DYNAMICS OF GVC POSITION OF V4 AUTOMOTIVE SUPPLIERS: IMPLICATIONS FOR PUBLIC POLICY

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Abstract

In the post-covid world, governments explore options to enhance their policies so that corporations can act as successful motors of recovery and sustainable growth. Countries select various objectives related to global value chains (GVC), such as participation, value capture, inclusiveness and resilience, yet might be unaware of the position of corporations they are supposed to motivate. In this paper, we aim to (re-)investigate the position of Visegrad Four (V4) suppliers within the regional automotive value chains and to compare results with suppliers in other EU member states using the trade in value added (TiVA) statistics. We set two research questions: How does the position of V4 in automotive GVCs differ from the positions of other EU member states and significant other automotive-producing countries? What is the link between the domestic value added in gross exports of final automotive products and the selected policy variables? A multiple linear regression model is run with TiVA in the automotive industry as the dependent variable and independent variables embodying proxies of GVC-oriented policy consequences. The analysis identifies significant differences in value-added levels between V4 countries and other EU countries, and other large automotive-producing economies. Labour costs, productivity, investment in R&D and innovation support are among the factors where V4 countries fall behind.

Implications for Central European audience: The results of our research might be helpful for respective authorities and governments in V4 and other Central and Eastern European countries. They can be of use when setting goals and implementing policies targeted at promoting innovation, upgrading within existing GVCs and in cooperation between universities and research centres on the one hand and the automotive industry on the other.

Keywords: Trade in value added; GVCs; automotive industry; GVC policy; V4 countries
JEL Classification: D04, F62, E61

Introduction

Visegrad Four (V4) countries – Poland, the Czech Republic, Hungary and Slovakia – share a historical background and feature similar economic characteristics. They show large inward FDI stocks and a considerable share of industry in the GDP creation (IMF, 2021). In 2019, the value added generated by the industry accounted for 29% of GDP created in V4, as opposed to 25% and 22% in the case of world and EU averages, respectively (World Bank, 2022). National governments might be tempted to support or "lock" the vital industry sectors, above all automotive manufacturing. They support participation in GVCs and seek higher added value for domestic suppliers (Török, 2022; Nagy et al., 2022). However, the question is whether this is the main objective they should pursue. The last decade saw Industry 4.0, robotization, just-in-time and supply chain optimization gaining ground (Szabo, 2020; Gotz et al., 2020). The covid-related crisis first brought about the demand crisis and issues related to the emergency supply of strategic goods. In the second stage, the demand bounced back quickly (Bourghelle et al., 2021; Meyer et al., 2022).

Nonetheless, various restrictive measures and unsatisfactory relations with freight providers caused the supply chains to break apart (Butt, 2021; Paul et al., 2021), with a lack of materials (Rajput et al., 2021) and workforce (Luckstead et al., 2021) necessary for production. These trends harmed industrialized economies severely (Lafronge-Joussier et al., 2022). On the other hand, the possibility of V4 countries benefiting from nearshoring as reconfigurations of supply chains towards higher resilience is discussed (van Hassel et al., 2022; Ciravegna & Michailova, 2022).

Economy-wide statistics and single-enterprise case studies are becoming obsolete, with GVCs coming to the forefront of current debates on growth and policy. Classical economy (Smith, 1776; Ricardo, 1817) focused on production factors and competition among nations. Paul Krugman (1998) improved the classical economic notion by specializing in specific industries and their clusters. In our research, we focus specifically on the industry level and discuss the active role of companies. Also, extensive literature on global value chains (GVCs) and global production networks (GPNs) has focused on the situation and how countries can start participating or create the maximum value, typically on the global scale rather than in specific regions. Compared to usual GVC-related research, this paper focuses on the specific issue of disruptions and shocks.

As far as automotive industries in V4 countries are concerned, they seem to find themselves in a "middle-income trap", which is reflected in the high share of assembly activities connected with lower added value creation within the automotive supply chains (Capik & Drahokoupil, 2011; Jasiecki, 2020).

Our research aims to evaluate the consequences of policies and macroeconomic factors within V4 countries that might be considered essential for the GVC position of automotive suppliers. We run one multiple regression model and two sets of t-tests of means. The first t-test compares the V4 countries with the rest of the EU member states, while the other compares them with leading automotive-producing countries, with data being the mean of 2014-2018 metrics. As the proxy reflecting the position of domestic automotive suppliers within the respective GVC, we selected the domestic value added in gross exports of final automotive products as a percentage of the total country's automotive exports. The indicator shows the share of domestic inputs in the value of finished vehicles. It reveals whether the

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https://doi.org/10.18267/j.cebr.319

country in question acts predominantly as an "assembly factory" of parts imported from abroad without having the possibility within the GVC to add a decent share to the value of vehicles as final products. We aim to reveal the link between the aforesaid dependent variable and selected policy variables (e.g., number of researchers per capita, patents per capita, education or R&D expenditures as a share of government budget) and macroeconomic variables (e.g., GDP per capita, FDI inflow per GDP, Logistics Performance Index). The paper reviews the role of V4 countries as a manufacturing powerhouse of the EU and questions why these countries lag behind the EU average. Pavlinek (2012) argues that the decision of leading automotive firms about the location of R&D activities (necessary for increasing the value-added content of the production and upgrading within the automotive GVC) depends on the ability of the region to provide them with, among others, a large supply of highly qualified scientists, favourable governmental policies towards R&D and strong institutional support for R&D. Cerna et al. (2022) assess within a SWOT analysis that the economic recession and low investments in R&D, especially government expenditures on R&D, represent threats, while a low business operations risk and cooperation with technical universities and research institutes are regarded as opportunities for the automotive sector in V4 countries.

We set the following research questions: How does the position of V4 countries in automotive GVCs differ from that of other EU member states and other significant automotive-producing countries? What is the link between the domestic value added in gross exports of final automotive products and the selected policy and macroeconomic variables?

To answer them, we review the selected variables pointing to governmental policies with a specific focus on the automotive industry. We mirror them against the position of automotive suppliers of V4 countries within GVCs.

The structure of the paper is as follows. In the literature review, we reflect on the existing GVC-related literature, the position of the V4 countries within GVCs, and policies affecting firms within GVCs. We employ quantitative analysis in the form of multiple linear regression on the data on trade in value added in the automotive sector. In the first model, we compare data in the form of means of 2014 to 2018 in V4 countries with other EU countries. In the second model, we compare the data mentioned above related to V4 countries with other leading car-producing countries. We make special remarks about the development of these metrics, too. In conclusion, we discuss how the results can help V4 governments better shape their GVC-oriented policies compared to what they aim at nowadays and the extent to which V4 countries fall behind in competitiveness variables and thus miss their opportunity to upgrade within GVCs.

1 Literature Review

The first subchapter discusses the importance of considering a country's GVC position, measurement possibilities, and its determinants. The second subchapter focuses on methods through which the GVC position can be adjusted and how governmental policies should relate to GVCs rather than the general industrial policy. In the third subchapter, we present the role of the automotive industry in V4 economies, the position of local suppliers in automotive GVCs, and how public policies shape the business environment from the point of view of the industry.

1.1 Global value chain position

Why is it important?

At the firm level, the position within GVCs is equivalent to the comparative advantage of nations as shaped by Ricardo (1817), specialization of regions and clusters in the new economic geography model (Krugman, 1998), or a nation's competitive advantage (Porter, 2011). The underpinning logic stays the same. The key is to focus on the production of what we know the best, irrespective whether it is due to the absolute or relative abundance of needed production factors. Decision-making processes investigated in international business research are at the company level; thus, GVCs form the basis for investigating company relationships.

Different metrics

There are many different metrics for measuring a firm's participation within GVCs. Let us mention the functional analysis of GVCs, added value, and proportion of value added in the final product. The value-added method can then be used as a general metric in the form of a backward GVC participation index or forward GVC participation index. The former refers to the ratio of the foreign value-added content of exports to the economy's total gross exports, whereas the latter constitutes the ratio of domestic value added sent to third economies to the economy's total gross exports) (Folfas, 2017; Wang et al., 2017). The Smile curve (Shih, 1996) has been a popular explanation of the value added to various tasks along the economic production. In the beginning, research and development and design activities attract much value added as a highly skilled workforce is necessary. In the middle, assembly and production according to guidelines can be relatively easily replicated and thus do not attract much value added. On the other end, marketing and associated services are vital for the product's success and thus generate a high portion of the value added.

Factors

We can name innovation among the factors that affect a country's GVC position (Zanfei, 2000). The Global Competitiveness Report by the World Economic Forum (2020) mentions 11 key topics that a competitive country needs to cover efficiently: robust and long-term governance; ICT infrastructure; progressive taxation; education; labour laws dealing with flexible work arrangements; eldercare, childcare and healthcare; sustainable investments; free market competition; R&D; inclusion; and diversity. Kowalski et al. (2015) indicate additional factors: macroeconomic situation (market size, development level, industrialization level and geographical proximity to other markets) and policy questions (tariff barriers, FTA membership, FDI openness, infrastructure, education, IP protection, R&D and institutional quality).

1.2 GVC policies

Public policies usually aim rather at the macroeconomic position of economies, discussing the effectiveness of liberal vs. protectionist attitudes, quality of institutions, and motivators for inward foreign investment flows (Howlett et al., 2009). Regional policy has shifted its focus on generating citizens' welfare by supporting lagging regions to reduce inequalities or supporting leading regions to drive further growth for the country (Ottaviano, 2003). Other notable worldviews include investment decision-making theories: Dunning's (1980) eclectic paradigm includes three factors of successful foreign market entry – ownership, location and

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https://doi.org/10.18267/j.cebr.319

internalization. The resource-based view (Wernerfelt, 1984) postulates that firms seek resources vital for success and further growth. Investments are thus often resource-seeking rather than market-seeking.

Be it single enterprises, joint ventures, industrial clusters, or whole regional or national economies, these can get their global chain position shifted by a process called upgrading or downgrading. This term was coined by Gereffi (1999), and a typology of the methods was reviewed by Blazek (2006). Among others are product upgrading, process upgrading, functional upgrading, inter-sectoral upgrading and organizational succession. Firms can perform various activities to acquire a specific part of the value added in the production process based on the functional tasks they cover. Moreover, they *"pursue diverse strategies to upgrade their value chain activities, leveraging the shifting geographies associated with new trade rules"* (Gereffi et al., 2021), an effect further amplified by the covid crisis. The state can facilitate and regulate the environment where the firms operate (De Marchi & Alford, 2022).

As Pietrobelli et al. (2021) pointed out, we are moving towards GVC-oriented policies. It started with the increasingly prominent position of private businesses, especially multinational enterprises (MNEs), that drive world economic growth. Public policy first seeks to attract MNEs' investment within the country's territory (participation principle). Once there is enough investment to provide labour opportunities for the population and decent tax revenue, the focus shifts towards improvement in the position of the local enterprises within the GVCs and a rise in the value added generated within the country's territory (value creation principle). However, this process is highly uneven – a different set of policies is thus introduced to equalize the situation and distribute the profits of economic activity across all groups (inclusiveness principle). Even the most coherent policies cannot fully mitigate economic crises and market volatility in today's highly globalized world. Thus, it is recommendable to avoid fragile systems (resilience principle). The importance of resilience is even more imminent in the VUCA[1] world we live in (van Tulder et al., 2019). The objectives move from "basic" to "advanced". It is a natural development path – once the primary level is reached, we move forward to the next step. However, attaining a higher level does not automatically mean that the lower level is granted.

In many cases, it can be a dilemma. For instance, an inclusiveness policy in an economy firmly positioned in GVCs (high participation) can eventually cause a fall in the GVC participation rate. That can be due to TNCs' switch to other locations with better participation policies (i.e., probably more accessible production factors and higher market accessibility). Alternatively, better upgrading policies (i.e., more skilled labour, better know-how to be tapped), eventually leading to higher profits, make the TNCs relocate. Kowalski et al. (2015, p. 31) also point out the different impacts of the factors and policies on GVC participation under varying circumstances. In developing countries, the effect of high-quality institutions or the rule of law seems to play a more critical role than on high-income markets, where (ICT) infrastructure or tax conditions seem to constitute the driving factors. Nevertheless, a firm and its success are at the centre of policy objectives and evaluation.

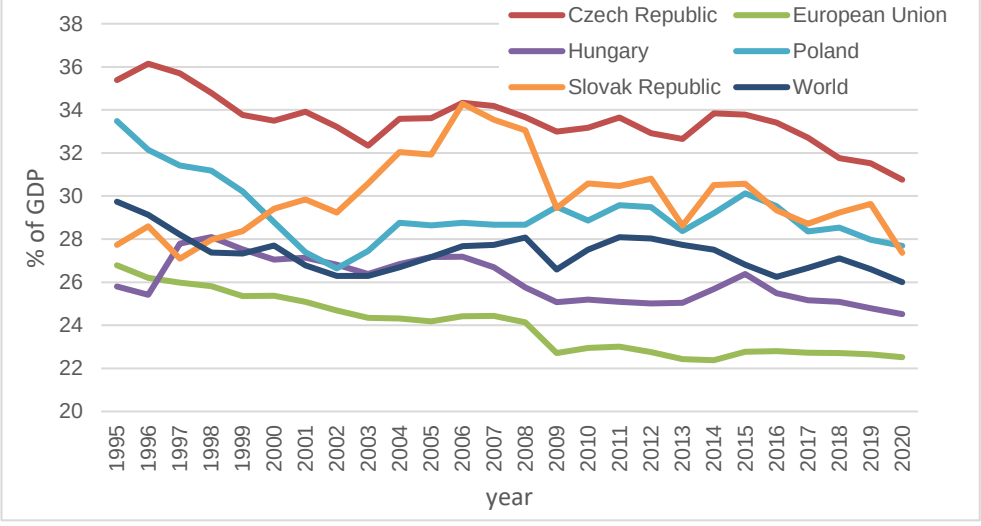
[1] Volatile – uncertain – complex – ambivalent

1.3 Automotive industry in V4 countries and policies

Specifics of V4 countries

We focus on V4 countries (Poland, the Czech Republic, Hungary and Slovakia). They are post-communist countries with a relatively rapid transformation towards a market economy (Mikloš, 2021) that entered the European Union in 2004 and have benefited from proximity and economic ties to the core EU market, Germany (Kordalska & Olczyk, 2019). These factors helped the V4 group become an industrial powerhouse of the EU. In the early integration years, it was believed that market size and growth potential played a significant role, partly through the factors of costs and availability (Benacek et al., 2000). Both manufacturing and business services were offshored into V4 countries (Sass & Fifekova, 2011). However, at present, investments are primarily in foreign ownership and control, which is reflected in highly negative net international investment positions (Prochazka & Cerna, 2022). Figure 1 depicts the evolution of the share of industrial value added in GDP. Compared to the EU and world averages, all the V4 countries but Hungary have shown more vital roles of industrial value added in GDP creation. Although there has been a downward trend, specifically in the case of the Czech Republic and Poland, the gap expressed in the percentage points remains, in principle, the same. Consequently, the Czech Republic, Poland and Slovakia are more sensitive in terms of GDP creation to external shocks that weaken the capacity of the manufacturing industry to create value added.

Figure 1 | Industrial value added (% of GDP)



Source: World Bank (2022)

At the individual firm level, the Central and Eastern European countries (including the V4 countries) demonstrate their specificities. Unlike developed market firms, local firms face challenges when internationalizing and succeeding on global markets. Despite being often "born globals", they mostly decide to expand to markets with cultural or geographical proximity as they possess limited resources and capabilities. In other situations, they only respond to their home country's hostile environment (Caputo et al., 2016). The same was also observed by Sun et al. (2018), mentioning that some CEE firms decide to undergo a

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https://doi.org/10.18267/j.cebr.319

strategic entry onto a new market along with a strategic exit from a CEE country. Cieślik et al. (2015) showed determinants of a successful expansion for new EU member states – especially labour productivity and employment of university graduates. Firms in Hungary, Poland and the Czech Republic have been exposed to exchange rate fluctuations (Asif & Frömmel, 2022). Investing firms also face a challenging labour market situation due to rigid systems fixed with traditional employee security (Horwitz, 2011), which has been exacerbated in recent years due to low unemployment and rising labour costs.

At the value chain level, the two recent decades have meant repositioning of industries in the upstream direction. However, the countries are still largely lagging behind the rest of the EU, and the transition is proceeding very slowly, as measured with input-output tables (Hagemejer & Ghodsi, 2017). In any case, CEE inclusion into GVCs has had interesting positive spillover effects on labour productivity of related service providers or component suppliers (Orlic et al., 2018). Manufacturing successes also spill over to finance sectors (relatively more in the Czech Republic or the Baltics) or transportation services (relatively more in Poland, Slovakia and Hungary), as noted by Kordalska and Olczyk (2021). Meanwhile, some ancillary services allow the countries to improve their involvement in upstream activities, and vertical specialization within value chains causes core-periphery differences to be magnified, where CEE countries often play the periphery role (Gerőcs & Pinkasz, 2019). In some cases, the higher value-added functions can still be localized in the CEE countries, such as in the automotive industry (Pavlinek et al., 2009), although the impact is not very high.

At the country level, Sachs and Warner (1996) present a road map for the successful development of the region. Countries are supposed to adopt policies for opening their economies to allow export, investment and quick integration into the global economy, similar to the successful East Asian industrialization or Washington Consensus policies. CEE countries have become a specific model of a "dependent market system" (Nölke & Vliegenthart, 2009). Nölke (2018) later mentioned that the countries will have a chance to abandon such a setup, but only by transforming it into a "state-permeated system". The region can now be separated into V4 countries being "dependent export-driven" and the Baltics being "dependent debt-driven" (Bohle, 2018). The aforementioned hostile environment also materializes in low contract enforcement, being the issue for MNEs that have decided to relocate from Southern European countries to seek relatively cheap and productive labour (Hnat & Sankot, 2019). The CEE countries were also named the European academic periphery due to their lower amounts of patents and less research impact (Luczaj, 2020).

V4 countries have strong automotive production capabilities. The automotive industry leaves a major footprint on their economies, which puts them in danger in the case of great external shocks (Cerna et al., 2022). Slovakia and the Czech Republic have ranked first and second in the world in the number of vehicles produced per capita. In absolute terms, Poland and Hungary ranked 22nd and 25th in 2020 (OICA, 2021). The number of cars produced per worker in the automotive industry (ACEA, 2020) indicates high mass production in Czechia and Slovakia, less in Poland – the labour productivity is much lower there.

Moreover, the rebound after the coronavirus indicates a persistent strong position among the car-producing countries and regions (ACEA, 2021). It is essential to mention the position on the smile curve, i.e., within the GVCs. Pavlinek and Zizalova (2016) reconfirm that the

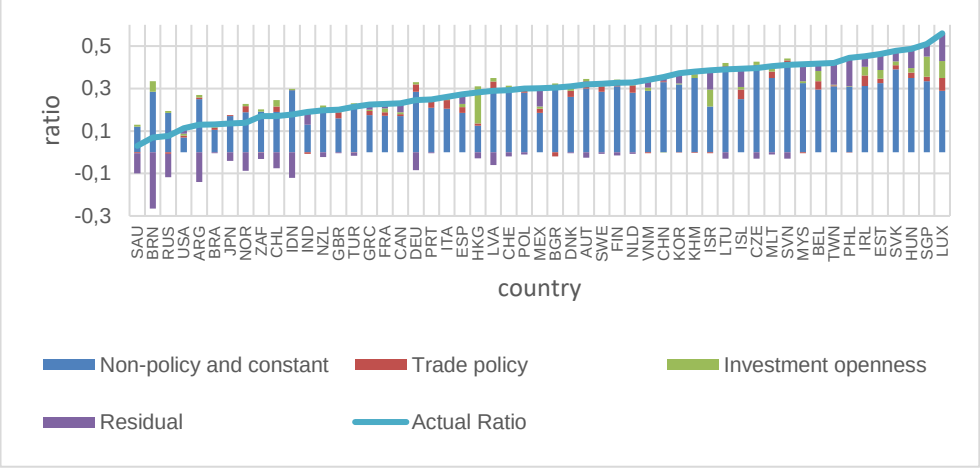
linkages and spillovers among foreign-owned MNEs and local suppliers are limited and R&D activities, although extensively performed in the V4 region, have a relatively small effect on further learning of locally owned firms. Similarly, Sass and Szalavetz (2013) document the improvements of Hungarian automotive suppliers through functional and process upgrading.

Policies

Generally speaking, public policies respond to momentary situations and fail to live up to long-term objectives. Using the lens of Pietrobelli et al. (2021), we can observe that the 1990s were in the name of free market policies. The late 1990s and the first decade of the 21st century saw a shift towards participation policies aimed at attracting FDI, creating jobs and increasing competitiveness through cheap labour and integration into the EU economy. It was only in the 2010s, in the aftermath of the financial crisis, when new voices were heard that the shift should be made from GVC participation to value creation, increasing the value added of local exports (Vlckova, 2018). Investment incentives shifted from general support for job creation to support of highly skilled positions (Cerna et al., 2017). For example, in 2019, the Czech Republic publicly announced its "Country for the Future" concept of support for high-tech sectors. This programme centres around innovation, quality institutions and improved infrastructure without any mention of resilience, preparedness for crises or inclusiveness of the support. The available policies have generally never been set to prevent or systematically solve short-term demand fluctuations and economic disruptions. These issues have been solved by ad hoc support to bankrupting firms and arbitrary bailouts, which have caused significant distrust of firms towards the business environment (Stanford, 2010; Grossman & Woll, 2014). In the ongoing covid crisis, governments decided to support firms that are considered economic pillars to strengthen the overall resilience of the economies and supply chains (Pietrobelli et al., 2021; Azadegan & Dooley, 2021).

Figure 2 indicates the backward GVC participation, as the share of foreign value added embedded in local production. The highest scores can be seen in Hungary and Slovakia; the Czech Republic ranks high as well.

Figure 2 | Backward-looking GVC participation ratio



Source: Kowalski et al. (2015)

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https://doi.org/10.18267/j.cebr.319

2 Methodology

In conformity with the literature review and determinants of GVC policies assumed to affect the nature of a country's GVC participation (see chapter 1.1), we investigate to what extent these determinants influence GVC participation within the regional value chains of the automotive industry. Our multiple linear regression model uses OECD TiVA database data (OECD, 2022). The GVC participation is embodied in the dependent variable "domestic value added in gross exports of final automotive demand products" (i.e., *Motor vehicles, trailers and semi-trailers, that is all types of vehicles*) as a percentage of the country's total automotive exports. The higher the value, the lower the dependency of the country's automotive industry on imports of components and the weaker the country's position as a mere vehicle "assembly plant". As reasoned in chapter 1.1 and further chosen according to available data sets, the independent variables are clustered into two groups, see Table 1.

The policy variables relate to the quality of the institutions in charge of creating a competitive business environment. The policy variables cover most of the scope of the Global Competitiveness Report. R&D expenditures and the number of researchers are proxies for the real impact of research activities. Similarly, the number of patents per capita does not estimate the quality of the patents. Education expenditures, expenditures on tertiary students, and teachers' salaries are proxies for the situation of education quality. Ease of doing business indicators serve as a comparison between countries, although they do not objectively measure the quality of the environment. The macroeconomic variables, as reviewed by Kowalski et al. (2015), give a snapshot of the overall state of the economy, with particular attention paid to the technological environment.

Table 1 | Model independent variables

Policy variables	Macroeconomic variables
R&D expenditures (as % of GDP)	GDP in absolute terms
Researchers (as % of workforce)	GDP per capita
Patents (number per capita)	Labour productivity (output per hour worked)
Education expenditures (as % of GDP)	FDI inflow (as % of GDP)
Expenditures on tertiary students	High-value manufacturing (% of value added)
Teachers' salary (vs. average salary)	High-tech exports (as % of GDP)
Ease of doing business – contract enforcement	Technical workers (as % of the workforce)
Ease of doing business – starting a business	Manufacturing (as % of GDP)
Innovation (European Scoreboard)	Logistics Performance Index
FTA participation (yes/no)	Labour cost (per hour per worker)

Sources: European Commission (2022), International Labour Organization (2022), OECD (2022), World Bank (2022)

There are two models. The first one compares the V4 countries with the other EU member states. In contrast, the second one compares them with the world's biggest automotive producers in 2020 (i.e., Germany, USA, Mexico, China, Japan, India, South Korea, Russia,

Brazil, Spain, France, UK; OICA, 2021). TiVA statistics are available until 2018; hence, to avoid short-term fluctuations, we measure the mean of the latest five years available, i.e., 2014-2018. The exploratory analysis is made with all the independent variables. However, several variables are excluded after performing the multicollinearity test in SPSS. Instead of ten policy variables and ten macroeconomic variables, only five policy variables and six macroeconomic variables are used for the final multiple linear regression to understand which determinants affect automotive GVC participation of our entire dataset. Heteroskedasticity is checked for and denied; ordinary least squares residua are practically non-existent.

3 Results and Discussion

In Table 2, we compare variables in the V4 countries with the rest of the EU countries and the top 12 automotive-producing countries.

The only variable where the V4 countries rank above the average is the medium- and high-value manufacturing as a share of total value added within an economy. It is just natural because, as mentioned in chapter 1.2, the V4 countries historically have a strong position in the manufacturing industry. On the other hand, in many indicators considered vital for industrial upgrading in GVCs (namely the hourly labour cost, labour productivity, number of researchers, teachers' salaries and education expenditures, innovation level, ease of starting a business), the V4 countries fall behind the average of both the EU and top automotive-producing countries. Even countries with a comparable GDP per capita, such as Italy or Spain, attain much higher scores in many of these: teachers' salaries, patents, hourly labour cost and output per worker.

After the multicollinearity check, we selected the highlighted variables for the multiple linear regression. The statistics published by European Commission, International Labour Organization, OECD and World Bank (namely the Doing Business Index, which was discontinued later on) serve as data sources for the variables. They represent commonly used sources of statistical data that provide extensive datasets from both time and geographical perspectives. Wherever possible, we apply the mean of 2014-2018.

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Table 2 | Model variables, t-test of means (comparison of countries)

	EU vs. V4 countries			Automotive vs. V4 countries		
	T	Df	Sig. (2-tailed)	T	Df	Sig. (2-tailed)
TiVA	4.573	6.984	0.003	7.321	7.709	0
FDI inflow	1.551	23.177	0.134	2.712	11.312	0.02
exp education	1.823	22.734	0.081	0.47	11.815	0.647
exp students tertiary	1.313	6.214	0.236	0.234	7.657	0.821
high-value man per VA	-1.615	5.173	0.165	-0.301	6.195	0.773
HT export/export	0.197	6.286	0.85	1.531	10.021	0.157
logistics (5 highest)	1.046	10.918	0.318	0.913	13.647	0.377
patents	0.879	23.869	0.388	1.743	11.002	0.109
R&D per GDP	1.24	9.834	0.244	1.758	13.531	0.101
hourly labour cost	4.048	23.777	0	2.514	4.185	0.063
output per hour worked	3.395	23.511	0.002	0.492	12.208	0.632
technicians/R&D worker	1.083	6.388	0.318	0.211	5.622	0.84
researchers/workers	2.949	19.264	0.008	0.887	9.662	0.397
teacher salary/similar	4.167	14.874	0.001	2.305	4.483	0.075
DB start business	2.997	4.438	0.035	1.518	9.008	0.163
DB enforce	1.117	6.05	0.306	1.381	10.713	0.195
EU scoreboard	3.416	13.332	0.004	3.994	5.059	0.01
GDP	0.424	10.344	0.68	2.985	11.291	0.012
GDP per capita	2.608	23.025	0.016	0.09	13.725	0.93

Source: Own calculations from EC (2022), ILO (2022), OECD (2022), World Bank (2022)

N = V4 countries (4); EU (23); largest automotive producers (12).

Table 3 contains the multiple linear regression model. The results suggest that the trade in value added in the automotive industry is significantly determined by the Logistics Performance Index and teachers' salaries compared to salaries in positions with a similar education level. The lower the teachers' salary or worse ranking in the Logistics Performance Index, the higher the trade in the value added. It fairly contradicts expectations and points towards the fact that the relationships between variables are very complex. Other factors that are difficult to measure or for which we do not have the data could affect the results. On a 90% confidence interval, the share of high-tech exports in total exports (positive correlation) and Doing Business contract enforcement score (worse score – lower TiVA) also turn out to be statistically significant. The relationship of high-tech export with trade in value added is far from surprising, yet it underscores the importance of products with a higher value added rather than doing business with large quantities of lower value-added goods. What can be relevant and used as a policy recommendation is precisely the business environment that affects the trade in value added – countries showing better contract enforcement and easier conditions for starting a business then attract more value added. Also, it is interesting to see that the logistics situation is not crucial, and the negative correlations indicate some side

effects in these complex and ambiguous relationships. The positive correlation between high-tech export proportion and value added indicates the importance of advanced technological production.

Table 3 | Multiple linear regression model

	Unstandardized coefficients	Std. error	Standardized coefficient ß
(Constant)	42.425	0	
exp students tertiary	-0.188	0	-0.143
MV HV M per VA	-0.307	0	-0.393
HT export/exp	0.11	0	0.092
logistics (5 highest)	-0.173	0	-0.006
technicians/RD worker	-0.002	0	-0.213
teacher salary/similar	-0.663	0	-0.016
DB start business	-0.142	0	-0.104
DB enforce	-0.094	0	-0.083
EU scoreboard	0.23	0	0.718
GDP	0.005	0	0.834
GDP per capita	-5.36 E-05	0	-0.108

Note: $R^2 = 1.00$, N = 36

Source: Own calculations from EC (2022), ILO (2022), OECD (2022), World Bank (2022)

Conclusion

How does the position of V4 countries in automotive GVCs differ from that of other EU member states and other significant automotive-producing countries?

Our research findings suggest that despite playing notable roles at the EU and world level, the V4 countries' automotive sectors trade in the domestic value added much less than the EU members on average. It has been demonstrated by some scholars (Nolke & Vliegenthart, 2009; Bohle, 2018; Gerőcs & Pinkasz, 2019), yet opposed by the research of others (Pavlinek & Zizalova, 2016). The same applies to the comparison with other world's leading automotive-producing countries. Nonetheless, apart from the trade in value added, we have proved important lags of V4 countries in variables widely considered vital for industrial upgrading in GVCs (hourly labour cost, labour productivity, number of researchers, teachers' salaries and education expenses, innovation level and ease of starting a business). Especially the role of proper contract enforcement needs to be nurtured, so that a stable business environment is maintained. It could lead to higher investment rates and more extensive research, education or logistics infrastructure budget. Most of the variables studied in our model offer room for improvement in a future path towards GVC participation based more strongly on activities adding higher value (Vlckova, 2018).

What is the link between the domestic value added in gross exports of final automotive products and the selected policy and macroeconomic variables?

Volume **12** | Issue **2** | 2023
https://doi.org/10.18267/j.cebr.319

In the multiple linear regression model, we find only a few statistically significant influences on the TiVA indicator (Logistics Performance Index, teachers' salaries, high-tech exports and enforcement of contract score as part of the World Bank's obsolete Doing Business Index). It partially supports the expectation of Kowalski et al. (2015) that the quality of institutions positively affects the final GVC position and the one of the World Economic Forum (2020) reflected in the Global Competitiveness Report. The latter points out the importance of infrastructure, education and free market competition, reflected in the contract enforcement score.

Implications for policy, research and businesses

Our research supports the idea of the V4 countries falling behind automotive leaders in terms of the ability to create value added (lower value added and hourly labour costs), although automotive manufacturing leaves substantial economic footprints in all V4 countries (Cerna et al., 2022). The performance of V4 countries in this regard can be deemed a weak basis for future upgrading within the automotive GVCs. The policies needed for escaping the assembly country position of V4 countries should target mainly increasing the innovation potential, R&D capacities and logistics performance. The latter finding constitutes the contribution of our paper to the GVC literature focused on the automotive industry. Not only will future success be measured by the value created or captured by a country (Kordalska & Olczyk, 2021), but it will also matter whether the economic activity is sustainable like green industrial policies (Szalavetz, 2021). The same will apply to resilient GVCs (Pietrobelli et al., 2021) that are ready to face supply chain disruptions stemming from territorial risks, such as the war in Ukraine. Automotive suppliers deciding on their investment location will have a good reason to choose V4 countries thanks to their relatively extensive presence of high-value manufacturing and relatively good scores in logistics performance. If they seek economies with high potential for the future, they should choose places with good contract enforcement or high education expenditures.

The limitation of our research is the time interval used for the calculations. In future research, we can consider more policy variables and search for other statistically robust independent variables to be employed in the regression model. The data set is limited as the analysis is done only at the country level. In order to understand the causality and the interlinkages among the variables, it would be necessary to investigate the company or supply chain level more deeply. In the contemporary, highly changeable environment, the causality is extremely difficult to identify and prove statistically. Also, it is essential to note that the World Bank has discontinued the Doing Business Index. However, it could have influenced our results, too, but only to a limited extent. We base our analysis on static data and do not consider the dynamics, where teachers' salaries or hourly labour cost have been increasing faster in V4 countries than in the rest of the European Union (European Commission, 2022). Likewise, the trade in value added is only a partial macroeconomic metric that disregards particular specifics of unique cases.

Most of the drawbacks of our research mentioned above can serve as a starting point for future research. Indeed, it would also be worthwhile to explore further facets of our research questions so that we could reveal the differences in the V4 countries' GVC positions, particularly within the automotive sector or in other industries. In addition, it could be valuable to investigate more closely the relationships among various variables and the GVC position or the trade in value added.

Acknowledgement

The article is based on the conference paper "Dynamics of GVC Position of V4 Automotive Suppliers: Implications for Public Policy", presented at the 22nd International Joint Conference: Central and Eastern Europe in the Changing Business Environment held in Bratislava on 19-20 May 2022.

The research originated at the Faculty of International Relations of Prague University of Economics and Business. There is no associated research grant.

We are grateful to the editor of the Central European Business Review for providing the opportunity to publish our article and to three independent reviewers who provided valuable feedback.

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The research article passed the review process. | Received: May 5, 2022**; Revised:** September 4, 2022**; Accepted:** September 9, 2022**; Pre-published online:** November 17, 2022**; Published in the regular issue:** May 25, 2023.