification is not confirmed!

Table 27: Number of countries per UMD and value added ratio category in 2014, based on downstreamness index 0.36 and cut value 0.46

2014, (pcs)	**U**	**M**	**D**	**sum**
High AV	0	6	7	13
Medium AV	2	14	7	23
Low AV	2	3	3	8
sum	4	23	17	44

Source: own calculation and edit based on WIOD. Note: value added data for RUS are insufficient, therefore its low classification is not confirmed!

The analysis summarised in Table 26 and in Table 27 is based on several methodologies (by Upstreamness and along different cut values). The results of all the analyses show that IT sectors in the Upstream group tend to be in the medium to low value-added group, Manufacturing sectors tend to be in the medium value added group, and Downstream countries tend to be in the medium to high value added group.

The significant difference between the examinations is the amount of UMD classifications. In the Upstreamness classification, significantly more countries' IT sectors are classified as Upstream.

Taking all IT sectors in the world together, the value-added share was 54.6% in 2000 and 57% in 2014. Overall, the IT sector is teetering on the edge between manufacturing and downstream. Some contradictions can be discovered if it is classified as a manufacturing sector, as the literature for smile curve generally shows that manufacturing sectors have a lower value-added share than upstream or downstream sectors. With a value between 50-60%, it is more of an upstream or downstream sector. The type of IT would fit well in the upstream sector as a development sector but given that many services are directly encountered by the end-user, the downstream nature of the sector is also well justified. The number of upstream countries is low. Few specialise in this area and their numbers have decreased slightly. The trend towards manufacturing and eventually downstream, and towards the medium and high value-added range, bodes well for the future of the sector. The prevailing digitalisation trends worldwide are likely to confirm this. More and more devices require IT services to be supplied and continuously delivered in return for various subscriptions, which increases the downstream weight.

5.4.4. Top countries

Looking at the data, the IT sector in several countries ranks where we would expect it to be based on the available information, for example the USA ranked among the downstream sectors in both 2000 and 2014 with a relatively high value-added share. This might seem logical to anyone, as the term "Silicon Valley" immediately comes to mind, and several big players such as Microsoft, Google, Facebook, Amazon, Apple, etc., which, according to the literature, fit perfectly into the downstream category. Note that the US accounted for 32.3% of world IT value added in 2000 and 28.4% in 2014 (as well as a share of IT value added outsourced to Ireland and other countries in 2014). For other countries, the calculated value tends to raise further questions. The most prominent places (downstream, high value-added rate) include Lithuania, Türkiye and Mexico.

A significant number of stakeholders are pushed into the middle in the manufacturing category. Several large, well-developed countries, such as Switzerland, the UK, France, Canada, and all the countries not listed individually (ROW, rest of the world) are also included, although the latter has shifted downstream.

What is also interesting is the upstream side. These countries (e.g. the Czech Republic, Luxemburg, Malta) could be theorised as potential winners in IT outsourcing or developer knowledge accumulation, but it seems that they do not have enough bargaining power. Most of the countries listed here do not have a high value-added ratio, those can be found rather in the low to medium value added range.

High value-added ratio may also be the result of a certain selection, since if my capacity is low and I can afford to be choosy, I may consciously focus only on the better options.

One of the most remarkable results is that Ireland has been transformed from a category on the borderline between upstream and manufacturing to a completely downstream but incredibly low value-added sector. Its relevance is very high, as it represents 5.1% of the value added of the national economy, with a ratio of 20% of value added to output, although it represents only 1% of world IT output. This is largely explained by the "Google model" phenomenon, whereby several large IT companies (Google, Apple, Facebook, etc.) have set up branches in Ireland, and thus account for a significant part of their output and value added there, mainly for tax reasons, but the real economic performance of the country is not insignificant either.

Another lesson is that India is a country to be watched in the future, as it has been able to further strengthen its already high IT position, both in downstream, value added and economic weight dimensions. It has achieved a higher value-added share than any other country. In the period under review, the country doubled the weight of the IT sector in the national economy from 1.6% to 3.8%, making it the second largest among the countries studied, after Ireland. It also accounted for 6.3% of the world's IT value added in 2014, up from 1.7% in 2000. Presumably, a significant part of this is also outsourcing by the US, which has lost around 4% of its share.

Also noteworthy among the results is Mexico, which has a remarkably high value-added share and is stable in the downstream category. Its weight in the national economy is not particularly high according to the facts, but the articles available report a steadily increasing weight. In the case of Mexico, it is clear that this is the result of a deliberate central strategy to take advantage of the proximity of the United States. There has been a conscious effort to develop and support IT studies in higher education. At universities, 20% of graduates obtain a degree in an IT-related subject. In addition, the sector continues to be strengthened by attracting large, well-known IT companies such as GE, IBM, Oracle and Intel (Ivemsa, 2021 and Oxford Business Group, 2021).

When examining the sector, an important question is who the most prominent countries are globally that contribute the most to the world's IT value added. The top 7 countries are listed in Table *28*.

Table 28: Top countries for IT sector (2014)

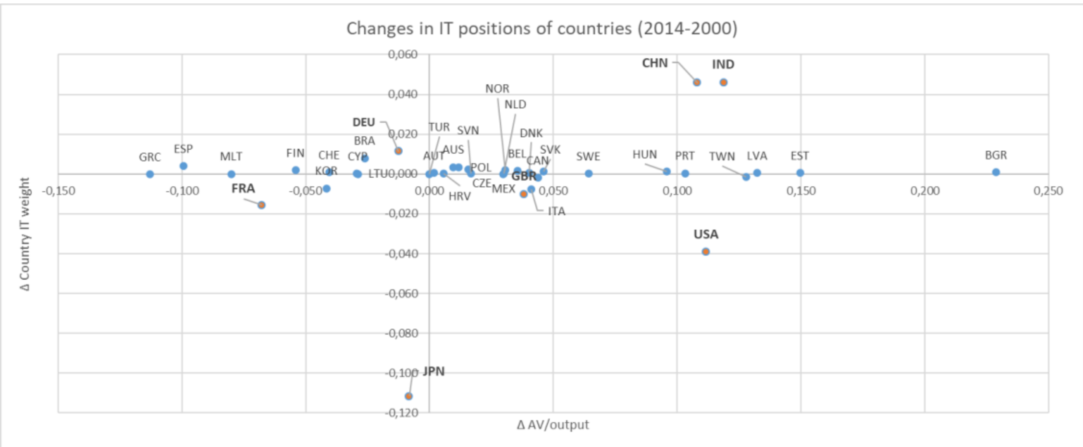
#	Country	IT weight
1.	USA	28,4%
2.	DEU	7,6%
3.	JPN	7,4%
4.	GBR	6,5%
5.	IND	6,3%
6.	CHN	5,2%
7.	FRA	5,0%

Source: own calculation and edit based on WIOD

The US is the absolute winner in this comparison, producing almost 30% of the world's IT value added in 2014. There is no significant difference between the other top countries.

In addition to the observation of the " podium " in 2014, it adds further depth to the analysis to include changes between the two dates under consideration (2000 and 2014).

Figure 36: Changes in the IT positions in countries



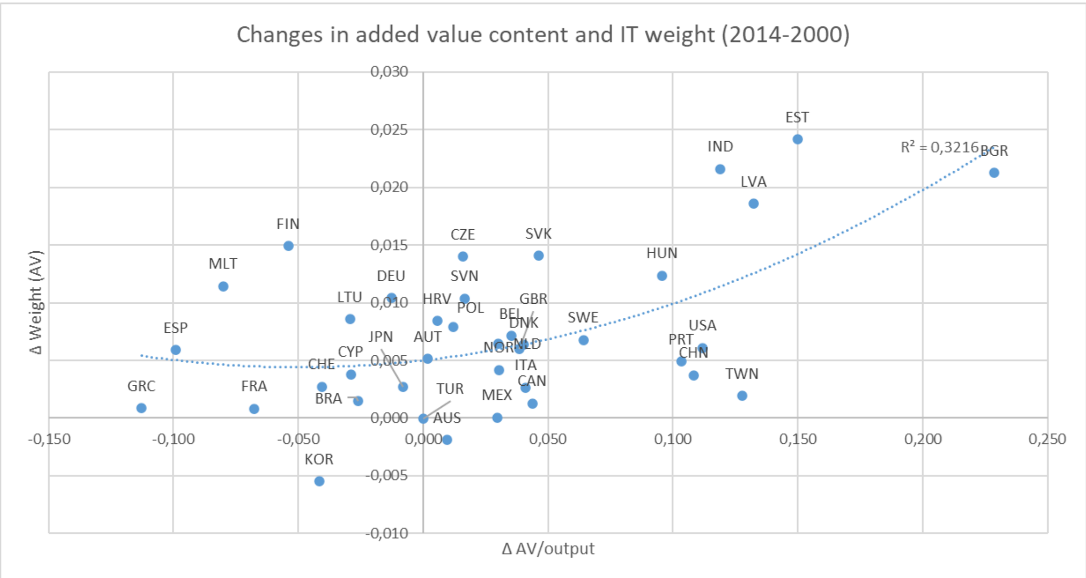
Source: own calculation and edit based on WIOD

Figure *36* compares the change in countries' weight in world total value added and the change in value added content. Based on the analysis, the following conclusions can be drawn:

- Countries that are not in the top 7 have not seen a significant change in their IT weight over the period. The non-priority countries are located along the *x*-axis.
- Those top countries that did not significantly increase their value added content did not achieve significant increases in IT weight, moreover, Japan experienced a significant decrease.
- Looking at the trio of China, India and the US, it can be observed that the same increase in value added content is accompanied by an inverse change in IT weight, due to the fact that China and India have achieved significant volume growth in combination with efficiency gains, thus reducing the US' dominance by a small margin from 2000 to 2014.

In relation to the change in value added content, I have also examined the correlation between the change in value added content and the change in the weight of IT in the country, the result of which is illustrated in Figure *37*.

Figure 37: Correlation between value added content and IT weight



Source: own calculation and edit based on WIOD

There is a relatively strong relationship between efficiency change and the change in the weight of IT in the country. However, the upper left-hand part of the coordinate system shows that an increase in volume can also strengthen the position of IT within the country. These countries have increased the volume of less profitable tasks, presumably some of the increase in volume has been transferred to these countries through outsourcing.

5.4.5. Cluster analysis

Cluster analysis was used to group the countries. Zsolt Matyusz and Dávid Losonci provided methodological assistance in the calculations and helped to discuss the results. Cluster analysis itself is a classification tool with a myriad of approaches and techniques. Its primary purpose is to identify groups in the data where observations within each group are more similar to each other than observations in other groups. The cluster analysis techniques used (hierarchical and k-means clustering) and the associated statistical tools are discussed in detail by most statistical textbooks. For a detailed overview of cluster analysis, see e.g. Everitt et al. (2011).

In our cluster analysis, we followed the following steps:

0) we constructed standardised z-values for the variables under study (Downstreamness, AV_output, AV_IT_weight, Country_IT_weight), which we used for clustering. In this case, the positive values of the variables represent above-average values compared to the sample, while the negative values represent below-average values.

1) A hierarchical cluster analysis was performed using Ward's method to determine the range of potentially optimal cluster numbers along with the solutions associated with each cluster number.

2) K-means clustering was also used to examine the solutions that emerge within the range (2-9 clusters) defined in step 1.

3) We compared the results of the two methods by cross-tabulation analysis, measuring the strength of association using Cramer's V index. A higher V value indicates a stronger association, i.e. a higher degree of similarity of solutions for a given cluster number. The results are shown in the table below:

Cluster number	Cramer's V
2	0,209
3	0,772
4	0,751
5	0,864
6	0,838
7	0,727
8	0,895
9	0,824

On this basis, the 8 clustered solutions were adopted and subjected to further analysis. The final cluster centres formed, and the size of each cluster are shown in the following table:

	Cluster							
	1	2	3	4	5	6	7	8
Zscore(Downstreamness)	**,58102**	**2,67609**	-,18756	**-,58652**	**2,80901**	,06283	**1,71827**	**-1,08187**
Zscore(AV_output)	,09334	**-3,16145**	,20893	-,41170	**2,35150**	**1,02010**	,27793	**-2,50894**
Zscore(AV_IT_weight)	,13660	**3,81517**	**,88115**	-,38723	**2,40577**	**-,96544**	**-,59632**	-,36316
Zscore(Country_IT_weight)	**4,62463**	-,26020	,01483	-,22850	**,76687**	-,37083	-,22448	-,38643
Size of cluster	3	1	27	27	1	13	10	4

Japan and the US were the first cluster members in 2000, and the US remained in the cluster in 2014. This cluster has an outstanding Country_IT_weight compared to the sample and an above average Downstreamness.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
JPN00	0,55501	0,43359	0,178	3,11066	1
USA00	0,74511	-0,5715	-0,2123	5,75828	1
USA14	0,44293	0,41794	0,44405	5,00493	1

Ireland 2014 is the only country in the second cluster, with outstanding Donwstreamness and AV_IT_weight, but with an AV_output very below the sample average.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
IRL14	2,67609	-3,1615	3,81517	-0,2602	2

The third cluster is the most populous (together with the fourth cluster). For the observations presented here, AV_IT_weight is the only variable that deviates significantly upwards from the sample average. It is interesting to note that 6 countries are both included in this cluster, while the other countries are only included here in 2014, i.e. they moved here from other clusters compared to 2000, but never moved from this cluster to another.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
AUS00	-0,5133	-0,1796	0,66655	-0,0823	3
AUS14	-0,6252	-0,0941	0,46437	-0,0163	3
BGR14	0,36579	0,17432	0,96088	-0,4276	3
CAN14	0,08238	0,30794	0,17208	0,01128	3
CHE00	0,39	-0,0889	0,45824	-0,2173	3
CHE14	-0,0722	-0,4483	0,75204	-0,2016	3
CZE14	-1,086	0,17325	0,96927	-0,3738	3
DEU00	-0,0893	0,61088	0,03551	0,80033	3
DEU14	-0,6249	0,49972	1,15413	1,01956	3
EST14	-0,0318	0,84072	1,67289	-0,4353	3
FIN14	-0,3003	-0,1336	1,63375	-0,3312	3
FRA00	-0,1372	1,17084	0,80452	0,82116	3
FRA14	0,68698	0,57238	0,89367	0,52185	3
GBR00	-0,0972	0,36619	0,83463	0,99947	3
GBR14	-0,2641	0,70513	1,48104	0,80582	3
HUN14	-0,9341	0,81189	0,89152	-0,4024	3
JPN14	0,05514	0,36149	0,47083	0,96559	3
LVA14	-0,8508	0,59869	0,92614	-0,4362	3
MLT14	-1,5149	-1,2352	1,50836	-0,4424	3
NLD00	0,64597	-0,1037	0,39609	-0,1281	3
NLD14	-0,2273	0,1613	1,09358	-0,1206	3
NOR14	0,00193	0,12866	0,20854	-0,3216	3
ROU14	0,76049	0,1751	1,8599	-0,354	3
SVK14	-0,6231	-0,0716	0,68891	-0,4149	3
SVN14	-0,9018	0,31112	0,34909	-0,4341	3
SWE00	0,08278	-0,2708	0,85818	-0,2044	3
SWE14	0,75791	0,29723	1,58643	-0,2006	3

The fourth cluster also contains 27 observations. They are slightly below average for all variables, most notably for Downstreamness, 7 countries and the residual ROW (Rest of world) remained here in both years, and basically there were only shifts from here to other clusters. The only exception is Indonesia, which moved from cluster 6 to this cluster in 2014.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
AUT00	0,52322	-0,5028	-0,298	-0,3473	4
AUT14	-0,0976	-0,4865	0,25629	-0,3354	4
BEL00	-0,7266	-0,9203	-0,3492	-0,3307	4
BEL14	-0,9986	-0,607	0,41652	-0,2993	4
CAN00	-0,3706	-0,0796	0,03379	0,04645	4
CZE00	0,16387	0,03376	-0,5364	-0,4206	4
DNK00	-0,3932	-1,0271	-0,2011	-0,3607	4
DNK14	-0,642	-0,671	0,48179	-0,351	4
EST00	-0,5427	-0,4852	-0,9264	-0,4454	4
FIN00	-0,4471	0,34528	0,02949	-0,3693	4
HUN00	-1,4946	-0,0351	-0,4365	-0,4263	4
IDN14	-1,1217	-0,3843	-1,3699	-0,4103	4
ITA00	-0,6093	-0,6179	-0,0308	0,2501	4
ITA14	-0,7445	-0,2546	0,25403	0,10326	4
KOR00	-0,3565	-0,6917	-0,2783	-0,1565	4
KOR14	-0,2408	-1,0596	-0,8699	-0,2962	4
LUX00	-2,0301	-0,8148	-0,227	-0,4356	4
LVA00	-1,1382	-0,5718	-1,0723	-0,4452	4
MLT00	-1,7274	-0,5262	0,27672	-0,444	4
POL00	-0,7514	-0,0277	-0,9887	-0,4045	4
POL14	-0,6987	0,07743	-0,1363	-0,3368	4
PRT00	-0,4093	-1,2384	-0,9627	-0,4169	4
PRT14	-0,5995	-0,3232	-0,4342	-0,4102	4
ROW00	-0,1788	0,02089	-0,9502	0,43093	4
ROW14	0,3851	0,04771	-0,5471	1,32255	4
SVK00	-0,0573	-0,4793	-0,8229	-0,4405	4
SVN00	-0,5319	0,16323	-0,7661	-0,4403	4

The fifth cluster includes only India from 2014. It can be seen that all variables are above sample average, especially for the first three.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
IND14	2,80901	2,3515	2,40577	0,76687	5

The sixth cluster contains above average observations for AV_output and below average observations for AV_IT_weight. Five countries are here in both years, apart from Greece, Indonesia and Romania in 2000, but they moved to another cluster in 2014.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
BRA00	-0,2081	1,26699	-0,2205	-0,1027	6
BRA14	0,20781	1,03559	-0,0569	0,04849	6
CYP00	-0,5872	0,59514	-0,9842	-0,4443	6
CYP14	0,46637	0,33847	-0,5767	-0,4435	6
GRC00	0,84537	1,20548	-1,2417	-0,4267	6
HRV00	-0,2646	0,34663	-1,2293	-0,4437	6
HRV14	0,02826	0,3965	-0,3224	-0,4373	6
IDN00	0,06246	1,71638	-1,5308	-0,438	6
MEX00	0,37204	0,97972	-1,5955	-0,4328	6
MEX14	0,24815	1,24335	-1,5911	-0,436	6
ROU00	0,30745	2,40842	-0,4482	-0,4298	6
TUR00	-0,395	0,86433	-1,3738	-0,4164	6
TUR14	-0,2662	0,86433	-1,3797	-0,418	6

Members of the seventh cluster show outstanding downstreamness and below average AV_IT_weight. Three countries have been in this cluster all along (Spain, Lithuania and Taiwan), while India and Norway were in 2000 and China and Greece were added in 2014.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
CHN14	1,84215	-1,5108	-0,9979	0,55982	7
ESP00	1,37592	0,95969	-0,5081	-0,1874	7
ESP14	1,28152	0,08091	0,12767	-0,1108	7
GRC14	1,11629	0,20662	-1,1509	-0,4313	7
IND00	2,63528	1,29977	0,08143	-0,1148	7
LTU00	1,60823	0,86399	-1,3027	-0,4454	7
LTU14	2,37482	0,6037	-0,3806	-0,4386	7
NOR00	0,92336	-0,1408	-0,2417	-0,3574	7
TWN00	2,88612	-0,3575	-0,9	-0,3456	7
TWN14	1,13906	0,77364	-0,6905	-0,3733	7

Cluster 8 is below average on all variables, similar to Cluster 4. However, in contrast, the Downstreamness and AV_output values are much more below average. Bulgaria, China and Ireland were in this cluster in 2000, while in 2014 only Luxembourg was included.

Country	Zscore (Downstreamness)	Zscore (AV_output)	Zscore (AV_IT_weight)	Zscore (Country_IT_weight)	Cluster
BGR00	-1,1435	-1,8506	-1,324	-0,4453	8
CHN00	-1,5007	-2,4684	-1,3976	-0,3198	8
IRL00	-0,589	-1,7491	0,90732	-0,3513	8
LUX14	-1,0943	-3,9676	0,36157	-0,4293	8

5.5. Summary

In the study I focused on the IT sector and sought to answer the question whether differences between countries in IT can be measured at the sectoral level. The answer was yes. As a methodological tool, I used Antras-Chor's index of upstreamness and downstreamness and the value-added share of output, so that I could plot the countries available in the WIOD database along the Mudambi smile curve. The results show that there is a complete mix of country positions, but still the usual smile curve shape between the two dimensions of analysis is visible. This is a remarkable result because the variation between countries in the same sector has never been presented in this way before.

A further result is that the shifts between the two study dates (2000 and 2014) draw attention to which countries are worth focusing on because they have moved differently from the average in terms of the values measured (e.g. Ireland). The analysis highlights the countries which have relatively good GVC positions, and the change in the position between the two examined period. India and Mexico are good examples. Of course, it also highlights the opposite, countries in poor positions. These should be analysed in a focused study later.

Another result of the research is that it confirms or refutes a number of assumptions. One of the latter is that the IT sector would be assumed to be mostly upstream or downstream, as it is either close to development and production of primary inputs or close to consumers and final consumption outputs, whereas most countries are in the middle of the manufacturing category. If we think about this further, given the current digitalisation trends and the fact that IT is now embedded in the tools of all sectors, this trend seems logical as countries are equipped to serve it.

A noteworthy research result is the identification of the most significant economic linkages of the IT sector, i.e. the sectors that supply the largest share of its inputs and process the largest share of its outputs. The most significant links are predominantly service sectors with high value-added content.

The methodology used has limitations which must be taken into account, since the value-added share and value added itself are both grossed-up categories, but since all countries are analysed for the same dates and on the same database, their relative positions allow conclusions to be drawn. It should be pointed out that the generally accepted conclusions for the smile curve are somewhat more nuanced for the IT sector. It is generally accepted that in the middle of the curve the players are in a worse position and have a lower value-added ratio, which is not good for the competitive situation. For the IT sector, the smile curve of upstreamness and value-added content takes the shape of a "/", i.e. higher value added content is achieved closer to the end-use. This can be attributed to higher demand, higher knowledge requirements and good bargaining power. Where countries are lagging behind along this vertical dimension, it is worth examining which of these factors, or lack of them, is responsible.

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Appendix

List of abbreviations for countries

AUS Australia	IRL Ireland
AUT Austria	ITA Italy
BEL Belgium	JPN Japan
BGR Bulgaria	KOR Korea
BRA Brazil	LTU Lithuania
CAN Canada	LUX Luxembourg
CHE Switzerland	LVA Latvia
CHN China	MEX Mexico
CYP Cyprus	MLT Malta
CZE Czech Republic	NLD Netherlands
DEU Germany	NOR Norway
DNK Denmark	POL Poland
ESP Spain	PRT Portugal
EST Estonia	ROU Romania
FIN Finland	ROW Other countries
FRA France	RUS Russia
GBR United Kingdom	SVK Slovakia
GRC Greece	SVN Slovenia
HRV Croatia	SWE Sweden
HUN Hungary	TUR Turkey
IDN Indonesia	TWN Taiwan
IND India	USA United States of America

6. Closing remarks and summary

6.1. Closing remarks

Just as in the introduction of my dissertation, I aim to infuse a more personal tone and simplicity into the conclusion, rounding off my dissertation that crowns the turning point of the past ten university years. Over these ten years, I have learned so much – I have sifted through countless notes, literatures, textbooks, completed both undergraduate and master's theses, and worked on various studies, ranging from small articles to more substantial ones. This dissertation seeks to distill a substantial chunk of the knowledge I have accumulated here.

I have come to realise that the saying holds true: the more we learn about something, the more we sense how little we truly know about it. Through my research, understanding and answering some questions have unfolded numerous new inquiries, charting new research directions that could fill the coming years or even decades with fresh challenges. Fields like analysing the knowledge intensity of activities or showcasing innovation factors, quantifying knowledge capital as a production factor, investigating micro-level disruptions of key players in international supply chains, and analysing income division based on ownership structures could potentially be such avenues. But before delving into these, the present dissertation must be concluded.

I have deeply contemplated on how to provide a succinct closing for four independently published studies, approximately 200 pages long, alongside their associated background materials, which collectively amount to several times that. How to offer a brief summarising closure that does not merely echo abstracts or summaries has been a significant pondering.

6.2. Summary of the dissertation

Ultimately, the results collectively underscore that understanding the differences between industries and the complexity of international trade (global value chain) as pivotal factors in economic development. It is clear that Central-Eastern European countries are catching up to the West, but they have not yet caught up entirely.

As key finding I would like to highlight some from my article-based dissertation. In Article 1. you can find that several studies have shown that value-added production and efficiency increase with firm size. We have confirmed this in our study. This suggests that increasing the size of the company may be a logical way out, but our research has shown that without real upgrading, the expected results will not be achieved. In Hungary, the firms which were upsizing (changed size category up) from year 2010 to 2015 there are problems with the contributions to added value increase. They could not really increase their added value, but it is true that not in the ratio we could expect from macro level examination.

In a pioneering way, Article 2 not only examines international import-export relations, and in net terms, but also territorial relations within Hungary (territorial/regional IOT), which reflects the local presence of global laws in the functioning of the economy. In summarising the articles, it will be well connected that Article 2 actually highlights the fact that the trap situation discussed in Article 3 is also present within Hungary among the regions, and if Budapest were to be excluded, it would not be in a bad position internationally either. However, this may be one of the costs of not being able to say the same for the rest of the country.

Examinations in Article 3 and Study 4 show that the upstreamness index of many sectors is getting lower, so that compared to the classic smile curve classification, sectors are shifting from manufacturing to upstream, and typically with a low value-added share. For this reason, it can be observed that, in contrast to the "U" shaped curve of the developed countries, the curve of the CEECs often takes a "/" shape, but also "r" and "^" shapes are not uncommon. These production structures only allow for extensive catching-up.

To conclude, it can be stated that economic development is a complex process influenced by disparities between sectors and the interrelation of industries within value chains. Countries that can effectively increase their productivity and value-added ratio, along with building the right economic relationships, have a better chance of achieving sustainable development and competitiveness in the global economy. It is important to emphasise that not everyone can be a winner in the race for catching up; there will always be those who lag behind. It should be mentioned that we can get into a trap situation not only through our own fault, but it is also up to us whether we do everything we can to avoid it or to escape.

The catching-up process in Central-Eastern Europe in the past 30 years was mainly based on FDI. In some aspects it was successful, because there is a smaller economic gap between Central-Eastern Europe and the Western countries. As it is written above, in spite of this, we are still in a trap situation. I can speculate that the economic structure of CEE countries is highly entrenched, leading them to navigate a constrained trajectory due to the potent forces of inertia at play. It predestinates that for adapting to changes these countries try to use a strategy which causes less harm in short term transition. In the CEE region there is an ongoing change, mainly in Hungary, and since Eastern capital is on the market, it tries to compete or even replace the role of the western FDI from the past 30 years. They are competing for the same upstream and manufacturing capacity, and the country mostly accepts it. It seems rational because it is the easier way. To develop other sectors, i.e. IT (in a good GVC position way), requires many knowledge (market, know-how, process, etc.), which is a difficult task and demands even more time and effort.

This speculation and thought experiment could be a potential roll on of my research, which opens new aspects. The complexity of GVC and the rapid changes ongoing are more important research fields nowadays than they were when I started my research. More radical changes are at the door because of the COVID disease's social effects, the reshoring trends and the ground-gaining of the Eastern capital.

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