EVOLVEMENT OF GLOBAL VALUE CHAIN POSITIONS IN CENTRAL AND EASTERN EUROPEAN COUNTRIES: A NEW DIMENSION IN CATCHING UP?

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Abstract

The paper examines the evolvements in the global value chain positions of the Central and Eastern European (CEE) countries. This approach enables us to reveal both economic and sector-level structural changes in the economic catching-up process. To study the structural patterns, we developed a modified smile curve framework that combines the 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 a “/” shape, which reflects an upstream-weak economy (e.g., BGR 2000; HUN 2000; LVA 2014). The second most common structure is marked by an inverted “U” shape (“^” shape), which denotes a manufacturing-heavy economy (e.g., 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.

Implications for Central European audience: Typically, the CEE countries are shifting towards 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 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 processes are done at a high rate in any sector. Heavy manufacturing should elaborate market connections and develop connections to customers. It alerts that a transition is required from extensive to intensive and knowledge-based developments.

Keywords: global value chain; catching up; smile curve; value added ratio; upstreamness; downstreamness; CEE countries

JEL Classification: O11, O14, O47, F14

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 rather 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 exports, outsource lower value-added activities or produce the products in another country in the form of FDI (foreign direct investment). Research by Minárik et al. (2022) shows a good example of how other activities related to the automotive industry production (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 using a high-level, aggregated indicator, which is contributed to 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 the gap in the literature by answering the following question: how much does the GVC position of the region contribute to the strengthening of catch-up?

The smile curve framework places these GVC analyses 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 participants in the economy. This statement is mostly accepted as general truth among economists. The widely used basic theorem and measurement can be related to the work of Shih (1992a), Mudambi (2008), Antràs et al. (2012) and Antràs and Chor (2013). 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 at the sectoral level as well (Rungi & Del Prete, 2017; Stöllinger, 2019; Hagemejer & Ghodsi, 2017; Boda, 2020; Boda et al., 2021, etc.).

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

The name “smile curve” derives from the relation of upstreamness (horizontal axis) and value-added ratio (vertical axis), as shown in Figure 1. According to the theory, a higher value-added ratio can be reached at the beginning and at the end of the value chain, which can help sectors/functions be more profitable than others at 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 the smile curve; hence, there is a wide range of international literature on the micro level, namely, corporate value chain and global value chain research, which I present in the following section 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 smile curve method.

I examine whether the smile curve can really appear considering the CEER (Central and Eastern-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 et al. (2012) and Antràs and 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 a similar result, but those findings are not presented in this study.

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

1 Literature Review

1.1 Theoretical background of GVC

Global value chain got at the centre of 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 provides different added value for saleable products and services. The corporate-level interpretation used by Porter reached another level of economic 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 in transaction costs caused a dramatic change in production tasks and in the 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 at the sector level.

In the globalised world, the same NACE-coded[1] sectors vary greatly 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 that. One of them is the specialisation of firms. A lot of enterprises just clear their processes and leave out some elements, because they cannot do them 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 joint venture.

Baldwin was also thinking about the global value chain when he created the model of the attainment of globalisation in his study. Baldwin and Evenett (2015) noted that due to the changes in trade activity, the majority of EU companies are capable of outsourcing tasks which were categorised as non-tradable before. In addition, Baldwin brought the following aspect common knowledge: bigger companies plan the labour required by the production by using partly domestic labour and their knowledge, at the same time calculating with labour from different parts of the world[2]. It turned out that those tasks that required high qualifications 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 through foreign direct investments, but some researchers argue that they caused more harm than benefits because the ratio of value-added in output stayed low. Examination of each country's smile curve can bring us one step closer to understanding. In the value-added production of most CEER countries, foreign-owned capital plays an important role (Sass, 2021).

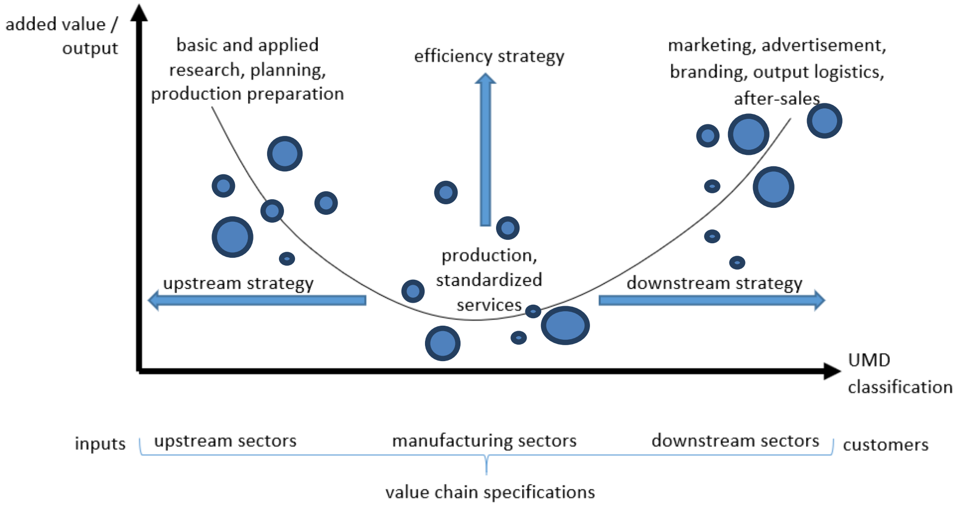
The most popular articles related to the smile curve are Rungi and Del Prete (2017), Mudambi (2008) and Antràs and Chor (2013), which provide insight into the theoretical context. They can be considered the basic literature on the topic.

Rungi and Davide 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 the smile curve in the literature as the sectors are organised in three categories (upstream, production and downstream; or pre-production, production and post-production) (Mudambi, 2008), so the curve in the coordinate system will be a parabola similar to a smile (see Figure 1). Sectors on the edges from those

[1] Nomenclature générale des activités économiques dans les Communautés Européennes – NACE (Nomenclature of Economic Activities)
[2] He meant both the mobility of labour including telework with digital assets, and the outsourcing of certain processes of the value chain to other participants.

participating in the analysis can "smile" since they have a higher added value per output unit. These are the sectors that should be reasonably strived after.

Figure 1 | Explanation of the smile curve theorem



Source: Own elaboration according to Boda et al. (2021), based on Rungi and Del Prete (2017). The first variant of the figure was published by Boda (2020).

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

Figure 1 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 for sectors. It also displays which sectors typically stand closer to inputs[3] and to their production, and also which sectors stand closer to the customers (market). Furthermore, strategic opportunities are also named for which direction the sectors can move. The common interpretation of the strategy can be seen at the corporate level, but sectoral strategic lines can also take shape in case the stakeholder companies are running along similar policies. The increase of the value-added ratio is a fundamental purpose of all companies and sectors since high benefits can be secured by high value-added content. Of course, an increase in value-added ratio can be successfully achieved 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 the concentration of resources to upstream and/or downstream directions can also be efficiency-increasing. In case a sector increases its input and production preparation 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 and discoveries. In case a sector moves rather towards the customers, it will run along a downstream strategy; for example, its products and services move to final consumption, increasing marketing, motivating sales and sales-related functions. However, in case it

[3] *Inputs: input materials, products and services that are involved in value creation.*

stays in the middle but wants to increase its value-added ratio in output, it can work along an efficiency-increasing strategy through the development and modernisation of manufacturing tasks. We should note that the bubbles in Figure 1 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, according to which section it falls in along the *x* axis, and also by the rate of added value and output in a certain year. Derivations from the other sectors need to be examined while determining the relative position to ensure 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 the *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 an efficiency increase or decrease. Therefore, the smile curve framework can also be validated by sectoral dynamics. For instance, if the company moves from production to upstream in line with an increasing value-added ratio, or conversely, if it moves from downstream to production in line with decreasing value-added ratio, the smile curve framework is confirmed. Hence, the direction of the increase strategy can be concluded by taking the timelines into consideration, namely, whether the sector turns upstream, downstream, bound in the middle, or with no movement along the value chain while still increasing its efficiency. This method is not appropriate for determining the purposefulness, since sectors can be dislocated in any direction by several external environmental factors.

1.2 CEER countries' economies in GVC

Examining the CEER countries and comparing them to the 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 1, so it includes both the vertical *y* axis dimension (rate of added value and output) and the horizontal *x* axis (sector position in the value chain). Classification of sectors into the right categories might also be set by defining the criteria of UMD extremes 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 at the firm level that describes the relation of classical value-adding processes within the company (Porter, 1985); however, Figure 1 describes a value chain which can be extended to intercorporate relations (Bowersox & Closs, 1996). A supply chain belonging to a global value chain can be reviewed at the 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, the outsourced operation-related transaction 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. Profits might increase if much greater savings are achieved by reducing wage costs than transaction costs[4]. All of the above contribute to the development of the smile curve framework since studies of segmented manufacturing and of conspicuous differences in the added value-producing capabilities among similar sectors of different countries become increasingly significant (Stöllinger, 2019). Based on the theory, it is presumable that significant differences will occur during the examination of sectors among the examined countries, since there are "upstreamer" and "downstreamer" functions even inside a certain sector, whose functions have become outsourceable much more easily at an international level, thanks to globalisation and ever-decreasing transaction costs.

Rungi and Del Prete (2017) and Mudambi (2008) described how they performed the sector classification into upstream, manufacturing and downstream categories (this will take place in the methodological chapter).

The authors also used other authors' previous results in their figures. Shih's (1992b) 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 of basic material values. These were deduced in a calculable form at the corporate level by Koppány and Kovács (2011)[5]. Two transitory categories can be mentioned before added value: the material-free production value, which is the gross production value minus material costs and resorted services, and also the net production value which is the material-free production value minus depreciation. 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 the 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 obtain a bottom-up calculation system.

The decreasing 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[6]. In case outsourcing gets to a place where they are more competent in the given task, the sum efficiency will probably increase. However, 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

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

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

[6] Development of IT has made the measure of outsourcing and the range of outsourceable 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 do not get to another chain-link.

appear in that company but in another one, since the output will belong to the other one and also 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 the observation dimension by Shih (1992a).

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. The reason is that it numerically defines the sectoral relations in inputs, outputs and consumption; furthermore, it has a bound and solid methodology on which UMD analysis can be laid. 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 the smile curve, in which computational methodologies were included. I rated the relevant studies according to which level of UMD classifications (micro, meso, macro) were used, which fields were covered by the analyses or by the authors, and what kind of database they used and who else's methodology or theory was adapted to their own work. It is summarised in Table 1.

Table 1 | Review of smile curve methodologies

Author, citation	Analysis time base	Field of coverage	Analysis unit	Analysis level	Database	Referred methodologies
ANTRÀS, Pol–CHOR, Davin (2013). Organizing the global value chain.	2000-2010	USA	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) Antràs and Helpman (2004) Antràs et al. (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)
Present 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 and Chor (2013) Mudambi (2008) Rungi and Del Prete (2017)

Source: Own elaboration based on abovementioned literature.

The abovementioned studies examine the smile curve and GVC from different perspectives, regions or time periods, and they have less focus on the combined methodology part with the WIOD-based measurements of the upstreamness. In this paper, the indicators are combined, and the grouping of the sectors into UMD categories is done using an exact methodology. This gives the chance that via a complex methodology, simplified and understandable results can be presented for country groups or sectoral groups. This study gives an exploratory overview of the chosen countries and country groups; moreover, it is compared with the benchmark countries.

2 Research Methodology

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

2.1 Classification of sectors according to their positions in value chain

In the overview of UMD methodologies, I adapted Antràs and Chor's procedure since their methodology is defined at the sectoral level, which plays a central role in my research, and the literature review also refers to the authors as providers of the core methodology. I find the 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 and Chor's (2013) methodology, by which EU and OECD countries are covered involving countries of my research as well. The methodology of Cieślik et al. (2016) is at a macro level, so it handles whole national economies, which does not fit my research, which is why I dismissed it. The abovementioned two studies use the WIOD database, with which I also operate in my research.

Antràs and Chor's procedure calculates an indicator based on sectoral relations balance (SRB; input-output table) for each sector, correlating the 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 follows: “The higher this indicator for a given industry, the more intensive its use as a direct input for final use production” (Antràs & Chor, 2013). Thus, the higher the indicator, the more downstream the sector; the higher the finished product rate, the more downstream the sector; and the lower the rate, the more upstream the sector.

The currently available data enable examination between 2000 and 2014. Fifteen years is a long period. Examining the phenomenon is enabled by attempts to create world input-output tables. Out of these, I use the results of the so-called WIOT[7] (World Input-Output Table, better known as the WIOD). This table assembles input-output tables of the majority of the world. (Particular input-output tables – SRBs – of 43+1 countries[8] can be deduced at

[7] *http://www.wiod.org/home*
[8] *A list of country codes used in WIOD is found in the Appendix.*

https://doi.org/10.18267/j.cebr.326

the current rate, in USD, yearly between 2000 and 2014[9].) The input-output tables display the following:

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

The smile curve is deductible from these data if we accept the upstream-manufacturing-downstream computational methodology after Antràs and Chor's downstreamness calculation procedure for the horizontal axis, and the value-added ratio of output as the vertical axis.

The computational methodology of the 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 need to be described. For this, I present Antràs and Chor's (2013) primer methodology in detail. Hagemejer and Ghodsi (2017) also took Antràs and Chor's (2013) methodology as a basis and applied it in the empirical calcirulations from the WIOD database.

2.2 Adaptation of Antràs and Chor's (2013) methodology

This subchapter contains the methodological description and highlights based on Antràs and Chor (2013). Depicted formulas and texts are inserted from the referred work, except those with another source label.

Upstreamness and downstreamness

The 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 categories not applied before (UMD). The authors used simple input-output basic correlation to create the methodology based on index numbers in sectoral relations balance:

$$Y_i = F_i + Z_i, \quad (1)$$

where:

Y_i is the full output of the sector *i*

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

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

[9] *As it is a deep structural analysis measuring the trend of very slow processes, the year 2014 cannot be considered obsolete due to the time consumption of the database.*

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

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

where:

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

$1 \leq i, j \leq N$ shows how much input was used by *i* to produce proper output for a one-dollar[10] *j*

We must take into consideration that the second expression on the right of Figure 2 shows the direct consumption from the 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 a higher-class summary, reflect how much the indirect consumption of *i* is as an input since they join other upstream processes in the value chain, but they miss out at least two manufacturing conditions on final consumption. The abovementioned can be represented as a compact matrix with a superposition of the sectors *i*:

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

where:

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

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

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

[10] *Money dimensions of used up data, Antràs and Chor calculated in USD.*

of the contribution for manufacturing processes of the input *i* goes indirectly, namely, rather in upstream stages.

To simplify, it can be stated that the higher the value of DUse_TUse , the more likely it is to be around the downstream sector, and the lower the value, 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 differentiation of indicators, I coherently refer to this indicator in the study as the 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 number of production stages of final consumption, depending on which stage the input joins the value chain. We must get back to Equation 2, where the output for final consumption (the first expression on the right) is weighted with 1, and the input directly used up during the production of final consumption (the second expression on the right) is weighted with 2, and the third expression on the right is weighted with 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 the case of each sector *i*, the 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 the value chain, and greater weights are used. It yields 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 sector got to final consumption and 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 enters the interval {0,1}. The second variable possesses several desirable attributes strengthening the measure of sector position.

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

Fally (2011) 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's conclusion is based on the idea that sectors that themselves purchase many inputs from other upstream sectors are also relative upstreamers. The upstreamness variable can also be called an index number of cost-push effects or forward linkages – the measure of the increase in outputs of all the sectors in the economy as a result of a one-dollar increase in the 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 and 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 those where goods are usually close to the end of the value chain.

2.3 Empirical definition

In the following section, I demonstrate Antràs & Chor's description of empirical definition by which they could uncover the share of production inside corporate trade. As a basis, they applied the regression examination among sectors.

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

The dependent variable S_{it} in the year *t* shows the share inside corporate imports in the sector *i* in the USA. They aimed to explain it in the sectoral downstreamness function D_i, while DUse_TUse or DownMeasure were also set. An 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 the 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 the input *i* is lower, ergo it is below the intersectoral median value of this variable.

The model indicates that differences among countries might be useful in the prevalence[11] of integration to eliminate prepossessions which concern endogenous positioning decisions of companies during different stages of production. That is why they examined specifications which reveal the sectoral changes at the 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 equation explains the intercorporate imports. S_{ict} refers to the exporter country at a yearly sectoral level, such as a similar set of sectoral variables, while it controls the pegged effects of the country in a particular year, α_{ct}, and also the standard errors (in a conservative aspect) per sector.

2.3 Aggregating sectors and country groups according to downstreamness indicator

To examine the sectoral correlation and to check 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 the WIOD, and also what value they have overall in the sectors in the world.[12]

To check the methodology, I drew the sectors of the countries in a coordinate system based on upstreamness/downstreamness and value-added ratio, additionally classified the sectors into UMD categories based on the indicators, aggregated the values (creating UMD sector

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

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

https://doi.org/10.18267/j.cebr.326

groups) and drew the curves. In the case of classifying into UMD categories, sectoral relations of a certain country 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 into 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 the manufacturing and downstream categories if sectors were classified based on cut value (e.g., India, USA). Classifications have to be corrected with sectoral relations; this way, UMD categories of smile curve are 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 the USA, Switzerland, Germany, Austria, Belgium etc.), although with a relatively lowR^2 value (approximately 0.2). Some countries with the same figure took rather a "/" shape. The calculation for the whole world also took rather a "/" shaped curve with an R^2 value of approximately 0.15. These statements are in line with Boda's (2020), who also used the WIOD database in his research.

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

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

Along downstreamness, the U and M cut value is 0.39, and the M and D cut value is 0.50 based on data from the year 2000. In 2014, they are 0.36 and 0.46. The data are summarised in the following table. Manufacturing takes from the upper value of upstream until the bottom value of downstream (see Table 2).

Table 2 | 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 in the upstream direction. The range of the two values does not change: in the case of upstreamness, the difference is approximately 0.05, while in the case of downstreamness, it is stable at 0.1, i.e., sectors move downwards together. It is important to highlight that in this world-scale examination, the trisection of sectors makes 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 attention to the dislocation.

The 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 the downstreamness index, all countries' sectors were summed up into sectoral groups according to whether the sector is considered upstream, manufacturing or downstream. With this simplification, every country or country group has three dots in each year in the smile curve coordinate system. It is not easy to choose the correct aggregation methodology because none can ensure totally equal circumstances, but in this study, I chose 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 the same sectors in each country are not placed in the 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 methods:

- 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 sectoral groups as we do 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 a given geographical unit can be considered a big country because the sectors are strongly connected. I calculated every indicator both ways and there was not a significant difference in the final results. If we aggregate each country's UMD sectoral group, we obtain a slightly more upstream-weighted results, so more sectors are added to the upstream category and more to manufacturing.

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

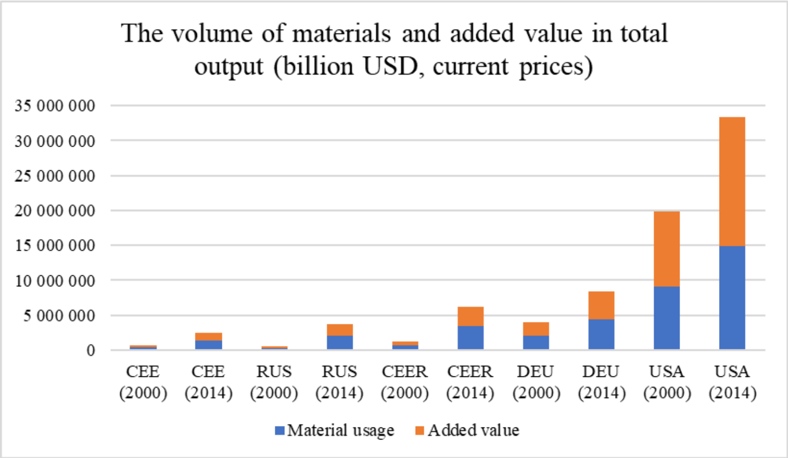
3 Results and Discussion

The Central and Eastern European region 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 Germany's value added. These were only 30% and 28% in 2000. Note: The distance from Germany is slightly shorter than that from the USA, where the values were 20% and 18% in 2000, and 25% and 22% in 2014.

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 USA and 81 million in Germany, compared to 144 million in Russia alone and a total of around 100 million people in the CEE countries. The CEER countries, complemented by Germany, would equal the USA in terms of population, but their total output and total value added are only roughly half those of the United States.

Figure 2 | Volume of materials and added value in total output in examined country groups (billion USD, current prices; 2000 and 2014)



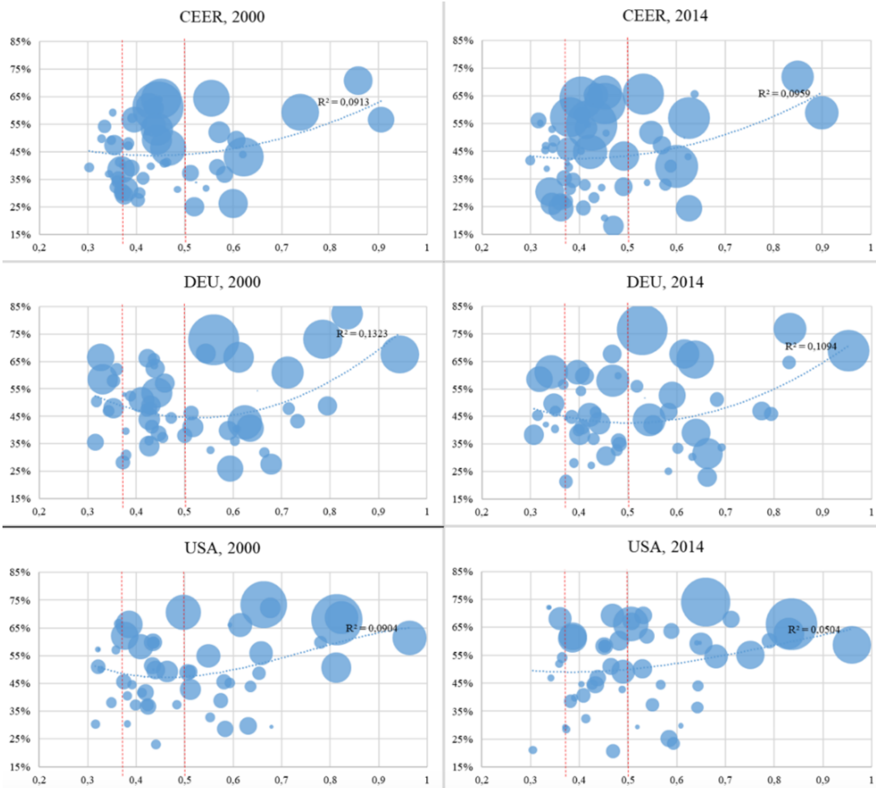
Source: Calculated from WIOD database. The percentages shown are the ratio of material consumption to value added in production. In this way, the value-added ratio and the material consumption ratio can be read.

The catching-up process is ongoing, but structural tensions are emerging. CEER countries tend to produce a higher share of inputs for other sectors than for 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 downstream. Production is also high in Germany, but there are also strong sectors downstream. In contrast, the USA has few and proportionately small upstream sectors and a huge downstream.

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 USA further strengthened the downstream side, and the presence of the sectors decreased on the upstream side. These are shown in Figure 3. 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 3 | Sectoral smile curve of CEER country group, DEU and USA; 2000 and 2014

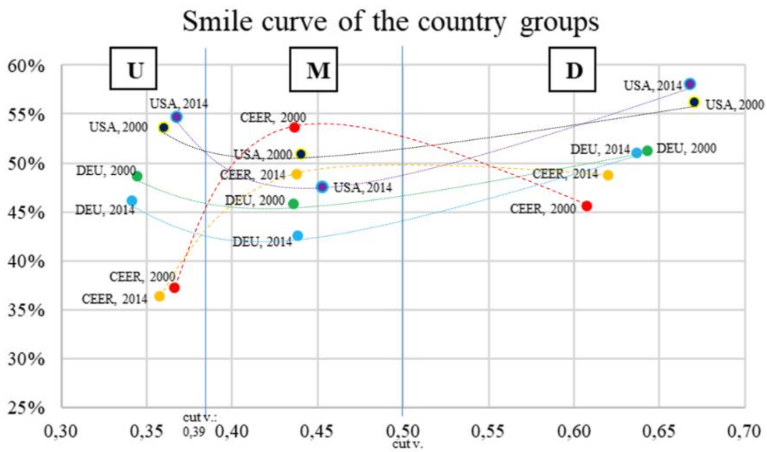


Source: Own elaboration according to WIOD.
Note: Bubbles represent sectors; *x* axis: downstreamness indicator; *y* axis: added value ratio; bubble size: ratio of each sector's added value in the total added value.

In the detailed bubble figure for all sectors in Figure 3, 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 3, 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 4.

In the Eastern European region, 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 a value-added share in the manufacturing sectors a few percentage points higher 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 4.

Figure 4 | Smile curve of examined country groups in 2000 and 2014



Note*:* *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 produce 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, whose value-added production accounts for 34/37% of total value added. For the benchmark countries, these ratios are shifting downstream. These are summarized in Table 3.

Table 3 | UMD structure of examined country groups in 2000 and 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 are 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 3 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 that of 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, it was already 70% in 2014. This is a big catch-up. If we add the production value, it already makes 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 4 provides an overview of the main set of structural indicators by country and group of countries. Figure 5 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 the 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 6).

Table 4 | Share of UMD sectoral groups in CEER countries and country groups and in benchmark 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%

Note: The table could not be technically adjusted due to the lack of original input from the authors.
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 undergo 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 value added by 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 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

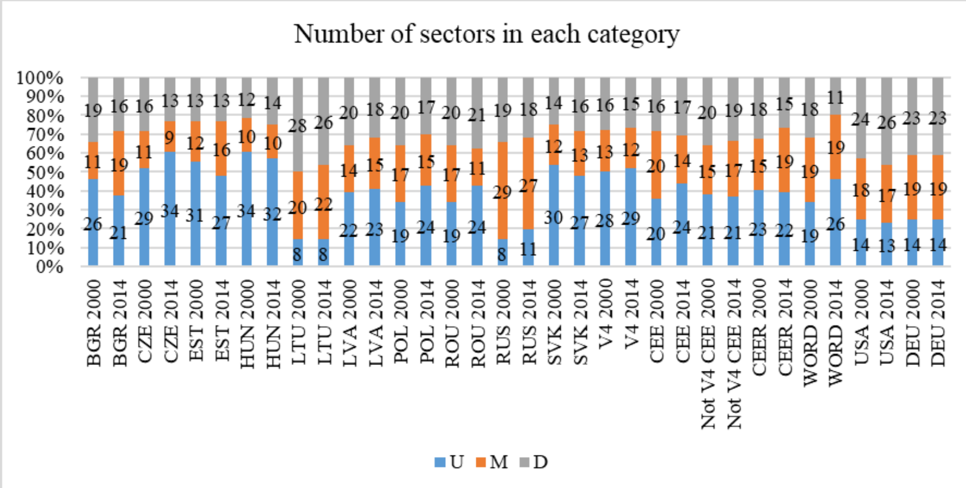
https://doi.org/10.18267/j.cebr.326

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 suppliers 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 values 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 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, the number of countries where it increased and where it decreased was relatively balanced, but the group remained stagnant on average, compared with 19 increasing to 26 in the world average. The manufacturing group typically includes fewer sectors in CEER countries than in the world average or the 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 focus 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 the 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 5 | 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 5 and the table in the Appendix. In this paragraph, I will highlight some outstanding values and concluding remarks.

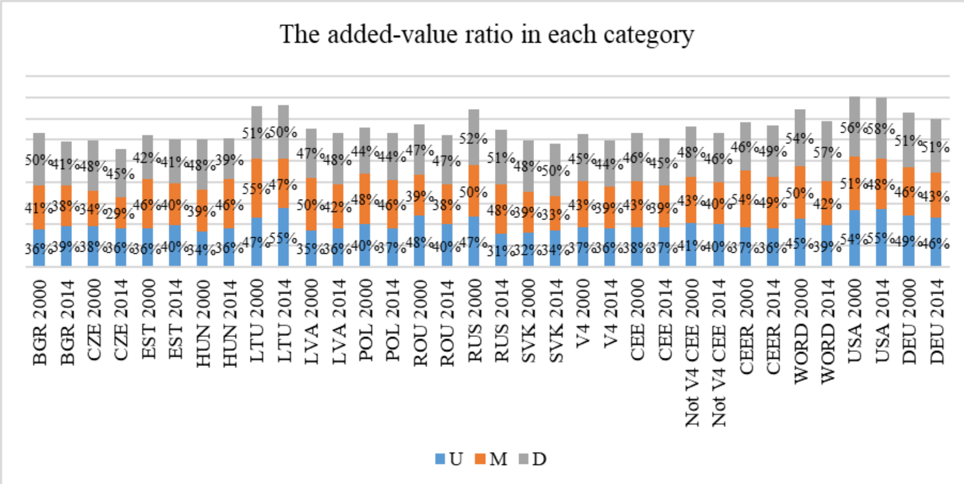
The *y* axis of the smile curve is the share of value added, so for the shape of the smile to emerge, both the upstream group and the downstream group must have a higher value-added share than the manufacturing. It should be noted that overall, the goal is not the shape of the smile, but to keep these 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 the 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.

The values for 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 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 6 | 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 the ratio. This cannot be considered 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 1, 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 5), 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 there would therefore be a decline in this group.

In this simplified modelling, there is an upgrade situation. The aim of Table 5 is to demonstrate how much the structure matters.

Table 5 | Simplified modelling of transition to a US value-added production structure for 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%

Note: The table could not be technically adjusted due to the lack of original input from the authors.
Source: Own elaboration based on WIOD data

The analyses also show that the structure of Germany has weakened somewhat compared to the USA. 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 5) 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 this field of production more.

Conclusions

The Eastern European region 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 it was already 70% in 2014. 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 falls into this category in the CEER countries than in the benchmark countries.

In relation to 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. The 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 in the sales function. The opposite can be found in the case of sectors stuck in the middle of the value chain.

The smile curve framework and theory seem to be proven true according to the results of analysing several developed and strong countries' economies, though the expected U curve is not outlined in other countries and in the 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 of the reasons for sectoral efficiency differences among countries and of different UMD classifications.

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

Within the CEER country groups, only a few countries have similar structures and results as the benchmark countries. The strongest (if we consider the size as well) is Russia, and the next are Lithuania and Latvia, but the latter 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, 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 country's 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 USA, DEU, and CEER respectively, confirming that the more downstream the country, the more successful its economic structure.

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 in 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, e.g., 2019, or the 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 a 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 to 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 their owners. It means that it is also not suitable for separating the value added in different sectors, whether owned by a local or a foreign party. The examination covers only a geographically bounded location. In the future, it can be a next research topic, which should be distinguish ownership as well.

Acknowledgement

I would like to thank Dr. György Boda for supporting my study by regularly discussing the results and methodology.

The manuscript was supported by the New National Excellence Programme of the Ministry for Innovation and Technology (ÚNKP–21–3–II).

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The research paper passed the review process. | Received: 8 June, 2022**; Revised:** 26 August, 2022**; Accepted:** 22 October, 2022**; Pre-published online:** 2 April, 2023; **Published in the regular issue**: 19 July, 2023.

APPENDIX

Appendix A │ 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**

Appendix B │ 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%

Note: the table could not be technically adjusted due to the lack of original input from the authors.

Source: own calculation from WIOD

Appendix C │ Sectoral data of CEER country group and DEU and USA; 2014

2014		CEER			DEU			USA		
num	name	Downstream ness	AV/Output	Ratio in total AV	Downstream ness	AV/Output	Ratio in total AV	Downstream ness	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%

Note: the table could not be technically adjusted due to the lack of original input from the authors.

Source: own calculation from WIOD

Appendix D| The main indicators calculated for the CEER countries and the benchmark countries.

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%

Note: the table could not be technically adjusted due to the lack of original input from the authors. 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.

Source: own elaboration based on WIOD