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The realities of EU industrial policies analysed through automotive value chain dynamics

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ABSTRACT

Processes in the past decades have resulted in the segmentation of European industries into 'headquarter' and 'factory' economies, though these categories are not fully distinct. 'Headquarter' economies typically host the higher value added activities and service units while 'factory' economies are popular locations for lower segments of the value chains. This setup has implications for EU level industrial policy strategies. In the current times of accelerating technological development and the ever growing servitisation of industries, 'headquarter' economies genuinely have better capabilities and resources to gain more share of the value added, and can actually steer the course of events in the sector. In the EU peripheries, new investment often covers relocation of previous technologies and retired assets of original equipment manufacturers (OEMs). The 'factory' economies are in a disadvantage in several aspects, while the headquarters optimise according to their own set of strategic preferences, which further compromises the opportunities of industrial actors in the peripheries to shape their own future. Industrial policies, however smart and well designed, have limited chances to influence the character and speed of changes. We review reported cases through which we test literature and contrast realities with aspirations regarding smart and sustainable industrial development across the EU.

KEYWORDS

global value chains (GVCs), European Union (EU), industrial policy, automotive industry

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1. INTRODUCTION

Industrial policy in the European Union is not elevated to the supranational level. Member states are responsible for their own industrial policies, however, their industries as well as their policies are largely shaped by their EU membership. In the 2010s and 2020s, reflecting on the substantial transformations occurring in the real economy worldwide, EU industrial policy strategies have taken a new, more active stance after several decades dominated by liberalisation and deregulation efforts. Most lately, according to the newly formulated priorities of the 2019–2024 European Commission, the EU launched its next growth strategy in December 2019, coupling growth with actions related to the climate challenge. The new strategy is called the European Green Deal (EC 2019). Under its scope, in March 2020, just upon the outburst of the COVID-19 crisis in Europe, the European Commission published its new industrial strategy for a globally competitive, green and digital Europe. The strategy "aims to drive Europe's competitiveness and its strategic autonomy at a time of moving geopolitical plates and increasing global competition" (EC 2020a). The document claims to apply a new approach to European industrial policy, taking into account the various actors, the internal market as the framework, and the two major challenges of the 2020s, i.e. digitalisation and greening, paired up in the so-called digital–green twin transition.

As the new EU industrial strategy is devoted to considering the needs and realities of the industrial actors themselves, we take a closer look at them, with the purpose of potentially fuelling inputs for policy strategies and actions. We narrow our focus to the automotive value chains where European actors play an influential role globally. We apply the headquarter (HQ) vs. factory (FC) economies framework for our analysis. Our review of reported cases serves our aim to test the relevance, feasibility and potential of the EU policies in the field.

Our research question is the following: How do factors shaping the current dynamics of the European automotive value chain influence actors in HQ versus FC economies and what are the implications for the new industrial policy approach in the EU?

2. THE OVERALL FRAMEWORK AND SETUP

Before scrutinising the real economy through relevant cases, we first introduce the overall framework and setup. Accordingly, value chains and policy influence on them are reviewed in brief, as well as the European macroeconomic environment. Then we move on to (industrial) policy considerations and, as a related issue, outline the EU centre–periphery problematique, again with focus on the real economy.

Our globe today is cross-wired by convoluted pipelines and global value chains (GVCs) bringing goods and services to customers and businesses to any geographic destination. Interconnected business and governmental entities are related to these networks, with different levels of dependence and influence. The opportunity to grow and gain a greater market share fuels firms' desire to increase market presence while mandates a strict control over costs to maintain competitiveness, or otherwise condemned to be left behind (Szalavetz 2017). Nevertheless, the dynamic expansion of international markets is increasingly impacted by uncertainties constantly disrupting business operations, which demand supply chains to be flexible, resilient and agile while leaving them vulnerable. It is not only an internal, business-driven expectation to assure a stable operation to deliver business objectives, but there is also a national, regional and global economic interest to maintain an environment in which value creation through supply chains is efficiently maintained.

One way to connect the micro and macro level of economies is to assess the role of GVCs in economic development. To such ends, input–output (I–O) data along economies and sectors can be analysed based on Leontieff's (1936) theory and method. The I–O analysis can actually be extended by including the domestic value chain segments resulting in a 'value chain tree' (Knez et al. 2021).

The recent COVIC-19 pandemic has exhibited GVCs from new angles. Highly internationalised economies became paralysed in supplies when faced with sudden lockdowns (Bonadio et al. 2020). Availability of internationally mobile transport capabilities became scarce under the restrictions. The semiconductor supply constraints have spectacularly highlighted the growing complexity of modern manufacturing as well as the need to assure stable flows on behalf of both business and policy-making. Both the USA and the EU have strongly committed themselves to getting involved in developing policies and strategies to boost the building up of new local semiconductor supply capabilities, together with further research and development competencies to eliminate the full dependence on out-of-region suppliers for this key electronic component of many industries (Meng – Biery 2021; EC 2022). The success and real impact of the policy can be evaluated in the long run with a potential result of reducing external risks, while raising ones embedded or newly occurring in local, domestic economies (Bonadio et al. 2020).

During the period of the COVID-19 pandemic, international trade showed outstanding resilience. Trade infrastructure was hit hard but then exhibited flexible adaptivity (AIIB 2021). The pandemic has shed light on the vulnerability of our international production and trade systems including GVCs (Reiter – Stehrer 2021), although such concerns had already been expressed in the EU earlier (EP 2021). The European Commission was quick in calling for strengthened resilience of European value chains (EC 2020b). The review of supply-side and demand-side effects reveal the arising need for GVC restructuring, considering the geographical, temporal, systemic, product-specific and transmission dimensions. For policy, support to reshoring into the EU, possibly through a comprehensive strategy at the EU level, is recommended. For the longer term, stable self-sufficiency in strategically important products becomes crucial (Reiter – Stehrer 2021).

In 2022, a further event started to cause disturbances in international supply chains: the Russian invasion in Ukraine triggered rolling sanctions on the aggressor by the EU and the USA. The war and the sanctions have had direct and indirect effects on the European automotive production ecosystem and its networks. The effects concern technologies, global markets, the supply of raw materials and spare parts, energy supply and costs, as a result of which the daily operation of automotive manufacturers is fundamentally influenced, at varying exposure levels across companies though (Túry 2022).

The original economic type goals of European integration had been economic development, upward convergence, and the overall well-being of people. However, throughout the decades, and especially from the 1990s onwards, divergence and differentiation have complicated the previously rather smooth one-way path of European integration characterised by widening and deepening in parallel (Pelle 2017; Pelle et al. 2021). The largest stress test for the EU economy until 2020 was the global financial and economic crisis (GFEC). Nevertheless, the COVID-19 pandemic has appeared to be a next such milestone, just as the 2022 Russian invasion of Ukraine, affecting international trade and energy supplies in the first place. The consequences of the latest crises for the EU are comparable to those of the GFEC. Yet, the causes and roots of these crises have been very different. Nevertheless, the misery of the Southern Eurozone periphery continues while the Central and Eastern European (CEE) countries showed better resilience to the COVID-19 shock. Overall, the EU seems to be path-dependent in the sense that crises tend to set back European integration achievements and tend to put intra-EU convergence on hold. Instead, the core–periphery divide appears to be deepening as crises are harming the better-performing core EU member states to tendentiously lesser extents than the peripheral members, especially the Southern Eurozone countries (Pelle et al. 2021). Regarding the economic actors in these critical times, resilience has become a key feature of companies, as well as of countries. Resilience in this sense is the ability to bounce back from the deterioration caused by shocks, which requires mechanisms that quickly facilitate adaptation as a response to crisis events (Brunnermeier 2021).

Among others, Grodzicki and Geodecki (2016) studied peripherality in its historical, geographical, and colloquial dimension, the latter referring fundamentally to economic backwardness. Examining the EU economy's core–periphery division along the GVCs, including investigations of domestic participation, for economic actors in the peripheries GVCs offer the opportunity for entering international/global production networks. This typically occurs by performing relatively simple tasks, even in the production of complex goods, while for the core, GVC participation provides opportunities for further upgrading and specialisation in high value-added activities. Based on the I–O analysis and calculated RCAs,[1] the core–periphery division in Europe is demonstrable; in particular, the existence of a North-Western core, and three peripheries: the Southern European, a 'rich' CEE and a 'poor' CEE. Grodzicki and Geodecki (2016) also reveal the outstanding dependence of CEE on GVCs, which may at some point be a barrier to catching up, even if the region is strongly integrated in the European production networks and is specialised in industries similar to those in the developed core. The reason for this pattern potentially becoming a limit is that the ownership of capital and technologies remains dominated by companies originating from the core (Grodzicki – Geodecki 2016). Nevertheless, with the FDI-based peripheral catching-up model potentially coming to its end by the 2020s, the questions arise what way to go forward for these economies and what future for domestic enterprises, predominantly SMEs, given that the international economy is mostly organised into GVCs (Galgóczi – Drahokoupil 2017).

Another recent GVC-based I–O analysis points out the peripheral position of Portugal and Greece, not only in the sense that these countries participate in the intermediate goods trade in the lower segments of GVCs but also in the sense of being less integrated into international production networks, as their relatively remote geographical positions largely determine peripherality. In the peripheral open economies of Europe, consumption of final goods should not be let entirely replaced by imports. Accordingly, industrial policies must make efforts to attract and/or preserve strategic industries in the peripheries to ensure sufficient generation of domestic value added and thus longer-term balance, especially during and after crisis times (Domingues et al. 2021).

[1]Revealed comparative advantage

Gräbner and Hafele (2020) and Gräbner et al. (2020) demonstrated the structural division between the core and the periphery of the EU and the Eurozone along data such as employment shares in manufacturing, productivity growth, financial openness, and export and import. The uneven within-EU technological exchange (manifesting in the export-import structures of core and periphery countries) results in further structural polarisation (Gräbner et al. 2020) – again, a call for apt industrial policies.

3. VALUE CHAIN DYNAMICS IN THE EUROPEAN AUTOMOTIVE INDUSTRY

After having reviewed the overall framework and setup in which European GVCs operate, we now turn our attention to evidence gained from the real economy. We apply the method of reviewing business cases. We conduct this review embedded in the conceptualisation of international economic activities being executed in 'headquarter' and 'factory' economies (Baldwin – Lopez-Gonzalez 2015). We base our contributions on evidence, with the purpose of deriving conclusions for industrial policies.

3.1. Headquarter and factory economies in Europe

The distinction between HQ and FC economies originates from Baldwin and Lopez-Gonzalez (2015) who claim, expressively oversimplifying, that HQ economies are the ones that "arrange the production networks" while FC economies "provide the labour" (Baldwin – Lopez-Gonzales 2015: 1696). Nevertheless, the concepts are not particularly elaborated any further although whether a country is more of an HQ or an FC economy determines its position in and dependence on the international supply chains.

The HQ – FC setup has been widely used and empirically tested (Timmer et al. 2019; Stöllinger 2019, 2021), identifying asymmetries between the two groups. The concepts are further elaborated to country and regional levels, expanding to business function specifics (e.g. Kordalska et al. 2022), intending to determine positions and longitudinal paths of changes in European value chains.

Szalavetz (2017) discusses how the spread of Industry 4.0 technologies and working methods may influence the FC economies of CEE, considering it a region of "intermediate-level factory economies" (Szalavetz 2017: 135), and coming to the conclusion that these originally not so underdeveloped peripheral economies face severe challenges with the advent of Industry 4.0, pointed out by Nagy et al. (2020) as well. This is especially relevant as lower-skill jobs are persistently lost while new jobs would require high skills that the labour supply of these countries is unlikely to meet. However, there is also evidence of successful upgrading of activities implementing Industry 4.0 solutions (Szalavetz 2017).

Baldwin and Lopez-Gonzalez (2015) captured the triggers of value creation through cross-national supply chain trade activities driven by the following three concepts: importing to produce, importing to export, and value-added trade. Based on these, HQ and FC economy relations were identified. Other intersectoral transaction evaluations analyse a range of different I–O models while also measuring trade related value additions (Braun et al. 2021; Kordalska et al. 2022). This approach remains the golden standard. The EU defines value addition as "income calculated as the sum of labour compensation and return on capital. It can refer to a given industry or to an economy as a whole and when computed at national level is sometimes used as a proxy of GDP" (Arto et al. 2020: 14).

3.2. Variables to compare headquarter and factory economies

Based on literature, we have identified the main aspects along which HQ and FC economies can be analysed and compared. First and foremost, HQ economies typically host corporate activities with higher *value added*: corporate strategic management, research and development, high-skill intramural and/or insourced services (legal service, accounting, financial services, marketing, etc.). These are complex knowledge intensive activities requiring high-skilled workers and high tech solutions. As the activities with higher value added capabilities are located in HQ economies, typically growth or expansion in the higher segments of the GVCs take place there. At the same time, FC economies are typical locations for lower added value, routine activities with production functions such as assembly, less technology-intensive and more labour-intensive production utilising relatively low wage labour. Strategic functions show only weak presence (Bykova et al. 2021; Guzik et al. 2020; Kordalska – Olczyk 2022; Pavlínek – Zenka 2016; Pavlínek 2018; Pavlínek 2020; Pavlínek 2021; UNCTAD 2021). Albeit FCs are usually equipped with state-of-the-art technologies (Jürgens – Krzywdzsinski 2009), value-added capacity improvements are not always achieved. New and innovative technologies (e.g. electric vehicles (EVs) or autonomous cars) push already existing production processes (e.g. internal combustion engines (ICEs)) towards standardisation which are to be carried out in FCs, implying diminished capacities for value creation for them (Gerőcs – Pinkasz 2019). However, we can say that there is successful R&D in FCs (Szalavetz 2019a). Guzik et al. (2020) found 150 R&D centres in the CEE region but these centres perform mostly routine product development functions due to certain barriers (organisation of corporate R&D, shortages of qualified R&D personnel, low level of R&D expenditures; Pavlínek 2022).

A further aspect of distinction between HQ and FC economies is the level of *servitisation* referring to the growing service content of products, significantly affecting the manufacturing process as well (Pelle – Somosi 2018). In the automotive industry, there is an ongoing shift from a product centric towards a customer centric approach, challenging car manufactures to position their product more as a mobility service (Genzlinger et al. 2020). Industrial business entities are forced by competition towards incorporating technological advancements riding the waves of Industry 4.0, which triggers a high interrelation with service contents. Servitisation is likely intensive (and intensifying) in manufacturing units of businesses located in HQ economies while necessarily at most moderate at production sites located in FC economies. Industry-related services are either linked to the value chains as upstream services (e.g. product design or material-related R&D) or could be supporting manufacturing itself through planning, maintenance, or engineering. They may also be linked to downstream flows, backed by marketing, sales, and distribution related service elements (Stehrer et al. 2014). Gaiardelli et al. (2014) developed a descriptive product–service systems classification model and applied it for analysing BMW's product–service offering exponentially progressing in development from the core automobile product towards mobility services. A specific example for the increased service component can be the over-the-air capability (Halder et al. 2020; Ghosal et al. 2022) that can identify and project the condition of certain parts of the vehicle, developing new revenue channels while capturing more functionality and benefits in the value chain. This represents an additional service component for the car to be developed by R&D, whether internal or external to the OEMs, maintained and upgraded on an ongoing basis during the lifecycle of the product. Therefore, all entities involved in value creation in HQ and FC economy units are affected, going through a servitisation fuelling a coevolution of product, functionality and process upgrades in the value chain (Szalavetz 2019b).

To deliver *digitalisation*-driven intelligent systems, companies are required to transform data collection, storage and analysis of transactional, planning and controlling systems (Ajah – Nweke 2019). To utilise digital platforms, standardisation of the presence and usage of these tools is key, which demands constant investment in continuously modernised and/or replaced technologies. At the same time, *automation* expectations are highly increasing and driven by technological advancement. Automation can also be triggered by labour supply bottlenecks. The speed and quality of automation can be different in HQ and FC economies though. Digitalisation and automation related solutions are transforming the automotive industry (Guzik et al. 2020). Additive manufacturing, Internet of Things (IoT), cyber physical systems (CPS), Big Data analytics, robotisation and smart factories are the most influential digital technologies in the sector (Demeter et al. 2020; Pelle et al. 2020; Szalavetz 2017). However, HQ and FC economy players are affected disproportionately as research centres focusing on digitalisation are usually located at the headquarters of OEMs while FCs generally lack such centres (Simonazzi et al. 2020). Moreover, HQs are usually the first to introduce new technologies as labour costs are higher there, implying higher return on digitalisation and automation. While automation in FCs is at a much lower level, robotisation has grown hastily in the past years in CEE countries mainly due to rising labour costs and labour shortages. Subsidiaries in FCs operate a mix of semi-manual and highly-automated activities (Aláez-Aller 2020; Drahokoupil 2020). FC subsidiaries of local automotive companies indeed were among the first ones to embrace automation and digitalisation related technologies and as global automotive players need their FC affiliates to stay competitive, they have chosen to develop them (Szalavetz – Somosi 2019). Yet deployment of these technologies is not sufficient, subsidiaries also need to implement new production methods and transform processes (Szalavetz 2020).

In parallel with technological expectations, there is a strong call for *green investments*. In fact, obsolete assets in one part of the chain can present an upgrading opportunity in another part. Headquarter economies may reuse assets in less developed parts of the value chain, through which additional activities can be relocated from HQ to FC sections of the chain (Drahokoupil 2020). Maintaining the same level of asset quality across the value chain is only valid in highly standardised operations and products. New investments in FCs may actually involve old technology. Examples include investing in ICE production in FCs while retooling HQ facilities for EV manufacturing (Gerőcs – Pinkasz 2019; Túry 2018). Undoubtedly, new technologies first appear in HQs and investments there concentrate on these while in FCs investments target not only obsolete technologies but also state-of-the art ones (Jürgens – Krzywdzsinski 2009). Nevertheless, FDI in CEE countries has led to the modernisation of the automotive sector (Pavlínek et al. 2017). For automotive firms, investments in new technologies in FCs are needed to truly leverage on the benefits of electrification, digitalisation and regional value chains (Szalavetz 2019a; Vaidya et al. 2018). Furthermore, FCs have recently become highly preferred investment locations for battery producers making them crucial players in European battery value chains (Delanote et al. 2022).

Sustainability, though partly legally motivated, is often an internal target within industries and companies. The European automotive industry is pressured to become more sustainable also through EU targets (Grelier 2019),[2] and some member states have introduced even stricter standards (Delanote et al. 2022). In addition, there are societal requirements and customer needs (Wittmann 2017). As a result, the shift towards EV production is increasing at an accelerated pace. Depending on the level of influence or the level of ownership to act, improvement and monitoring could differ among HQ and FC economies. Headquarter economies might own the developments while factory economy chain partners are to execute and deliver actions, which can create polarised pressure points (Pavlínek 2022; Russo et al. 2022). Besides legislative pressures, global competition also pushes carmakers towards electrification. China and the USA are ahead in EV production: China is the global leader in EV manufacturing and the leading EV manufacturer is Tesla, an early mover US firm. European companies reacted later, but are catching up to their US and Chinese competitors (Fredriksson et al. 2018; Pavlínek 2022; Túry 2019). Global competition is high in battery production as well, led by Chinese and South Korean firms and the EU is currently lagging behind (Delanote et al. 2022; Simonazzi et al. 2020). Regulations and global competition pressure necessitates technology developments (Conway et al. 2021) that usually start in HQs but also opens opportunities for FC affiliates for technological capabilities upgrading (Szalavetz 2018). Sustainability and especially electrification related developments required FC subsidiaries to make some non-negligible technology development efforts. In fact, CEE countries experienced an uptake in climate-friendly patents (Delanote et al. 2022; Szalavetz 2018). However, electrification occurs at a slower pace in FCs than in HQs due to functional specialisation in standardised manufacturing like ICE and EV battery production (Gerőcs – Pinkasz 2019), lower innovation capacity and labour cost advantages (Delanote et al. 2022). Still, CEE countries are becoming focal points in EV production, some predominantly evolving as EV producers, others gaining key importance for battery production (Delanote et al. 2022; Guzik et al. 2020). These battery factories are crucial for European EV production for covering demand (Túry 2019), but, given the mostly standardised product, manufacturing them in FCs is rational (Gerőcs – Pinkasz 2019).

Expanding activities or changing units within HQ or FC economies always have a strong strategic *relocation* objective that might be different for HQ or FC units. The former are sensitive to closeness to sophisticated markets and management resources, are attractive locations to build employer branding, utilise the availability of new services, etc. For FC sites, the relocation objectives are still strongly economically driven, mainly relying on their cheap and qualified labour, proximity to final consumers and production experience (Hudec – Sinčáková 2021, Pelle et al. 2020). In today's European automotive industry, relocation motives can be connected to the lifecycle of the ICE (being in a standardised phase) and the EV (uprising), which implies the potential relocation of ICE production to FCs due to their low cost material inputs and mostly cheap labour (Gerőcs – Pinkasz 2019), since ICE production is more labour intensive than EV manufacturing. Over the years OEMs have motivated their suppliers to relocate to FCs and even integrated suppliers from FCs (although to a limited degree), making these players at least partly embedded in FCs (especially in Poland and Czechia) (Rugraff – Sass 2012; Drahokoupil 2020). Thus, FCs are still viable locations, as firms are more likely to relocate their activities to places where linkages are well developed

[2]For example, the 55% reduction in CO_2 emissions by 2030 or the ban on newly registered ICE cars by 2035 (EC 2021).

(Hudec – Sinčáková 2021). On the other hand, digitalisation and automation challenge FCs' key comparative advantage, the low labour costs, and even question the logic of relocation of labour intensive activities to FC locations as new technologies enable more profitable production in HQs (Dachs et al. 2017; Drahokoupil 2020). HQs are seen and even preferred for backshoring due to higher quality and flexibility, know-how and closeness to home-base R&D capabilities (Dachs et al. 2019). HQs are the leading zones for innovation activity (Pavlínek 2021); their innovative clusters attract advanced competency based functions (Rugraff – Sass 2016).

For the purpose of our study, we formulated certain literature-based keywords regarding all our variables. These keywords guided us in our content analysis, but we did not restrict our research only on these (Table 1).

4. REVIEW OF REPORTED CASES

As shown above, the concepts of headquarter and factory economies are used to differentiate clusters of countries based on the aggregate value added through different functions and locations in the value chain across industries. The automotive industry is featured specifically in such a duality. In our investigation, we aim to compare firm specific information on the European automotive industry.

4.1. Method and sample

In our research, we relied on our dedicated, hand-collected database of investments in the automotive industry in HQs and FCs (162 items). Firm specific inputs were collected in relation to automotive value chains in Europe during 2017 and 2021, based on originally reviewing 1202 articles, news items and announcements. Although there are limitations to the content gained from these sources, we found this an adequate way to gain insight into firm level activities. During the source item selection, we assured that the same news from different sources would be eliminated in order to avoid multiplication of popular updates. To drill further down, investment was used as a key filter to establish the flow of development focus within the European automotive networks. Out of the 1202 source items, 162 were found to report on value chain related investment activities, either at strategic or operational levels (Table 2). 46% of these source items were selected from English language sources (EU Commission press releases, Reuters, Bloomberg, etc.). The remaining 54% were published in Hungarian sources (HVG, Portfolio.hu, jarmuipar.hu, etc.). Looking at the contents, 78 source items referenced Hungarian business entities while 84 source items (of the selected 162-item sample) were not linked to Hungary, which suggests that Hungarian cases are overrepresented in the sample. We cannot ensure a fully representative study.

To find out investment volumes, we went through the 162 source items with the help of content analysis. Yet, in the first round these dedicated investment amounts were determined in EUR, USD, GBP and HUF so they needed to be converted to EUR. When converting currencies, we checked the date of the investment and used the foreign exchange rate of that date and then exchanged USD, GBP and HUF to EUR manually.

Out of the 162 source items, 40 covered strategic level investment plan announcements without detailing the units where advancement and improvement efforts were focused on. We consider certain investments as strategic if they concern the field of activity and the scope of firms and the goods and services produced (Mazzolini 1981), have significant long-term

Table 1. Operationalising variables based on literature review

Aspects	Keywords	Examples from the literature	Reference
Value addition activities	Assembly, autonomous vehicle development/ manufacturing, electric car manufacturing, ICE, R&D, standardisation	High value-added activities in HQ: R&D and manufacturing of electric/ autonomous vehicles. Low value added activities in FC: manufacturing of ICE vehicles and electric batteries.	Gerőcs – Pinkasz (2019), Guzik et al. (2020), Kordalska – Olczyk (2022), Pavlínek (2018, 2020, 2021)
Servitisation	Servitisation, service, mobility	Product, functionality and process upgrades of the value chain in both HQs & FCs. over-the-air capability.	Gaiardelli et al. (2014), Genzlinger et al. (2020), Szalavetz (2019b)
Digitalisation & automation	Additive manufacturing/3D printing, automation/ automated, big data, cloud, CPS, digitalisation/ digitalise, new technology, IoT, robots	Robotisation and the changes in the number of industrial robots, R&D in the field of digitalisation and automation, use of new technologies in both HQs & FCs with varying intensity.	Aláez-Aller et al. (2020), Drahokoupil (2020), Simonazzi et al. (2020), Szalavetz (2020)
'Colour' of investment, greening	Battery production, factory advancements, factory retooling, investment, modernisation, new technologies	In HQs: investment in digitalisation, electrification, automation and connected cars. In FCs: investment in electrification (batteries), automation, ICE production.	Drahokoupil (2020), Pavlínek et al. (2017), Szalavetz (2017, 2019), Túry (2018)
Sustainability	Battery production, CO_2 reduction, EV production, EV targets, ICE	EU targets for CO_2 emission reduction (e.g. phasing out ICE by 2035) for both HQ and FC units. Global competition with the USA and China in EVs with more relevance for HQ. Battery production and its importance with more relevance for FC.	Delanote et al. (2022), Gerőcs – Pinkasz (2019), Guzik et al. (2020), Pavlínek (2022), Szalavetz (2018), Túry (2019)

(continued)

Table 1. Continued

Aspects	Keywords	Examples from the literature	Reference
Relocation objective	Backshoring, innovation, labour cost, labour intensive, location, relocation, standardisation	HQs seen as innovative areas with high quality and efficiency. FCs seen as low labour cost locations with automotive production traditions by now.	Dachs et al. (2017, 2019), Hudec – Sinčáková (2021), Nagy et al. (2020), Rugraff – Sass (2012, 2016)

Source: authors.

Table 2. Sample features

Summary of source for articles, news, announcements during 2017–2021						
Key words		**Total (number)**	**With strategic level investment plans**		**With operational level investment plans**	
Europe, Value chain, Automotive, Investment		162	40 source items 630 billion EUR investment		122 source items 228 billion EUR investment	
OEM and supplier share of reported operational investments						
Value chain role in production	Source items (no.)	Source items (%)	Total billion EUR	% of Total	Average billion EUR	Deviation from Total
OEM	47	39%	145	64%	3.1	+65%
Supplier	79	61%	83	36%	1.1	–41%
Total	122		228		1.9	
Headquarter (HQ) and factory (FC) economy location share of reported operational investments						
Location type	Source items (no.)	Source items (%)	Total billion EUR	% of Total	Average billion EUR	Deviation from Total
HQ economy	35	29%	39.2	17%	1.1	–39%
FC economy	87	71%	188.8	83%	2.2	16%
Total	122		228		1.9	

Source: authors.

impact and are large-scale and difficult to reverse (Papadakis – Barwise 1998). The strategic investments in our sample reflect digitalisation and electrification related commitments. On the other hand, operational investments might not fundamentally transform business but still affect productivity and performance (Shivakumar 2014). Examples for what we considered strategic investments include the Volkswagen group deciding to allocate 73 billion EUR on digital and electric vehicle technology over the period of 2020–2025 or Ford spending 22 billion EUR in Europe on electrification till 2026. Other major players have similar ambitions to digitalise and get ready for a greener era. In our view, operational investments consider a specific location or plant, not the whole production line of the carmaker, for instance Audi's 14 billion EUR investment to restructure its Győr facility, BMW's 400 million EUR investment in Dingolfing to retool it for EV production, or Tesla's Berlin Gigafactory with a 5 billion EUR investment.

The remaining 122 source items specified the unit level flow and purpose of the investment plans at operational levels. These were selected to review the highlighted aspects of general headquarter and factory economy characteristics for specific companies and locations. The next layer of the analysis split the source items on roles in the vertical flow along the value chain, differentiating OEM roles from supplier roles (Table 2).

Although 61% of the selected source items covered supplier-related value chain development activities, 65% of the reported investment still went to OEMs. Less attention is paid to the development of Tier 1–2 actors. When evaluating the average investment, there is a sizeable difference: OEMs playing a coordinating role in the automotive industry possess more accessible capital to pursue business strategies. At Tier 1–2 levels, the investments may have a lag, once adjusted to the OEM requirement.

As a next step, we split the operational investment data between headquarter and factory economies, based on the location of the units (Table 2). We found that 71% of the selected source items covered factory economy location related value chain development activities (in Bulgaria, Czechia, Hungary, Poland, Romania, Slovakia and Slovenia, all CEE countries with considerable automotive industry), with a similar dominance of an 83% share in the reported investment realised at actors in these locations.

4.2. Case reviews and comparison

We continued with content analysis of our sample along the key aspects of distinction between headquarter and factory economies. First, *value addition* was examined. Clearly, a large part of development occurs in HQ economies; however, the picture for FC economies is more diverse. Electrification necessitates automotive firms to invest in the restructuring of production to manufacture EVs in HQ economies, which pushes the production of ICE cars to FC economies (e.g. Volkswagen converted its Zwickau, Emden and Hannover facilities in Germany to produce electric cars but moved the production of traditional cars to CEE, mostly Czechia.). Our evidence confirms that the lower value-added productions are likely relocated to FC economies while the higher value-added manufacturing remains in HQ economies. Yet, due to high demand and pressure on automotive firms, FC locations are involved in EV production to a growing extent, with increasing number of FC affiliates dedicated or reorganised for EV production (e.g. BMW's Hungarian plant will solely produce EVs). Moreover, due to electrification, FC economies are attractive locations for battery producers (e.g. LG Chem in Poland, SK Innovation or Samsung in Hungary), mostly covering lower value-added activities. Furthermore, several investments in CEE are not connected to electrification or digitalisation; these are investments in plant extension or new production facilities for ICE car parts (e.g. Peugeot's and IAC's Polish, Volkswagen's Slovakian and Hanon Systems' Hungarian plants). Although these investments are significant, their contribution to the competitiveness of the CEE automotive industry is dubious and might result in a low value-added production trap.

Automotive firms are required to invest in and develop their plants in FC economies as well, for the sake of their competitiveness. Consequently, many actors emphasise the development of their facilities in CEE countries and improve those sites both digitally and in terms of sustainability, contributing to higher value-added production. Furthermore, automotive firms leverage on the available knowledge and networks in FC economies and establish research centres in the CEE (e.g. Continental or Thyssenkrupp in Hungary). These R&D facilities indicate that although FC economies tend to host low value-added activities, initiatives for embracing higher added value creation are also present. Therefore, we confirm that HQ economies produce higher value-added goods while FC economies tend to be specialised on lower value-added ones, however this trend is changing due to mainly the newly created R&D centres located in FC locations. Yet, the gap between HQs and FCs remains.

Regarding *servitisation*, we theorised that the amount of service component of the production activity can greatly depend on whether it takes place in a HQ or a FC economy. Reviewing the direction of investment is not adequate to make a statement on industry servitisation. Our sample does not give us sufficient insight into the automotive industry servitisation in the HQ vs. FC economy relation. However, on a strategic investment level we have found that automotive firms are investing in servitisation, but they consider it as part of their digitalisation efforts (e.g. Stellantis and Volkswagen both dedicate millions of EUR to car software developments but these are part of their digitalisation strategies).

Digitalisation and automation are crucial for firms and even countries to remain competitive but there is a distinction between HQ and FC economies: while the former are at the forefront of digitalisation and always striving for new development opportunities, the latter only have a following role and are characterised by low levels of local initiatives. This is visible in our sample through business restructuring in Western European locations (e.g. Volkswagen set up a specific software development division in Germany, Audi came up with a new German subsidiary to develop digital business innovations or Mercedes converted its German sites into digital production systems), or through partnerships which are formed typically between OEMs and IT firms in HQ economies targeting co-development of digital solutions (examples include Microsoft and BMW, Volkswagen and SAP, Nvidia and Siemens, or Stellantis and Google). Even so, digitalisation related practices are becoming common and automotive firms invest in the modernisation of their CEE sites, in certain cases even bringing digitalisation related R&D centres here (e.g. Thyssenkrupp's or AVL's new Hungarian R&D centres). Hence, we can confirm that HQ economies are highly digitalised and are thriving, they are the leading parties to provide the competitive edge, while in FC economies digitalisation is expanding and HQ practices are followed, but the level of local initiatives is rather low, being more like a necessary must.

Digitalisation and electrification related *investments* can be found both in HQs and FCs; the main difference is that while in HQs the majority of investments concern these fields, in FCs it forms only a limited part. However, the trend is promising as more investments target either greening or digitalisation in the CEE region. Examples of HQ investments in modernisation and development include factory restructuring to produce electric cars (BMW in Dingolfing, Tesla in Berlin, Stellantis in Turin, Bosch and Volkswagen Group in their German locations, Ford in Cologne etc.), or digitalising and automating production. Yet, these initiatives spill over to FC economies; examples can be found both for production digitalisation (e.g. AVL's or Suzuki's developments in Hungary or Skoda's investment in digital technologies in Czechia) and for electric transformation (e.g. Mercedes' Hungarian, Stellantis' Polish and Hungarian or Ford's Romanian plant modernisation). But, as already detailed, in several cases investments in CEE have no electrification or modernisation focus, but involve older technologies. We can say that investments in HQ economies are green but in FC economies we find a mix of green and grey.

The ambition to become more *sustainable* is reflected in company decisions. Carmakers generally support the shift to electric cars. The initiative usually originates from HQ economies but, due to the high pressure, by now most of the CEE countries are also highly involved in electrification. Examples from across Europe are BMW's 400 million EUR investment in Dingolfing, the reorganisation of Stellantis' Melfi plant and Renault's French sites to meet the EV production criteria, the new Tesla Gigafactory in Berlin and several battery plants in Western Europe (e.g. Svolt Energy, CATL and Bosch in Germany, Stellantis in Italy, Northvolt in Sweden). CEE is not falling far behind as electric Mercedes cars and electric Audi engines are produced in Hungary, and numerous battery plants operate or are to open in the upcoming years in these countries (e.g. LG Chem, Umicore and Johnson Matthey in Poland or SK Innovation, Semcorp, Bumchun Precision and Shenhzen Kedali in Hungary). Conversely, legislative push is also highly traceable, especially in certain partnerships where the intention is to reach EU targets. Such partnership was formed between FCA and Tesla or Ford and Volvo as the zero or low emission cars of Tesla and Volvo were counted together with FCA's and Ford's cars, reducing the emission average for FCA and Ford. Altogether, sustainability in core (HQ) countries is business and legislative environment driven while in the periphery (FC) expectation driven, the latter economies following HQs at a slower pace due to infrastructure and legislation lags.

Due to the ongoing changes in the automotive industry, *relocations* from CEE to Western Europe are also studied. As new technologies ease the switch of production locations and electrification requires less labour, the location and investment decision factors are changing: low labour costs and available skills are losing relevance, but the size and evolution of market demand, the locations' ability to host digitalisation or closeness to higher value-added activities start mattering more (Pelle et al. 2020). All these recently influential factors characterise mostly HQ economies. Still, such relocation is seemingly not happening as the production brought to CEE earlier is now embedded, and relocating it would be costly and complex, possibly breaking existing networks. Thus, instead of reshoring production, firms invest in development, modernisation and labour skill improvements in their CEE plants, rendering them more competitive and leveraging on existing synergies between automotive firms and local suppliers and institutions (Pelle et al. 2020). In certain cases, even new R&D centres are brought to the CEE region (as detailed above). Moreover, the FCs not only attract investment to existing plants but are also becoming locations for new European sites of battery producers (e.g. SK Innovation or Samsung in Hungary or LGChem in Poland). Undoubtedly, HQ economies are attractive in terms of location and relocation as purchasing power is high and driven by sophisticated consumer base, and proximity to high value added activities is given. Tesla's Berlin factory proves this well as these were among the main reasons for choosing Germany, besides the excellent infrastructure. Nevertheless, FC economies are not only economically sound, but also organically host production facilities that would be costly and complex to be moved due to local network integration. Many of the large suppliers of OEMs are investing in the modernisation of their FC sites instead of relocating them so that they can better serve their buyers (e.g. Continental, Schaeffler or Infineon in Hungary).

As a summary, Table 3 outlines a selected set of relevant examples across all operationalised variables from our review.

Table 3. Examples for operationalised variables in our sample

Aspects	HQ economy unit example	FC economy unit example
Value addition activities	• Daimler's 2.6 billion EUR investment in R&D in electric mobility • Northvolt's 645 million EUR investment in a Swedish laboratory for electric mobility	• LG Chem's 990 million EUR expansion investment in battery producing plant in Poland • Thyssenkrupp's 6 million EUR investment in a new Hungarian R&D centre
Servitisation	• No specific operational investment in connection with servitisation, but in many cases it is implied in digitalisation-related strategic/operational investments • A strategic example: Stellantis' 30 billion EUR investment in electrification, new technologies and software	• No specific operational investment in connection with servitisation, but in many cases it is implied in digitalisation-related strategic/ operational investments for the whole production line of the firm
Digitalisation & automation	• Renault's investment of 36 million EUR in robotisation in France • Bosch's 1 billion EUR investment in autonomous driving and IoT-related production	• Audi's investment of 14 billion EUR in Hungary to automate and robotise the plant • AVL's 7 million EUR investment in Hungary for a new research facility partly targeting autonomous driving
'Colour' of investment, greening	• BMW's 400 million EUR investment in Germany in EV production • FCA's 700 million EUR investment in Italy in EV production	• Volkswagen's 1 billion EUR investment in capacity expansion for ICE production in Slovakia • SK Innovation's more than 300 million EUR Hungarian EV battery plant investment
Sustainability	• Volkswagen's 1 billion EUR battery cell plant investment in Germany as the firm shifts to electric mobility • BMW to invest in Germany in retooling locations for EV production	• CEZ's 1.6 billion EUR EV battery plant project • FCA's 2 billion EUR investment in their Polish site to retool it for hybrid and e-vehicle production
Relocation objective	• Tesla's first European Gigafactory in Germany thanks to skilled labourforce, stability, and excellent infrastructure • CATL to build its first European subsidiary in Germany due to the presence of major carmakers	• Opel's new Polish plant for commercial vehicles thanks to cheap, available and skilled labour mainly • LGChem's or Semcorp's Hungarian EV battery related plant to serve the European EV producers

Source: authors.

5. CONCLUSIONS

The division of locations of industrial activities into HQ and FC economies by the literature and its analysis in our evidence base may provide implications for the EU macroeconomic environment, the core–periphery stance, as well as EU industrial policies. We have formulated the conclusions and implications of our analysis accordingly. First, leading automotive firms in Europe do invest in digitalisation and sustainability, in line with the EU policy goals of the digital–green twin transition, pushing suppliers of both HQ and FC economies in these directions, despite the often underdeveloped infrastructure of FC (the periphery). In terms of policy implications, support for more effective local spillover of the undertaken investments, maintenance and development of the digital, R&D and education infrastructures, but also electric charging networks is recommended to foster the desired changes. Concentrating on the battery production facilities in CEE, these may well serve the European automotive industry as a whole, especially by shortening GVCs and eliminating the risks deriving from extra-EU value segments but, at the same time, likely cement the factory economy status of the periphery.

The main threat of the current industrial policy routines in Europe is that the circumstances and historic evolution of factory economies may easily lock the concerned countries into this less favourable category and conserve their peripheral status. Thus, escaping from the trap of low value creation capabilities is not only a question of gradual development but would also require a quality-type jump into a new stage of being able to provide the necessary conditions, with special regard to a smart and supportive business and policy environment. This would also be of common European interest.

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