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The automotive industry in developing countries and its contribution to economic development

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ABSTRACT

Many developing and emerging economies have sought to establish a domestic automotive industry as part of their economic development strategies. This paper reviews the literature on the experiences of several of these countries and develops a success-failure spectrum of participation in the automotive global value chain (GVC) as well as an analytical framework for understanding differential performance. The success-failure spectrum is based on an understanding that for countries to benefit from establishing a national automotive industry with respect to their overall industrialization and economic development ambitions, they need to nurture a large number of local component manufacturing firms with substantial technological capabilities, while not sacrificing the international competitiveness of the sector. The review covers all developing and emerging countries that have seen the emergence of a competitive domestic automotive industry over the last two to five decades, or in the cases of failure, attempted through significant government intervention to build up such an industry. The analytical framework interacts three sets of explanatory factors: 1) Local demand and production conditions related to economies of scale, 2) automotive GVC factors and lead firm strategies, and 3) the industrial and trade policies implemented by governments. Both the analytical framework as well as the performance spectrum have been developed in an iterative manner, through the analysis of secondary literature on the automotive GVC and lead firms strategies and secondary case study literature on the automotive industries in several developing countries. The review of the secondary literature is supplemented with primary data from the author's doctoral research on the South African automotive industry. Having introduced both the performance spectrum and the analytical framework, individual country experiences are discussed in depth to demonstrate the explanatory power of the framework.

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1. Introduction

The changes in the global production system since the disintegration of the Fordist corporation (outsourcing) and the eventual offshoring of many of the disintegrated activities all over the world, with the emergence of so-called global value chains (GVCs) and global production networks (GPNs), are well documented in the literature (for a chronology see Whittaker et al. 2020, 76–80). Over the last two decades, a vibrant literature has emerged that discusses the implications of these developments for catch-up industrialization of developing countries (among others: Kaplinsky, 2005; Baldwin 2011; Gereffi and Sturgeon 2013; Milberg, Jiang, and Gereffi 2014; Lin and Monga, 2017; Andreoni 2019; Whittaker et al. 2020). While some of these contributions are rather bullish about the potential of these changes for developing countries, others have responded to them by advising more caution (Kaplinsky 2005; Andreoni 2019; Whittaker et al. 2020).

The more optimistic analysts usually emphasize the positive impacts that are the result of the global fragmentation of production. Instead of building the full supply chain domestically, industrialization has become about joining a supply chain (Baldwin, 2011). Some like Baldwin (2016) have become extremely excited about the prospects for developing countries and have proclaimed that we are the outset of the 'great convergence'. Countries do not have to develop entire industries or a deep industrial base before participating in global trade anymore, because GVCs give them the opportunity to link up to global production by specializing in niche activities. The positive tale argues that countries can now participate in advanced exports of manufactures with limited initial capital and get access to state-of-the-art technology and production knowledge. Lin and Monga (2017: 186–92) make this argument in their book on how developing countries can catch up and industrialize. They see huge potential in the fact that developing countries can link up to GVCs by specializing in niche activities that are in line with their relative comparative advantage.

Some other contributions are more cautious when it comes to assessing the opportunities for catch-up in a world of GVCs. Kaplinsky (2005) and Lee (2019) acknowledge that the question is not whether developing countries should link up to global production, but how. Kaplinsky observes a global excess capacity in productive capabilities and cheap labour and therefore warns of a 'fallacy of composition' if many countries, at the same time, try to catch up through an export-oriented growth strategy (229-31). His analysis is as relevant today as it was 15 years ago when he wrote it. He concludes that countries should not just engage with GVCs for the sake of it, but strategically and selectively to capture rents from exporting (242-49). Lee (2019) makes a similar argument and advises both firms and countries to strategically engage and disengage with GVCs in order to achieve upgrading.

The global fragmentation of production is a reality that one cannot escape. Looking at a country's exports today does not tell us much about that country's level of industrial development. As long as we do not analyze the foreign value added in a country's exports, as well as the thickness of its industrial structure, we might be dazzled by the apparent sophistication of its exports (Whittaker et al. 2020, 114-119). In fact, it is well documented that

many countries' participation in GVCs as export platforms is characterized by low levels of domestic ownership and limited linkages to the domestic economy (Milberg 2007; Paus and Gallagher 2008; Paus 2014). In that case, we are back to the situation that Singer described in 1950, in which almost the entirety of the multiplier effect of a productive activity in a developing country accrues to the advanced country whose firm is undertaking the exports (Singer, 1950).

The debate about how to link up to GVCs for catch-up is closely related to the debate about the kinds of industrial policies that are still available and promising in times of GVCs, as in Hauge (2020), Milberg et al. (2014), and Whittaker et al. (2020). Whether it concerns the debate about catch-up industrialization in general or the debate about appropriate use of industrial policy more specifically, it is important to move the discussion from the general industry level to specific industries and specific GVCs. Whitfield et al. (2021) make this point very strongly, when they emphasize that GVCs differ with respect to how lead firms govern the value chain and how power is distributed in the chain, as well as with respect to how production activities are dispersed across the globe and how location decisions are being made, and how all of this impacts the prospects for local policy intervention, the opportunities for local firms to participate and upgrade, and the possibility for countries to capture rents from exporting as well as to create backward and forward linkages in their domestic economies. Andreoni (2019) makes a very similar point when he emphasizes that value creation and value capture opportunities are distributed differently across sectoral value chains (272).

In agreement with the points made by Whitfield et al. (2021) and Andreoni (2019), this paper takes an in-depth look into the dynamics of the automotive GVC[1] and how they have affected the different attempts of developing countries to link up to the value chain and to derive developmental benefits for their domestic economies. The two main contributions of this paper are 1) the development of an analytical framework for understanding localization achievements within and across country cases, as well as 2) the ranking of those developing/emerging countries (which have seen the emergence of a domestic automotive industry) on a performance spectrum with respect to their localization achievements. Both the analytical framework as well as the performance spectrum have been developed in an iterative manner, i.e. through the interaction of secondary literature on the automotive GVC and lead firms' governance and especially sourcing strategies, with secondary case study literature on the automotive industries in several developing countries. Hence, the analytical framework has not been developed through the reading of automotive GVC literature alone and then been applied to the country cases, but it has been refined and built based on the country case literature. The author has supplemented the secondary literature on the automotive GVC and the country cases with primary data from his own doctoral research on the South African automotive industry. This

[1] The focus of this paper is on passenger vehicle (PV) and light commercial vehicle (LCV) production. Other contributions, like Ivarsson and Alvstam (2005), have focused on heavy commercial vehicles (HCV), which includes trucks and buses. HCVs belong to the automotive industry, and their production is often driven by similar factors as is PV and LCV production, but this paper does not cover them.

includes data from interviews with four out of the seven locally active OEMs[2], four multinational tier-1 suppliers, six locally owned component suppliers, as well as policy makers and industry associations.

The importance of developing and emerging economies in the global auto industry has increased rapidly over the last three decades. Since demand in advanced countries is saturated and stagnating (Dicken, 2015: 483), automotive lead firms have turned to emerging markets with large demand for vehicles. The times in which the US and Canada, Japan, and the Western European countries made up 75 per cent of global passenger car production (data for the year 2000) are certainly over.[3] Countries like China and India have become the motor of the global auto industry. While the production of passenger cars in China was below one million in 2001 (Chu, 2011: 1241), it has exceeded 20 million in 2019 (OICA). Car ownership in China is still quite low at 188 passenger vehicles per 1,000 people.[4] Another candidate for a potentially very large car market is India. Passenger vehicle production in India was at 3.6 million in 2019 (OICA), and India has a car ownership rate of only 22 per 1,000 people.[5] Other populous countries in which car ownership is still below 100 per 1,000 people include most African countries, Colombia, Bangladesh, Vietnam, Indonesia, Pakistan, and the Philippines.[6] Those are the potentially promising markets for the future of the automotive industry.

Different developing countries and emerging markets engage in different ways with the automotive GVC. While countries like China and India attract assembly and component manufacturing foreign direct investment (FDI) in their own right, i.e. destined for production for the domestic markets, other countries receive FDI in the context of a regional production system. It will become clear throughout this paper that there are two different modes of integration into a regional production system with distinct implications for localization prospects: 1) the integration as a peripheral country into a large regional production system, and 2) the integration on more equal footing in a more balanced regional production system. Examples for the latter include Brazil and Argentina in Mercosur, and Thailand, Malaysia, Indonesia, the Philippines, and Vietnam in ASEAN. The examples for the first category are Mexico in the case of NAFTA, as well as the Central and Eastern European (CEE) countries in the European automotive production system. The countries of CEE were preceded by Spain and Portugal. More recently, the more peripheral countries of Eastern Europe are being integrated into European automotive production. Pavlínek (2020: 512) shows that Serbia, Bulgaria, North Macedonia, Moldova, and Morocco are the most recent recipients of significant automotive FDI. Some of the countries that are integrated in regional production

[2] OEM means Original Equipment Manufacturer. In the automotive industry, it is used synonymously with vehicle assembler/carmaker.
[3] Source: OICA. Global production statistics 2000. Accessed on 04/08/2020.
[4] 270 million PVs by 2020, according to http://autonews.gasgoo.com/china_news/70017340.html (Accessed on 04/08/2020). Population 2020: 1.439 billion (Source: United Nations).
[5] 2015 data. Light motor vehicles and cars = 28,800,000. Source: Statistical Year Book India 2017, Government of India. Retrieved on 04/08/2020 from http://mospi.nic.in/statistical-year-book-india/2017/189. Population 2015: 1.31 billion (Source: World Bank).
[6] Source: https://ourworldindata.org/grapher/motor-vehicle-ownership-per-1000-inhabitants (Accessed on 04/08/2020).

systems, also represent cases of countries that have developed local automotive industries for their domestic markets. The boundaries are not clear cut. Thailand and Turkey, for example, are both heavily integrated in regional and global production, but also have significant domestic markets. Another example, albeit smaller, is South Africa, which has a significant domestic market, exports regionally to the rest of Africa, but is also integrated into the European production system through the EU-SADC FTA (Free Trade Agreement).

One essential point when discussing the automotive GVC is that linking up to the GVC without domestic automotive assembly or without integration into a regional production system is very limited. Lejarraga et al. 2016 (24–25) discuss some options of participating in the automotive GVCs for countries currently without local assembly of vehicles and without local production of automotive components. They argue that some types of components of automotive production might be more comparable to manufacturing for the apparel or the electronics GVC. They mention Ireland's ambition to use software and electronics as a potential linkage to the auto GVC, while Peru is trying to link up to the GVC through the manufacturing of tyres and textiles for the interior system. Chile wants to exploit copper linkages, while the Dominican Republic is aiming to link up its leather production clusters to the auto GVC. All these countries are very marginal players in the global automotive industry. Together they make up 0.1 per cent of global exports of vehicle parts.[7]

Other examples of countries with automotive components production without domestic assembly include Singapore, Hong Kong, and Botswana. Botswana has attracted FDI from two wiring harness component manufacturers that are producing for the nearby South African automotive OEMs. Component production in Singapore and Hong Kong is much more substantial than in Botswana. However, these two countries are high income countries, and do not fit into our discussion. In addition to that, they are clearly linked to local production networks, Singapore to ASEAN and Hong Kong to China. Component exports from Singapore are predominantly for automotive assembly in Thailand and Indonesia (Houston et al. 2015, v).

The clear trend in the global automotive industry is one of regionalization, rather than one of full-fledged globalization. Proximity to final vehicle assembly is a key driver for most component manufacturing. Timmer et al. (2015, 585) show that regional value added (i.e. other European countries) in 2008 was higher than global value added as a share of total foreign value added in the automotive industries of European countries. Frigant and Zumpe (2017, 670) show that more than 90 per cent of German, French and Spanish auto-parts imports come from within the European production network (which includes North Africa and Turkey).

In order to acquire the technological capabilities needed to manufacture more sophisticated automotive components, the attraction of component manufacturing FDI is needed, which can usually only be attracted if vehicle assembly for the domestic market or a nearby large production system has become economically viable and assembly FDI has been attracted.

[7] UN Comtrade 2018, commodity 8708.

Hence, there is agreement in the literature that linking up to the automotive GVC without domestic assembly or without integration into a regional production system is limited to some simple components that are not exclusive to the automotive industry (Sturgeon and van Biesebroeck 2011, 190–91; Lejarraga et al. 2016, 23; Black et al. 2018, 16). One area where significant globalization has occurred is in electronics and telematics but driven by countries from East Asia that are already firmly on the catch-up ladder. Suggesting that e.g. African countries can just link up to the automotive GVC without having their own domestic industry is unreasonable. Hence, our discussion focuses on building a local automotive industry, and achieving international competitiveness and localization within that.

Local governments have historically been very interested in using automotive production to localize more parts of the value chain and to derive benefits for their domestic economies. The local political pressure is higher than in other industries because of the high visibility of the automotive industry and the emotional attachment to it by the local populous (Sturgeon and Biesebroeck 2011, 183). The rationale for countries to try building up a local automotive industry has historically been centred around objectives of employment, creating technological capability spillovers into local industry, and saving foreign exchange (Humphrey and Oeter, 2000: 44). In addition to that, the automotive industry has extensive linkage potential. Automotive component manufacturing, due to the variety of different types of components, has backward linkages to petrochemicals (polymers), steel, aluminium, copper, rubber, textiles, as well as important vertical linkages to the machinery and tooling sector. There are also significant horizontal linkages to other manufacturing sectors, like electronics, shipbuilding, and aerospace.

The focus of this paper is on the automotive industry itself, comprising vehicle assembly and component manufacturing, and not on linkages to other sectors. While the latter is a very important issue to address, it would go beyond the scope of the paper. This paper specifically looks at how different developing countries have managed to build local automotive industries, and how countries differ in terms of how much of the production is localized in the country, and in which types of components. One key thrust throughout the paper is that local content will be distinguished by local content produced by local subsidiaries of multinational companies (MNCs) versus local content produced by locally owned firms. Whitfield et al. (2021: 5–8) discuss in more detail why local ownership must be a key concern when thinking about catch-up industrialization. Other literature specifically discussing the automotive industry also emphasizes the importance of local ownership (Ibusuki et al., 2012: 180; Lee et al., 2021). Locally owned firms view the nation as the home base. Both their success and failure hinges on the development of the national industry. They have usually more significant linkages with the rest of the domestic economy. All of this justifies the focus on local ownership that is kept throughout the paper.

The paper proceeds as follows. The next section provides an overview of the structure of the automotive GVC and how the global dispersion of automotive production plays out. The section emphasizes three key phenomena that drive the automotive GVC, namely modularity, follow design & follow sourcing, as well as just-in-time and just-in-sequence supply. In section

3, I take a deeper look at how different developing countries perform on quantitative indicators of automotive GVC participation. The discussion of the different indicators and their limitations will illustrate the need for a sophisticated analytical framework that goes beyond the superficiality of the quantitative indicators to understand differential performance across countries. This framework is provided in Section 4. An in-depth discussion of the particularities of the automotive GVC and the (industrial) policy tools at the disposal of the emerging economies is needed to understand the conditions in which emerging economies and developing countries are engaging with the automotive GVC, and what they can do to maximize the benefits from that engagement for their economic development. I derive a success-failure spectrum of participation in the automotive GVC and show how the interaction of automotive GVC factors and the industrial policies employed by the countries provides a powerful analytical framework for explaining differential performance. Based on this, in the last section, I go through individual country case studies using the framework to explain their performance. Section 6 concludes.

2. The automotive GVC: Basic points

This section introduces some basic points that characterize the automotive global value chain (GVC). A brief discussion of the value chain's tiered structure is followed by the introduction of three important themes that are essential to an understanding of the dynamics of the value chain: 1) modularity, 2) follow design and follow sourcing, and 3) just-in-time and just-in-sequence supply.

A modern automobile consists of 10,000s of different parts. In the past, the vehicle makers conducted most steps of the production process of the automobile in-house. The raw materials entered the assembly plant on one side, and the car would come out on the other side. This has changed significantly. The production of automobiles has disintegrated into a long geographically dispersed value chain with a large set of different actors involved. While the vehicle makers (from hereon called OEMs) usually produce their own body panels, and often engines and transmissions, they tend to outsource most other components to supplier companies, the so-called component manufacturers (Henry, 2017). Table 1 provides an overview of the different components of a modern automobile, categorized by the different vehicle areas. There are also some cross-cutting components like bearings, bushes, and screws.

Table 1: Component classification according to IHS Markit, AutoTechInsight.

Vehicle Area	**Main components**
Chassis	Axle, brake parts, suspension, tires & wheels
Connected Car	Telematics, acoustics, loudspeakers, navigation
E/E & Semiconductor	Battery, alternators, actuators, cables, wiring, connectors, ECU, electric motors, sensors, switches
Interior Comfort & Passive Safety	Cockpit, door parts, seating, interior trim, textiles
Lighting	Interior & exterior lighting
Materials & Lightweighting	Body, bumpers, door frames, fasteners, gaskets, seals, adhesives, metal parts, sheet metal, glass parts, pressed/stamped parts
Powertrain	Engine parts, transmission parts, drive shaft, differential, clutch, exhaust parts, filters, fuel tank
Thermal Management	HVAC, heat exchanger, engine cooling, hoses/pipes
User Interface and Experience	Displays, instrument cluster, exterior mirrors
Autonomous Driving	Cruise control, cameras, park assist system, sensors
E-Mobility	Battery system, power electronics, e-motor

The automotive GVC operates along a tiered structure. The tier-1 suppliers supply directly to the OEM, while the tier-2 suppliers supply to the tier-1 suppliers, and so forth. The major tier-1 suppliers supply entire systems or modules that consist of many different sub-assembled components to the OEMs. One example for a system is the cockpit which consists of different modules like the steering, the instrument panel and different telematics elements such as navigation, which themselves consist of smaller components. The seating system is another example. The tier-1 supplier will either deliver the entire sub-assembled system or sub-assembled modules of the system to the OEM. When tier-1 suppliers deliver the entire system, they are sometimes called tier-0.5 suppliers or systems integrators (Dicken 2015, 491). Whether the OEMs themselves or tier-1 suppliers sub-assemble the system varies by type of system and by OEM. As mentioned above, the OEMs will often produce most of the powertrain (engine and transmission) in-house. In the case of seating, for example, it varies. BMW, Mercedes-Benz and Volkswagen still make around one third of their own seats, while the US and the Japanese OEMs have mostly outsourced it (Henry, 2017).

The same dynamic applies at the lower tiers of the supply chain. While tier-1 seat suppliers tend to make most of their frames themselves, several other components of the seating system, such as motors, heaters, airbags, and simple plastic trim are often outsourced to lower tier suppliers. The lower tiers of the supply chain, i.e. the tier-2 and tier-n suppliers, usually do not interact with the OEMs. These tiers of the supply chain are governed by the tier-1 suppliers. However, the OEMs also nominate suppliers and components to their tier-1 suppliers. This phenomenon is called "directed parts" (Helbig et al., 2018) and it means that the tier-1 suppliers have to source from OEM-nominated sub-suppliers. This usually happens to reap economies of scale along the supply chain and to ensure quality and performance consistency. An OEM does not want bearings or raw materials, such as plastic resin, to be sourced from 20 different suppliers, for the same vehicle.

Modularity

One important theme to keep in mind when discussing developments around the automotive GVC is the issue of modularity. The OEMs face an important dilemma. One the one hand, they are trying to cater to the customer need for product distinctness and individuality, but on the other hand they must generate economies of scale along the supply chain. To best deal with this dilemma, the OEMs have developed a modular production system. The objective is to produce many different car models that look very different on the surface but share many common components underneath the surface. The way this is done is through the use of common vehicle platforms, even for different brands (such as Skoda, Seat, Audi and VW in the case of Volkswagen Group). The modules that are often the same across different vehicle models are the floor, the engine, the gearbox, and the drivetrain, as well as the axles. In the traditional platform strategy, these modules form the platform. Differentiation that is visible to the customer then occurs via the body and the interior (Bratzel et al. 2015, 67). The platform strategy has been refined by automakers in different ways. The objective is to achieve further modularity beyond the platform, while not compromising product variety and distinctiveness for customers. Many automakers today have modular product portfolios that go beyond the engine, gearbox, and the drive train, and include air conditioning, the dashboard, seats, and drive assistance systems (ibid, 68).

There are limits to modularity in the production of automobiles because the components of an automobile are extremely interdependent, and this interdependence operates across module boundaries. In order to design a coherent safety system, for example, the characteristics of the engine and the chassis have to be aligned with the design of the brakes and the seat belts to achieve optimal safety performance in the event of a frontal crash (Zirpoli and Becker, 2011: 33). It is insufficient to design these components and even modules separately. Their design has to be coordinated. This is only one example of many (see also Cabigiosu et al. 2013) and explains why increasing modularity in the automotive GVC has gone hand in hand with more coordination between OEMs and suppliers rather than less, as has been the case in the electronics GVC (MacDuffie, 2013; Zirpoli and Becker, 2011). Ford, in the early 2000s, divided its vehicle into 19 modules, and tried to outsource each module to a different supplier. It did not coordinate the definition of the 19 modules with its suppliers, nor did it encourage design collaboration across module boundaries. It is no surprise that this endeavor failed (MacDuffie 2013). The rise of modularity, despite its limits, has happened across different OEMs (Waltl and Wildemann, 2014). This has necessitated a centralization and standardization of the design process between the OEMs and a limited number of tier-1 suppliers.

Follow design and follow sourcing

This centralization of the design process is related to two other phenomena that drive strategies and processes in the automotive GVC: follow design and follow sourcing. One part of the modularization strategy is to develop global vehicle platforms, meaning that the same, or only slightly modified vehicle models are sold across the globe. The vehicle models are designed in collaboration between the OEMs and the most important tier-1 suppliers in the headquarter countries of the OEMs and then rolled out across the globe. This is called ‘follow design’. This

development has been furthered by a change in the demands of local customers in emerging markets. In times of globalization, in which information from other countries is easily available and tastes are normalized across markets, local customers have become less interested in outdated vehicle models, even at low prices (Sugiyama and Fujimoto, 2000: 181).

In the same context, OEMs usually demand that tier-1 suppliers – their design partners – follow them into other world regions in order to facilitate this design collaboration – a phenomenon called 'follow sourcing'. Follow design and follow sourcing are not new phenomena. They have been around for the last three decades (Humphrey and Salerno, 2000). But they have become the norm and have a huge impact on how the automotive GVC is governed, mainly through their impact on the sourcing activities of the lead firms, i.e. the OEMs and the tier-1 suppliers. Humphrey and Salerno describe how OEMs used to design specific vehicle models for different end markets, which entailed good chances for locally owned component suppliers in emerging markets to win contacts with the OEMs. Follow design and follow sourcing have displaced this modus operandi and significantly worsened the situation for locally owned suppliers. This will be discussed in more detail below.

Just-in-time (JIT) and just-in-sequence (JIS) production

Design collaboration is not the only reason for follow sourcing. Follow sourcing is also encouraged by the OEMs because of the requirements around just-in-time (JIT) and just-in-sequence (JIS) production. JIT supply means that products of the right quantity and quality are delivered to the final assembly plant at the right time, as specified by the OEM to the suppliers. JIS delivery goes beyond JIT and means that modules and components are not only delivered just-in-time, but also just-in-sequence, i.e. sequenced for consumption at the final assembly plant according to the OEM's production schedule.

While modularity means that final vehicles share a lot of common modules, the customers' desire for product distinctness means that the parts of the vehicle that are most visible to the customer vary a lot from vehicle to vehicle. Almost no vehicle sold is exactly the same as another one. Wagner and Silveira-Camargos (2011) document that there are 80 different bumper variants in a modern BWM 3-series, about 24 different paint and interior combinations in a Toyota Corolla, and more than 1000 seat types in a Vauxhall Astra (5713). On average, 40 per cent of parts in a car are sourced just-in-sequence. JIS has significantly increased in importance since the 1990s (ibid, 5714). Pure JIT delivery without JIS only happens for standard modules with a low number of variants (ibid, 5716). Without JIS supply, OEMs or their suppliers would have to hold enormous inventory levels of different variants of components, which would render their operations uncompetitive (Bennett and Klug, 2012: 1292).

JIS supply and follow sourcing are related, since JIS requires close collaboration between the OEM and the tier-1 suppliers of modules with a large number of variants. On the supplier side, this collaboration requires high standards for the entire production process, especially in terms of logistics, quality and monitoring, as well as communication and IT systems integration

(Wagner and Silveira-Camargos, 2011). Delivering modules JIS requires very high investment, as well as production process capabilities. Because of all this, OEMs prefer to collaborate with their established tier-1 suppliers, hence follow sourcing.

Some broader trends over time

The interrelated phenomena of modularity, follow design/sourcing, and JIS supply have led to a situation in which it is much more difficult for locally owned component manufacturers in emerging markets to operate as tier-1 suppliers to the OEMs. Local suppliers will not become tier-1 system/module suppliers unless they are globally competitive. It is all or nothing: acquiring the capabilities and making huge investments to supply the OEMs in all their global locations, i.e. being the system/module supplier for one or more of their global platforms, or being confined to the lower tiers of the supply chain.

The situation was very different in the 1960s and 1970s, when OEMs used to build local supplier networks in emerging markets and sourced components through so-called 'built-to-print' arm's-length contracts from local component manufacturers. This system has been replaced by the described follow design and follow sourcing system, which locally owned suppliers rarely break into, at least at the tier-1 level (Humphrey and Salerno, 2000: 157–8). This has led several scholars of the global automotive industry to conclude that it is no longer possible or at least much more difficult to create and sustain locally owned competitive tier-1 supplier companies in developing countries (Havas, 2000: 258; Humphrey and Salerno, 2000; Pavlínek and Žížalová, 2014). Some have even proclaimed the "death" of the locally owned tier-1 component manufacturer (Barnes and Kaplinsky, 2000). Only one firm in the global top 100 suppliers by revenue is not from Western Europe, Japan, China, the US and Canada (Mexico's Nemak at rank 65).[8]

It is certainly true that the chances for locally owned component suppliers are rather slim at the tier-1 level. The OEMs prefer to work with their established tier-1 suppliers because of their high technological and design capabilities. This observation is supported by evidence from several studies on different emerging markets (Ivarsson and Alvstam, 2005; Kumaraswamy et al., 2012; Saranga et al., 2019). When OEMs conduct a new investment or expand an existing investment in a developing country, they demand their multinational tier-1 suppliers to locate close to their final assembly plant, usually in a so-called supplier park that will be located less than 10 kilometers from the assembly plant. The supplier park model has become the "most widely followed integration type" in the industry since the 1990s (Bennett and Klug, 2012: 1296). Sometimes, module suppliers even reside and assemble their modules under the same assembly shop roof as the OEMs. This mode of OEM-supplier integration is called "condominium" (ibid, 1295). But this is less common than the supplier park model.

Nevertheless, there are exceptions to the global trend of follow design and follow sourcing. Section 4 will discuss in detail under which conditions follow design and follow sourcing are less likely and how government industrial policy can tilt the conditions in favour of local

[8] Data for 2019 from Berylls Strategy Advisors (2020).

component manufacturers, local design, and higher shares of local content. For this section, it shall suffice to make some broad points that indicate that follow sourcing is "far from universal" (Humphrey and Salerno, 2000: 166) and that opportunities for local actors remain. In general, the lower the tier level, the higher the probability that a domestic manufacturer will be the preferred supplier, given that collaboration between the assembler and the supplier is less close and co-dependent and technical requirements are less demanding at the tier-2 or tier-3 level (Lejarraga et al., 2016: 29). It then becomes relevant to which extent government policy protects local firms from competition through imports. Local firms will usually not be able to compete against established manufacturers from the developed countries without some extent of protection.

In addition to that, it is important to note that the basic tendency of global vehicle platforms and designs, meaning that the same vehicle model is sold in developed and developing country markets alike needs some qualification. Countries with large markets still have much potential for local design or at least a significant extent of local design adaptations. Niche markets for low-end entry-level vehicle models with special adaptations to local circumstances can still generate the economies of scale that justify local design efforts when the overall market is large. Ibusuki et al. (2012: 193) argue that the tendencies towards the 'global car' with R&D and product development being located almost exclusively in the OEMs' headquarter locations has reached its peak in the early 2000s. Now there seems to be more design localization again, e.g. in the case of Brazil (ibid). There are many examples of vehicle models specifically designed for emerging market customers, such as the Renault Kwid and the Dacia Logan.

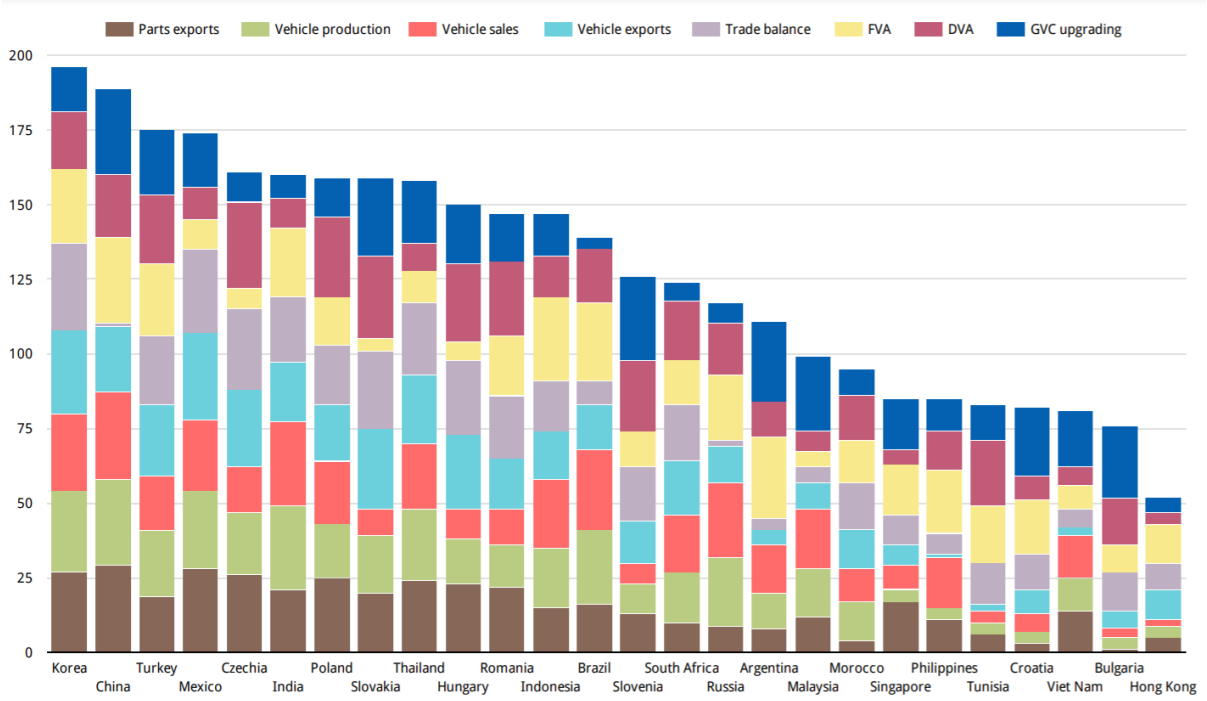
This section has introduced and described some general developments and tendencies in the global automotive industry. While follow design and follow sourcing, driven by modularity and JIT/JIS supply, are the norm, there is no reason for despair. There is still room for local firms to participate in the automotive GVC and to upgrade, as evidenced by the divergent performance of different countries with respect to their participation in the automotive GVC, which will be discussed next.

3. First look at country experiences through quantitative indicators

As discussed in the introduction, participation in the automotive GVC is common in developing and emerging countries. There are a number of quantitative indicators available to compare how different countries have fared in this endeavor. Figure 1 displays the comparative performance of 26 developing and emerging countries that participate in the automotive GVC along different quantitative indicators. These indicators are automotive parts exports, vehicle production, domestic vehicle sales, vehicle exports, the trade balance of parts and vehicles, foreign value added in domestic automotive exports (FVA), domestic value added in other countries' automotive exports (DVA), and the change of the ratio DVA/FVA between 2005 and 2015, i.e. GVC upgrading. The figure includes all non-traditional automotive countries out of the top 50 global automotive parts exporters, except for UAE, Serbia and Belarus, for which

the FVA and DVA is not available.[9] I ranked the 26 countries for all eight indicators, and the visualization displays the inverse of each ranking in a column (e.g. China ranks first in auto parts exports and therefore received a value of 26 displayed in the brown part of its overall column), cumulatively for all eight indicators.[10]

Figure 1: The performance of developing and emerging countries in the auto GVC



Author's own compilation. For detailed data and data sources, see Appendix.

These indicators have to be looked at in combination. Looking at them in isolation can yield wrong conclusions. Automotive parts exports and vehicle exports indicate international competitiveness of a country's automotive industry. The number of domestic vehicle sales indicates whether there is a domestic market for vehicles, and hence sufficient purchasing power. Domestic vehicle production indicates whether vehicle assembly FDI has successfully been attracted. If domestic sales are high, but production is low, then assembly FDI has apparently not been attracted, despite potential. When production is high, but domestic sales are low, this is an indicator that the country is a vehicle export hub, like e.g. Slovakia, Czech Republic, Hungary, and Romania are in Europe. Another important indicator beyond exports is the trade balance of automotive parts and vehicles. When the trade balance is negative, this is an indication that the local industry is not very strong. Especially when there is a high number of domestic vehicle sales, but low export numbers for vehicles and parts. For FVA in domestic

[9] Non-traditional automotive countries include all countries except for the US, Canada, all Western European countries, Japan and Australia.

[10] The illustration is imperfect in that it does not display actual differences per indicator between countries. The green column for China's vehicle production, for example, is only marginally larger than India's, since China is ranked first, and India is ranked second. But China produces five times more vehicles than India. Nevertheless, the graph allows us to understand qualitative differences between countries' automotive industries, especially when comparing countries that are ranked next to each other.

automotive exports, the reasoning is mainly that the lower this number is, the better, since a low number means higher local content. But initially, increasing FVA can also be a good thing, as FVA will increase when a country attracts FDI. For DVA in other country's automotive exports and the DVA/FVA ratio over time, the reasoning is that the higher the numbers, the better the country is performing.

Need for qualitative analysis to understand differential performance

While the above quantitative indicators can provide interesting insights, they do not tell us much about the reasons behind and the qualitative characteristics of differential performance. In addition to that, they only provide partial insights on the variables that interest us based on the theoretical vantage points discussed in the introduction. Ivarsson and Alvstam (2005: 1328) also emphasize that there is a need to distinguish between local firms and follow-source multinational suppliers when analyzing the situation of a country's automotive industry. The OECD TiVA database, from which the FVA and DVA indicators are derived does not say anything about ownership of the value added. The data from the OECD TiVA database – and the same goes for the WIOD database – is constructed "on the basis of the location principle rather than the ownership principle" (Timmer et al., 2015: 589). The same indicators are also focused on exports only, hence they do not provide information on domestic value added in domestically sold vehicles and components.

We also do not learn anything about the qualitative nature of domestic value added from these indicators. In which automotive components do locally owned firms specialize? What are their technological capabilities? And what are the spillover and linkage effects of the components that locally owned firms, and even multinational firms specialize in? For this kind of information, and also for an attempt to explain differential performance across countries, it is necessary to look at the case study empirical work on different countries. We will do this in depth below. Incontrovertibly, the quantitative data is essential to complement the qualitative data. But without the latter, any attempt to explain differential performance in such a complex industry as the automotive industry will remain superficial.

4. Analytical framework for understanding differential performance across countries

In order to estimate and compare the contribution that having a domestic automotive industry makes to a country's economic development, it is important to identify key performance indicators. These are based on the theoretical considerations about economic development discussed in the introduction. Ideally, a country would want to see the emergence of a large number of locally owned component manufacturing firms which employ a lot of people, accumulate technological capabilities and are capable of exporting to the global market in order to achieve economies of scale and to operate at the technological frontier. The level of local content in the industry should be high, with significant backward and forward linkages to other domestic industries. Over time, one would want to see upgrading of the firms and an increase in the level of technological sophistication and of the product complexity of the components produced. Looking beyond component manufacturing, one would want to witness the

emergence of indigenous vehicle assemblers, which first capture a significant share of the domestic market and then go on to penetrate the global auto market through exports and outward FDI.

Especially with respect to the last point, one risks drifting into a dream land detached from reality. In an industry dominated by carmakers from the advanced countries, it is extremely difficult for local assemblers to break into this phalanx of established lead firms. South Korea and increasingly China are the only countries that have seen the emergence of domestic assemblers that are globally competitive, as will be discussed in detail below. For the rest of the countries, in order to compare differential performance, the focus will be on the domestic component manufacturing base. Indicators of interest are the number of indigenous component manufacturing firms, their tier level, their technological capabilities, and the type and complexity of their product offerings. The component exports of those firms and the product complexity of their exports are also of interest, as well as their firm-level upgrading over time with respect to their functions, capabilities and product complexity. Beyond the component manufacturing industry, the backward and forward linkages of the automotive industry to the rest of the economy are of profound interest to gauge the industry's contribution to the country's economic development. The last point, however, is outside the scope of this paper as mentioned in the introduction.

The discussion in the introduction has made the point that it is very important to look at domestically owned firms in particular. This does not mean that multinational firms with subsidiaries in the country are irrelevant. They are important conduits for bringing production volumes, technology, and spillover and linkage potential to the country. They usually arrive together with OEM investments and it is an important task for governments to attract and facilitate these investments, without which there would be nothing for local actors to link up to. When it comes to estimating the industry's contribution to a country's economic development, however, it is important to put a special focus on locally owned firms. If they are not pulled along with increasing activity of multinational firms, the contribution to economic development remains subpar.

In summary, countries with automotive industries can be compared on whether an internationally competitive automotive industry with a deep domestic supply chain with high local content, local ownership and technological sophistication has emerged or not. Table 2 shows how different developing/emerging countries that have seen the emergence of a domestic automotive industry over the last two to five decades, or in the cases of the last category, attempted through significant government intervention to build up such an industry, have performed on these comparative criteria. The information for the ranking has been obtained by going through the available literature on individual and comparative country case studies, applying the analytical framework that is explained now.

Table 2: Performance spectrum of developing countries with automotive industries

Category	Countries	Description
Very successful case	South Korea	Fully domestically integrated industry; globally competitive national OEM.
Relatively successful cases with large production and export volumes and significant localization	China; India	Large domestic market-based industry development; globally relevant national OEMs.
	Thailand; Turkey	Regional integration (ASEAN/EU) and significant domestic market.
Intermediate cases with large production and/or exports, but limited true localization	Brazil	Inward-looking + Mercosur. Significant domestic value added, but MNC dominated.
	Mexico; Central & Eastern Europe	Peripheral integration into regional production network.
Intermediate cases with limited international competitiveness and/or weak local firm base	Malaysia; Indonesia	National car strategies. Limited international competitiveness.
	Philippines; Vietnam; Argentina; South Africa; Morocco	Significant local industries (vehicles and/or components) exist, but exports are far below Thailand, Turkey or Mexico. Limited localization.
Cases of failure	Colombia; Pakistan; Egypt; Nigeria	Failure to attract FDI and kick-start the industry.

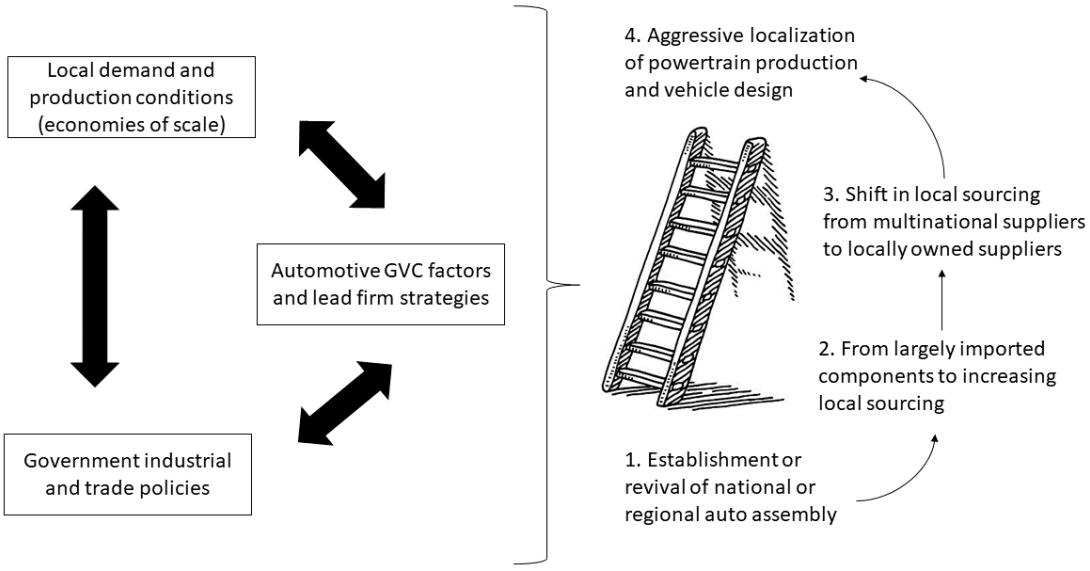
Summary of the analytical framework

Before jumping into the country case study literature in detail in Section 5, the analytical framework that helps us understand differential performance across countries needs to be presented. We have seen above that looking at the quantitative indicators alone is insufficient to explain differential performance. The analytical framework is based on the reading of the literature on the automotive GVC, as well as the country case literature. The framework has been developed in an iterative fashion while going through the literature. The basic point, as illustrated by the graphic on the left hand side of Figure 2, is that the automotive industry and thereby the extent of localization of the value chain in a country is driven by the interaction of three sets of factors: 1) Local demand and production conditions related to economies of scale, 2) automotive GVC factors and lead firm strategies, and 3) the industrial and trade policies implemented by the government. These three sets of factors interact and create different outcomes across countries. They are inspired by similar sets of factors proposed by Humphrey et al. (2000: 13) for a large research project comparing automotive industries across several emerging economies.

Of course, outcomes are shaped over long periods of time and not overnight. I propose a ladder of industry-level upgrading across four steps, as illustrated in Figure 2: 1) the establishment or

revival of national or regional auto assembly, 2) the move from largely imported components to increasing local sourcing, 3) the shift in local sourcing from multinational suppliers (follow sourcing) to locally owned suppliers, and 4) the aggressive localization of the production of the key vehicle area, the powertrain, and vehicle design, which locks in local content at high levels. Not every country will experience industry-level upgrading exactly along those lines. Some countries may start by inviting assemblers and multinational component suppliers to cater for the domestic market almost without any conditions, as many Latin American countries did under import-substitution industrialization, whereas other countries like India and China have historically been more cautious and more protective with respect to FDI (Schwartz, 2010). Hence, one might argue that countries that have experienced excessive levels of follow sourcing before establishing a national component manufacturing base might never be able to reverse it and hence step 3 on the ladder proposed above does not really occur this way. Nevertheless, we have seen above that follow sourcing and the dominance of multinational suppliers at the tier-1 level are a fact, and the ladder can still serve as a tool to locate countries on it and compare them. How one gets to the different steps on the ladder varies a lot across countries, as we will see below. There are many roads that lead to Rome.

Figure 2: Factors and outcomes shaping a national automotive industry



Source: Author's own compilation, inspired by Humphrey et al. (2000).

The first step on the ladder is the establishment or revival of national vehicle assembly. If production is for the local market, local assembly will replace the previous importation of completely-built-up (CBU) vehicles. To which extent local assembly will lead to domestic component production depends on the production volumes of the assembly activity. Integrated production can usually begin at production volumes of 50,000 vehicles per year. Below such levels of production volumes, it is not economically viable to conduct the high investments into machinery and tooling that are required for integrated vehicle production. OEMs can still produce vehicles locally through semi-knock-down (SKD) or complete-knock-down (CKD) production models. This just means that component kits are collected from assembly plants in

other countries and shipped to the SKD/CKD plant where they are just assembled. No or only limited manufacturing occurs locally. Such SKD/CKD plants require much less investment, are more labour intensive, and are already viable at production volumes of a few 1,000 units per year (Sturgeon et al., 2016: 6). SKD plants are usually the predecessor of CKD plants, as they require even less local assembly than CKD. Hence, the development spectrum goes from CBU imports to SKD assembly to CKD assembly to integrated vehicle production, depending on the local production volume, and with increasing opportunities for local component manufacturing.

Once integrated vehicle production has been established in the country or exists in a neighbouring country that the country can link up to, more focus can be shifted towards the local component industry. Here, the issue of local content is a complicated one. It is difficult to measure. Some OEMs report all components bought locally as local content. But the purchased components can still contain a significant share of imported sub-components. Other OEMs look at the local value added at the vehicle and the component level, i.e. what is the true value added in the country, excluding all imported content. And lastly, one can distinguish between local value added, added by multinational subsidiary companies as distinct of true local value added, added by locally owned companies.[11]

Whether or not localization of the supply chain occurs depends on the sets of factors introduced above. The following section will discuss in detail how the different factors that underpin the analytical framework drive the extent of true local content, added by locally owned component manufacturers. To which extent follow design and follow sourcing occur are key drivers of this outcome. The nuanced factors, both GVC and lead firm driven as well as policy driven, and their interaction are discussed below. The following sub-section discusses the overriding importance of economies of scale in the automotive industry, while the two subsequent sub-sections discuss the relevant automotive GVC factors and policy-related factors and how they interact to determine the extent of localization of the automotive supply chain.

The overriding importance of economies of scale

The automotive industry is a capital-intensive industry that is driven predominantly by economies of scale. They determine whether it makes sense to establish vehicle production in a location at all, and what kind of facility (SKD/CKD/integrated) will be established. Economies of scale are also the key influencing factor when it comes to lead firms' decisions around design localization and the localization of sourcing. When there is a large enough local market for locally designed or locally adapted vehicle models, the OEMs will be willing to undertake the significant investments and risks associated with design localization. Domański and Gwosdz (2009: 469), for example, report that when the Polish subsidiaries of the OEMs began to play an increasingly more important role in the OEMs' overall production portfolios, there was a commercial rationale for beginning R&D operations in Poland.

[11] Source: Interviews with different OEMs in early 2021.

Economies of scale are also the major driver behind the rationale for or against local component production. Component manufacturers will only invest in the required machinery and tooling if production volumes are sufficient to pay for it (Hassler, 2011: 432).[12] This goes both for MNC suppliers as well as local companies. MNC suppliers have many facilities across the globe, hence a new facility in another country always means investment in double tooling (Sugiyama and Fujimoto, 2000: 180). Whether they are willing to undertake this investment depends on the expected local production volumes. Locally owned component manufacturers are usually homebound, meaning they are targeting solely the domestic industry, at least in the beginning. They have to compete against MNCs that are globally competitive and can generate economies of scale through production for different markets. Local firms' only source of economies of scale will usually be domestic vehicle and component production, and their ability to invest in technology and equipment depends on that.[13]

While the demand conditions of the home market matter a lot with respect to the localization of design, the localization of sourcing depends simply on scale, independent of the end market. Once local firms have, for whatever reasons (and often, of course, it will be because local demand conditions have attracted a domestic automotive industry to be established in the first place), managed to enter OEM supply chains, it does not matter whether components and vehicles are produced for the domestic market or for export markets. Hassler (2009: 2237), for example, observed for the case of Thailand that the OEMs that only serve the domestic Thai end market have much fewer local supplier ties than the OEMs with large export production volumes. It is economies of scale that matter, not so much the target market.[14]

Lastly, domestic market size and the associated economies of scale are the source of state bargaining power, which is essential for implementing developmental industrial policy. This is a key point that will be discussed further below. Liu and Dicken (2006: 1231) emphasize the bargaining power that the Chinese government enjoyed when negotiating with OEMs, based on the enormous Chinese market, which was increasingly seen as a "must-invest" destination for global OEMs. The Chinese government was able to enforce entry restrictions, model rationalization, local content requirements (LCRs), and technology transfer because of this bargaining power. Liu and Dicken observe, that in general the state has more bargaining power when FDI is market-seeking rather than efficiency-seeking.

Auto GVC factors that influence localization

Having established the importance of economies of scale as an overriding factor driving localization prospects for automotive industries of developing countries, we can now have a closer look at the complex web of factors related to the workings of the automotive GVC that

[12] This point was also raised repeatedly in my interviews with OEM subsidiaries, multinational and local suppliers in South Africa.
[13] Local firms cannot simply export to international OEMs. The first step is linking up to a domestic or at least regional OEM's supply chain and then, when they perform really well, they might be able to cater for the OEM's other activities in other markets, also mainly depending on the component they are supplying.
[14] This point was also strongly echoed in an interview I conducted in early 2021 by the Managing Director of the South African subsidiary of an OEM.

impact on localization. Section 2 has already introduced some of the key themes driving governance in the automotive GVC, namely modularity, follow design and follow sourcing, as well as JIT/JIS supply.

In this sub-section, I will discuss literature that shows that the extent of local design adaptation is positively related with local content. The extent of local design is mainly driven by local demand, but also by a set of other sub-factors. The extent of the localization of sourcing depends on production cost factors, such as labor costs, local energy costs, as well as importantly on transport and freight costs. Currency risks also play an important role favouring localization. Follow sourcing signals commitment to the OEM and is often required from tier-1 suppliers as a precondition for being considered as a supplier at the tier-1 level for global vehicle platforms. As mentioned above, tier-1 MNC supplier follow sourcing has made life more difficult for locally owned suppliers, but it is a reality that local governments and firms must work with. Facilitating MNC investment is a precondition for the local automotive industry to stay alive. Without OEM and tier-1 MNC investment, the local industry will be cut off from global markets and the technological frontier and remain uncompetitive. Nevertheless, the local government should bargain hard to improve the conditions for local actors, as discussed in the next sub-section. Since MNC investment and follow sourcing are necessary, we will also discuss how component manufacturing MNCs' investment and localization decisions differ from those of OEMs. Lastly, there will be an extensive discussion of how the different factors discussed depend critically on the type of vehicle component under discussion.

Historically, the origin of the individual OEM mattered more than it does today. Sourcing patterns have converged significantly over the last three decades (Schmitt and Van Biesebroeck, 2020: 15). Other factors are more important for the global sourcing practices and the local subsidiaries' localization activities. Toyota's subsidiary in Brazil, for example, has undertaken limited efforts regarding the localization of its supply chain, which is mainly due to the fact that it is a relatively recent entrant into the Brazilian market and has trouble acquiring sufficient market share from the incumbents to justify more localization (Ibusuki et al., 2012). Toyota's subsidiary in South Africa, in contrast, has undertaken significant localization efforts and has among the highest local content levels of the PV and LCV OEMs locally present.[15]

Design localization

As discussed above, the automotive OEMs work with global vehicle platforms and usually employ follow design when entering new markets. Vehicle platforms require a huge development effort and investment, since they include the basic parts, such as the chassis, the body, and the powertrain. This huge investment is the reason why OEMs try to minimize the number of platforms they use. There is always a global standardization versus local adaptation trade-off at work that OEMs have to balance when operating in emerging markets (Sugiyama and Fujimoto, 2000: 176). Vehicle platforms specifically for emerging markets are only developed when the market is large enough. But there are several intermediate stages between

[15] Research interviews with NAAMSA (the South African automotive assemblers' association) and the Purchasing Manager of Toyota SA in early 2021.

the introduction of an unchanged global vehicle model and the design of a unique vehicle model for a particular market. OEMs can develop "tropicalized" derivatives of their global platforms specifically adapted to local conditions, including domestic market features and regulations (Ibusuki et al., 2012: 175–6). Such adaptations can be in response to local climatic conditions, road conditions, or local fuel specifications (ibid). Humphrey and Salerno (2000: 163–4) describe how OEMs in Brazil and India adapted their global vehicle models according to local customer preferences (the widespread use of chauffeurs in India and hence the need for electrical windows in the back where the owner sits, even in small cars), and to local road and usage conditions (e.g. chassis reinforcement, more powerful engine, modified suspension system). The re-design of overspecifications of the global model to reduce costs (e.g. local rules on pollution etc. are less stringent and hence, a less complex exhaust system is required) is also a common element of local design adaptation (ibid).

Why do we care about the extent of design localization? Because empirical evidence shows that local design is positively related with local content. Ivarsson and Alvstam (2005: 1331) show, even though their study is on the heavy commercial vehicle sector, i.e. buses and trucks, that local content in Brazil, China, India and Mexico is higher for those OEMs and models that are the based on local design. In the case of Mexico, the difference is more than 80 per cent local content for local design versus 50 per cent for non-local design. Brandt and Van Biesebroeck (2006) provide some insights on the causal channel at work in the relationship between design localization and local content, in their study of the Chinese automotive industry. When OEMs conduct what they call "aggressive localization" and build local design and engineering centers to design their vehicles locally, component manufacturers will also be more likely to conduct local design, and local design clusters will emerge. The chances for locally owned suppliers will also be better. Follow sourcing usually provides significant savings on homologations tests and tooling. The follow sourcing supplier will have the designs readily available because it has developed the component or module specifically for the OEM's vehicle platform. But if vehicles and components are designed locally, the advantages held by the follow sourcing platform supplier are lost (Humphrey and Salerno, 2000: 164–5). In addition to that, aggressive localization will also be more amenable to lead firms supporting domestic suppliers' learning efforts (Sturgeon and van Biesebroeck, 2011: 194), and OEMs will prefer local suppliers if they help them to adapt their products better and more quickly to the specificities of local demand (Ivarsson and Alvstam, 2005: 1327).

However, sometimes OEMs do not establish local design and product development facilities, even when they adapt the design of the locally introduced vehicle models. They often do the design modifications to local conditions at home in their headquarter design centres (Humphrey and Salerno, 2000: 164). The Japanese OEMs, for example, that developed country-specific vehicles for the Indonesian market, such as the Toyota Kijang, in the 1990s, mostly conducted the product development and desgin adaptations at home in Japan (Sugiyama and Fujimoto, 2000: 197). Again, design localization usually occurs along a spectrum. It is not a binary issue. Product development includes several different activities, such as product planning, designing, prototyping, testing, and process engineering. Each of these activities can be located in the destination country or at the OEM's established design centre (ibid, 182).

More recent observations on this topic show that car models sold in different continents are quire heterogeneous and are tailored to local preferences, standards and use constraints, which opens the door for local design and thereby for more aggressive localization of the supply chain (Frigant and Zumpe, 2014: 13–4). In my own research interviews with OEMs in South Africa, while it was emphasized that the local market is way too small for the introduction of specifically designed vehicles, local design adaptations still occur. One OEM has re-designed the air conditioning system for a vehicle model that mainly targets the South African market, in response to the different climatic conditions and consumer preferences in South Africa compared to the OEM's main market in Europe. There is no need for the type of highly automoted expensive air conditioning system that is used in the European market. This is an example of the re-design of an overspecification of the global model to reduce costs.

The Renault/Dacia Logan in Romania and the Renault Kwid in India are two examples of specifically designed vehicles for an emerging economy target market. When Renault invested in Romania in 2004, it started producing a vehicle designed for the domestic markets of Romania and other Eastern European countries. It used the same engine and transmission already developed for other Renault models, cut back on the electronics components, and added some local design for the vehicle's styling. Since most of its tier-1 suppliers did not relocate to Romania because they deemed the profit opportunities insufficient, Renault relied heavily on local suppliers. It acquired an old soviet-style industrial plant and implemented a labor-intensive mode of production with very limited automation, suitable to the local low wage costs. The Renault/Dacia Logan was a huge success. The platform has been extended to other affordable entry-level models, such as the Sandero, the Duster, the Lodgy and the Dokker. These five models are produced in ten different emerging market countries. Renault Technology Romania employs 2,300 engineers and technicians and takes the lead in the development of these models (Lung, 2017).

A similar case is the production of the Renault Kwid in India, which has achieved more than 90 per cent local content. The Kwid was designed specifically for the Indian market in 2015 but has since then also been produced in several other emerging market countries. Just like the Dacia Logan, the Renault Kwid is a small simple vehicle, designed as an entry-level vehicle for the rising middle classes in emerging markets. Other than the development of the Logan, most of the Kwid's product development happened locally in India. The Kwid has 98 per cent local content and 57 per cent true local content from indigenous locally owned suppliers (Barnes, 2018: 54; Midler et al., 2017: 52). Both these case studies, the Logan and the Kwid, demonstrate that aggressive localization of vehicle production in emerging markets does occur. However, we are also dealing with a chicken-or-egg problem here, since one of the main reasons for developing the Kwid in India was the presence of capable indigenous suppliers, whose origins are discussed in the country case study below, and a large niche for entry-level vehicles in the Indian market. Overall, it is important to keep in mind the relation between design localization and local content when trying to understand the localization prospects for automotive industries in developing countries.

Production cost factors

One key motivation for localizing the manufacture of vehicle components is to save on freight and transport costs and to reduce lead times. The purchasing manager of the South African subsidiary of a global OEM told me that imported components have a lead time of four to five months, which makes quick adjustments other than through very costly air freight, impossible.[16] Together with low local wage costs, competitive local energy costs, good local infrastructure, the provision of favourable conditions and benefits in special economic zones (SEZs) or export processing zones (EPZs), and the availability of raw materials, this can make local supply chains in developing countries cost saving. This is especially relevant when price-sensitive vehicle models, like small entry-level vehicles, e.g. for the local market in India (Kumaraswamy et al., 2012: 370), are concerned. The Purchasing Manager of the same South African OEM argued that the locally owned firms at the lower tiers in South Africa are extremely price-competitive because of their low overhead costs compared to the multinational component manufacturers. For the case of India, Barnes (2018) comes to the conclusion that the competitiveness of the Indian automotive industry critically hinges on the exploitation of low wage informal labour at the lower tiers of the supply chain.

In China and India, those OEMs that have developed a deeper local supply chain, have had more success than those that have not localized, as evidenced by the comparative failures of Daewoo and GM in India, as well as Peugeot-Citroen in China. The more successful OEMs that localized more benefitted from using low-cost manufacturing capabilities for production for the local market, but also for exports (Saranga et al., 2019: 11). Once OEMs, for whatever reason, have made the investment into a local supply chain and a local supplier base, they sometimes even use these local suppliers for their global production networks. This has been the case with domestic suppliers from India and China who can compete globally on cost, because of low labour costs compared to the advanced countries and comparatively high manufacturing capabilities (ibid, 5-6). This trend manifests itself in increasing component imports from emerging automotive industries in large developing countries into the advanced economies (Sturgeon and van Biesebroeck, 2011).

Exchange rate developments also frequently play a role in location decisions. The favourable development of the Thai currency, in conjunction with other important factors, as will be discussed in the country case study below, played a role in motivating pick-up truck manufacturers from Japan to relocate their global production activities to Thailand (Hassler, 2009: 2245). Other examples are the appreciation of the Japanese Yen in the 1980s that motivated Japanese OEMs to deepen their supply chains in India (Kumaraswamy et al., 2012: 372) and in the ASEAN-4 countries (Guiheux and Lecler, 2000: 216).

Different types of lead firms: OEM vs. MNC tier-1 localization decisions

The rationale for follow sourcing has already been discussed extensively above. It is not the purpose of this paper to investigate the power relationship between OEMs and large MNC tier-1 suppliers, which are often called mega-suppliers. It shall suffice to know that there is evidence

[16] Interview conducted in May 2021. Reiterated in another interview with a local supplier conducted in May 2021.

indicating that the power position of MNC tier-1 suppliers, at least of the module and system suppliers, has improved over the last two decades because of the consolidation at the tier-1 level, which has left the surviving firms in a more powerful position, as well as the assumption of important design responsibilities by the tier-1 suppliers (Dharmani et al., 2015; Durand and Milberg, 2020: 470). This might lead to a situation in which the tier-1 suppliers are able to resist the follow sourcing demands of the OEMs, which in turn can open the door for local suppliers, as in the case of the Dacia Logan in Romania. Nevertheless, it is still true that follow sourcing dominates. It signals commitment to the OEM and it is often a requirement for being considered as a platform supplier. During my interviews with component manufacturers in South Africa, it became clear that winning the tender for a tier-1 supply contract often depends on being able to supply the component/module in all the OEM's production locations on different continents. In the context of an exhaust system manufacturer this means that in order to keep their contract for the South African operations, they must open facilities in the OEM's other locations in Brazil and Thailand.

The decision process of whether a multinational tier-1 supplier wants to open a local production facility in a developing or emerging country is similar to that of the OEM. The production costs factors discussed above also apply. However, there are limits to how often suppliers want to set up plants in close proximity to every OEM assembly plant. The investment in extra tooling and equipment necessary is substantial and implies the loss of scale economies in other production locations (Ward, 2014). The multinational component supplier Mahle Group, for example, has 160 production plants globally, while Mercedes Benz Cars only has 15 global production plants.[17] The Mahle plants are much smaller, but the loss in scale economies is substantial. One option to avoid locating yet another facility close to the OEM is to hold a larger stock of inventory without establishing local production. Inventory is, however, very costly, and no workable solution in times when the number of variants of components is extremely high, as discussed above. Another option is to do final assembly close to the OEM plant, while keeping the original source of supply further away (Ward, 2014).

Again, as we have seen elsewhere, for example in the case of design localization, the issue is not a binary one. There is a spectrum of the extent of investment that a supplier can choose to undertake for a facility in a new location. The two extremes of the spectrum are not localizing at all versus establishing a full manufacturing operation with specialized and capital-intensive machinery, such as robotic welding machines for exhaust systems. Along the spectrum, they can opt for pre-assembly or late configuration of components, using more labour intensive production methods etc. (Bennett and Klug, 2012: 1288). They can also enter into an arrangement with a local company. In the case of South Africa, where production volumes are low, the multinational component suppliers are especially hesitant to relocate. But in order to get the global contract for an OEM platform, they must guarantee to supply the assembly plant in South Africa as well. One locally owned component manufacturer that I interviewed said that they have been approached by several multinational suppliers to become their local built-to-print supplier to the OEM, so that the MNCs themselves do not have to build a facility in

[17] Point raised by the Director of Global Strategy, Mahle Group, in an interview in April 2021.

South Africa.[18] The decision by the MNC supplier on whether to relocate or not and on which type of investment to undertake will often depend on the type of component under discussion, an issue that we are turning to now.

The type of component is crucial

The different factors discussed so far as having an impact on the localization decisions by OEMs and tier-1 suppliers are all affected by the type of component under discussion. As mentioned above, a motor vehicle consists of 10,000s of different parts that belong to vastly different vehicle areas (see Table 1 above). A wiring harness has little in common with an engine filter. I will still try to categorize the different types of components and their impact on localization factors and decisions somewhat in this section.

Analyzing large datasets of OEM vehicle models and component suppliers, Schmitt and Van Biesebroeck (2017) show that there is a significant correlation between the type of assembler-supplier relationship (arm's length sourcing, modular governance, relational governance, hierarchy/in-house) and the level of sophistication of the production technology, the extent to which a particular component is integrated in a larger module and the contribution of a component to the overall vehicle value. The type of component clearly is an important factor determining the way that a component is sourced, with all the relevant implications for the localization of the supply chain.

Transportation and freight costs as well as logistical transaction costs are very important for location requirements and decisions. Whether it makes sense to source a component from afar or from very close depends on the size, geometric complexity and fragility of the component concerned, relative to its value. The higher the first three relative to the last, the larger the imperative for geographical proximity (Schmitt and Van Biesebroeck, 2013: 479; Ward, 2014). Geometric complexity is a key issue here. A component might be light, but have a "poor truck utilization rate", meaning that it cannot be stacked well, and one ends up transporting a lot of air. A South African component supplier showed me a curvy engine intake manifold as an example, and Ward (2014) provides the example of the exhaust system which is difficult to transport because of its size and shape. In general, most components are less bulky than modules, which is why the assembly of component into modules often happens close to the final assembly plant to avoid higher transport costs. Modules are not only bulky, but often also fragile, and hence they require special and expensive packaging and containers, which favours proximate supply (Bennett and Klug, 2012: 1287).

Based on a survey of 42 automotive suppliers from around the world conducted by the Boston Consulting Group and the Fraunhofer Institute, the authors of that study conclude the following:

[18] Interview with a locally owned South African component manufacturer, who supplies three OEMs with injection-moulded components, in April 2021.

"Manufacturing next door to a car assembly plant is especially advantageous for products such as interiors, body and structural parts, transmissions, drive shafts, and heating, ventilation, and air-conditioning systems. Proximity is less important for electronics, engine control systems, and audio and telematic systems, which are relatively inexpensive to ship" (Spindelndreier et al., 2015).

Another aspect affecting localization are the JIS delivery needs of a component or module. Bennett and Klug (2012: 1286–7) assert that "complex parts such as seats, bumper systems or front and rear axles require late configuration and demands that suppliers deliver in sequence to the plant". Displays, in contrast, can be made in Asia and then inexpensively shipped because of their favourable size and shape and comparatively high value, and then simply plugged into the dashboard at the local OEM or tier-1 supplier plant (Spindelndreier et al., 2015).

The components and modules that nowadays have to be assembled in close proximity to the final assembly plant are often those parts that were produced by the assemblers themselves several decades ago, when automotive production was much more integrated. According to Humphrey and Salerno (2000: 158–60), such parts include seats, exhaust, axles, dashboard, wheel and tyre assemblies, as well as cooling systems and fuel systems, and the final assembly of internal trim, suspensions, instrument panel clusters and wiring harnesses. Nevertheless, the sub-components of such parts and modules are often still sourced from far away, especially if they vary little between vehicles (ibid, 161) and when other factors than geographical proximity are overriding, such as economies of scale and low wage and energy costs in central locations (Schmitt and Van Biesebroeck, 2013: 491). Asian countries are especially competitive in the production of more standardized components (Timmer et al., 2015: 584). This is evidenced by the increase of China's contribution to the value of global automotive production from three per cent in 1995 to 15 per cent in 2011 (ibid, 588). Chinese firms have a competitive advantage in standardized wheels, tires and lighting (Schmitt and Van Biesebroeck, 2020: 14).

The manufacturing characteristics of different components are a key driver of which factors matter most for the location decision. While labour costs are the key consideration for the manufacture of wiring harnesses, the locally available skills base is much more important for the manufacture of fuel injection systems (Spindelndreier et al., 2015). Other types of components, such as the flex-coupling assembly for the cold end of the exhaust system, require very large production volumes to justify the investment into the production technology.[19] They are produced in one centralized location in China, in this example, for all the global assembly plants of the OEM in question. The volume requirements at which localization is viable depend on the investment costs of the production tools, which vary significantly by type of component.[20] In the case of plastic moulding technology, Hassler (2011: 436) quotes a manager at the Thai location of a global OEM who argues that the local investment into the technology

[19] Interview with a South African cold end exhaust system manufacturer in February 2021.

[20] In an interview with the Commercial Manager of the South African automotive component manufacturers association NAACAM (April 2021), she emphasized that production volumes and economies of scale are indeed the key factor influencing the viability of the localization of component production. When volumes are too low, the investment in the required production technology is not viable.

for dashboard insertion is already viable at a couple of thousand units a year, while localization of the full instrument panel and the associated injection moulding technology only becomes viable at 30,000 units per year.

What does this all mean for local firms? One could speculate that the chances for locally owned component manufacturers will be much better in the case that follow sourcing does not occur, because in that case, OEMs will be forced to find local suppliers. However, times have changed and to build a local automotive industry that is globally competitive without significant investment of multinational tier-1 suppliers is unrealistic. We will see this in the country case studies below. Yes, when the local market is large and the government has some bargaining power to delay liberalization and to protect domestic componentry, it is possible for local firms to grow in sync with the overall industry. This has been the case in China, India, and to some extent in Thailand and Turkey. But to think that if only follow sourcing can be prevented, the outcome will be more beneficial for local economic development is naïve. In contrast, when countries fail to attract significant component MNC investment, this is a sign for the unattractiveness of the location, rather than a sign of success. Hence, it is key to get local production volumes up, which will attract both OEM and component supplier investment.

There are some components that have proven to be common components for supply by locally owned companies. In the case of India and Brazil, these components have been components like sheet metal, castings, forgings, as well as plastic components. Examples include petrol tanks, taillights, aluminium and other types of wheels, radiator caps, fasteners, mirrors, front and rear seatbelts, shock absorbers and glass (Humphrey and Salerno, 2000: 166–7; Kumaraswamy et al., 2012: 388). Safety-critical and technologically sophisticated components that require intellectual property usually remain in the hands of the global supply chain partners of the OEMs, which will be the mega suppliers from the advanced economies. These include, for example, components of engines, transmissions, braking systems, and instrument clusters (ibid).

Figure 3: Summary of the automotive GVC factors and their impact on localization

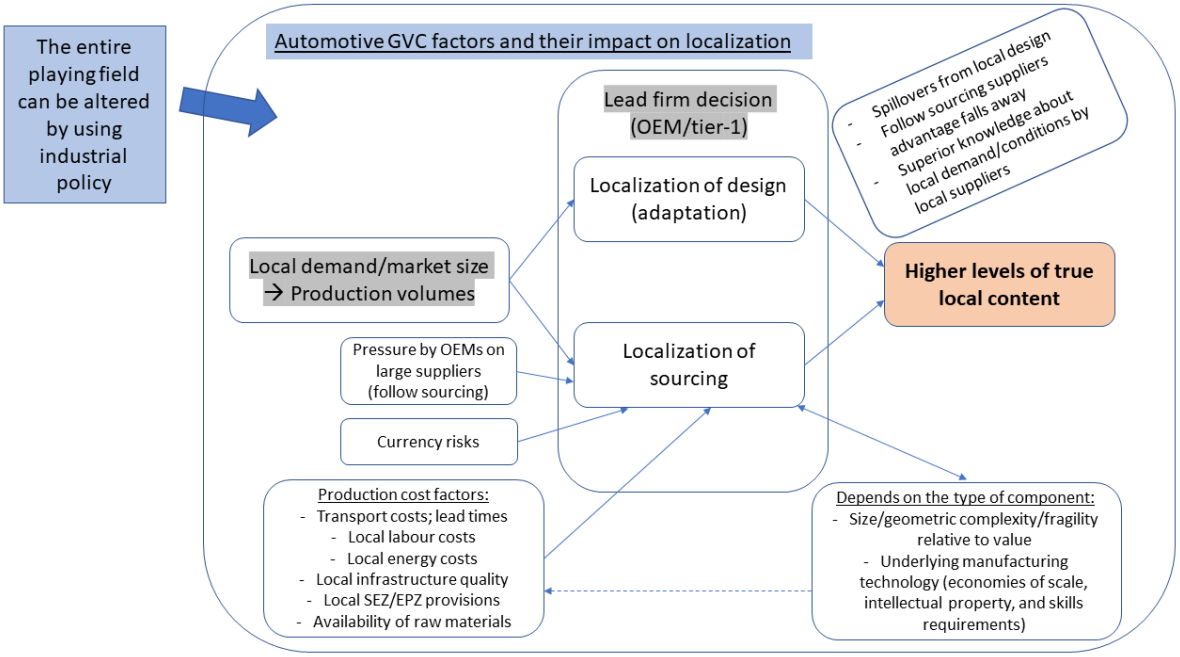


Figure 3 summarizes all the points discussed in this sub-section. From the perspective of the automotive GVC and the lead firm decisions, the extent of overall localization of the automotive industry depends on the localization of sourcing and design. This is, however, only one part of our analytical framework. In addition to automotive GVC factors, government policy factors are the other important set of explanatory variables. Government policy has played an important role in the more successful countries in altering the playing field in favour of local firms, by supporting them to be able to compete with multinational tier-1 suppliers, by improving the likelihood of design localization, and by facilitating value chain entry for local firms, which can then upgrade in the value chain and eventually target international OEMs and their markets.

The importance of local government (industrial) policy

The automotive industry is one of the most prominent examples for the need for industrial policy. The local government has to bargain with the incoming OEMs, since the interests are not perfectly aligned. Countries have historically enforced local content requirements and tariff protection for local componentry, they have demanded vehicle and model rationalization in the domestic market to ensure economies of scale, they have provided preferential treatment and support for indigenous firms, and facilitated local clusters and inter-firm collaboration, as well as inter-industry linkage building. These different elements of government policy will now be discussed one by one. It is clear from the cross-country evidence that without industrial policy intervention, there will not be significant localization. In the absence of policy, OEMs will prefer imports and follow sourcing instead of localization (Kumaraswamy et al., 2012: 376). Governments, however, want localization to "stimulate local economic development" (Liu and Dicken, 2006: 1242).

When discussing the experience of the automotive industries in the ASEAN-4 countries Indonesia, Malaysia, Thailand and Philippines, Guiheux and Lecler (2000: 211) argue that OEMs would have increased their local content to some extent without policy intervention, but only in parts with "low value-added, requiring no significant transfer of technology". Local content requirements (LCRs) are needed to increase local content in high value-added high technology components. Even when the local circumstances favour deviations from follow design and follow sourcing, as discussed above, this does not necessarily improve the situation for local firms. Humphrey and Salerno (2000: 166) show that Mercedes-Benz in Brazil predominantly chose other multinational suppliers when the follow source was not locally available or willing to follow. Saranga et al. (2019: 3), in their study of the automotive industries in India and China, conclude that OEMs and multinational component manufacturers will be much more likely to include local firms and make investments into local supply chains when "there are local content requirements and joint venture regulations to be honored in return for market access". Ownership limits and joint venture (JV) requirements are one important tool to force multinational investors to engage with locally owned suppliers (Kumaraswamy et al., 2012: 376). There are different modes of engagements between multinational suppliers and local firms. MNCs can build local wholly owned subsidiaries. They can enter equity JVs with local firms, they can sell their technology to local suppliers, and/or they can enter into non-equity collaborations with domestic firms on equipment or design. For critical components with proprietary technology, MNCs will be extremely cautious, but in other components, there is a role of play for government policy to encourage technology cooperation between MNCs and local firms. The question is not a binary one of either MNC supply or locally owned firm supply.

Import protection policies and LCRs have been ubiquitous across countries in the past. Schrank (2017: 2049) shows that in a sample of 28 developing and emerging economies for which the respective data was available, 27 of them had LCRs in place for their automotive industry in 1980 (the only exception being Kenya). The sample includes successful countries like South Korea, Thailand, and Turkey, as well as less successful countries like Pakistan, Venezuela, and Nigeria. It supports the claim that LCRs are a necessary but not a sufficient condition for developing a competitive automotive industry. It is undeniable that government policies can have a strong influence on shaping markets. Sugiyama and Fujimoto (2000: 191), for example, point out the "remarkable" difference in vehicle type consumer choice across ASEAN countries: In the late 1990s, 80 per cent of local vehicles sales in Malaysia were in PVs, while the corresponding number in Thailand was less than 30 per cent in Thailand and only 10 per cent in Indonesia. The Thai market was dominated by LCV sales, mainly in pickups, and the Indonesia market was dominated by another type of LCVs, namely vans. These outcomes are result of policy and market legacies, rather than divergent consumer preferences (ibid, 192).

Saranga et al. (2019) argue that gradual as opposed to hasty liberalization is one of the core reasons why China and India have done better with respect to the localization of their automotive industries than Latin America and Eastern Europe. All these places had ISI-type policies in place until the early 1990s, when all of them liberalized more or less gradually. Both China and India started with cautious liberalization, followed by a re-emphasis on local content

and model rationalization over the 1990s and more or less full liberalization in the early 2000s. The experience of Thailand was very similar to that, as we will see below. The Eastern European countries, in contrast, after the collapse of the Soviet Union, as well as countries like Brazil, Argentina and South Africa implemented much more immediate and full-scale liberalization. Saranga et al. claim that liberalization in China and India was "carefully orchestrated" and restrictions were only relaxed "once policy objectives had been achieved" (2).

Countries can either rely on multinational firms to produce locally and fulfill the LCRs or on local firms. That strategic choice has made a huge difference, as evidenced by the divergent experiences of China and India on the one hand and Brazil on the other. In China, local government policy forced multinational entrants into JV equity partnerships with local firms, which allowed the latter to upgrade. The Indian policy did not include this, but through the more gradual liberalization and investment and ownership restrictions, it provided the opportunity for local firms to invest in technological effort to upgrade their capabilities to enter into OEM supply chains. When India finally allowed 100 per cent foreign ownership, the local supply base had already been established and upgraded. Brazil's attempt at import substitution in the componentry did not yield a strong competitive locally owned supplier base, as it did not put any restrictions on ownership. MNCs occupied the protected space (Humphrey and Salerno, 2000: 151; Saranga et al., 2019: 10).

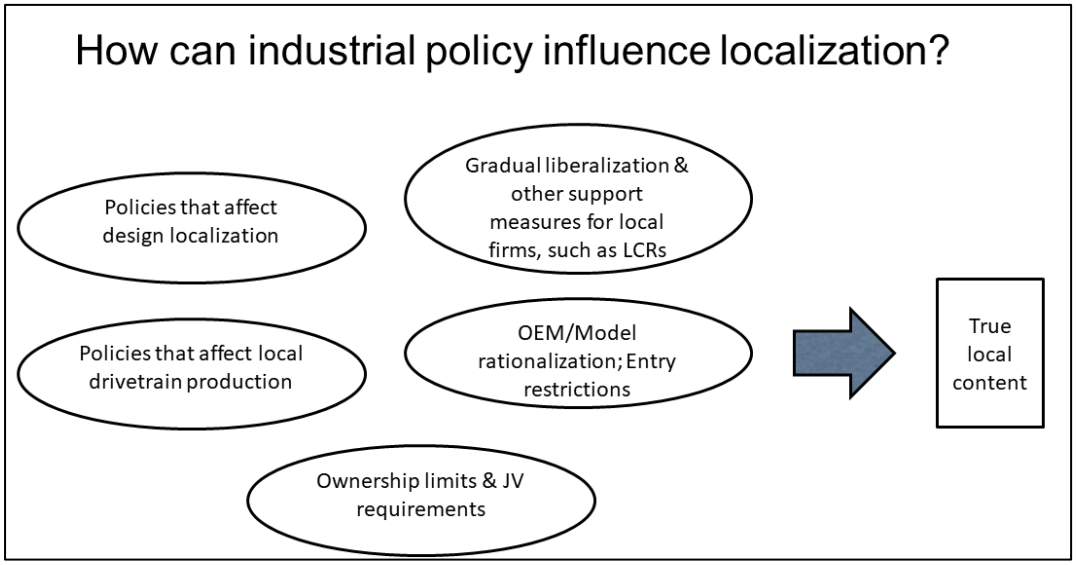
Another key area for government intervention is the issue of model rationalization. OEMs have distinct specifications for their components which prevents component manufacturers from generating economies of scale when they have to supply many different OEMs with distinct specifications. OEM collaboration on joint sourcing, and harmonized standards and material specifications is rare.[21] What needs to be avoided in this context is to allow unfettered entry of OEMs into the country and bargaining with the established OEMs to prevent model proliferation. This can be achieved through the restricted issuance of investment licenses and/or minimum investment requirements. Without those kinds of interventions, a fragmented market without sufficient economies of scale to support increased local content will be the result, as has been the experience of Vietnam, see below. Thailand has been successful in this regard with its focus on pickups and more recently on eco cars. The Turkish government has done well, too, by setting stringent homologation and service infrastructure requirements that have limited the number of OEMs competing in the domestic market (Barnes et al., 2017: 25).

More recent discussions in the literature on industrial policy have cast doubt on whether the invasive types of policy interventions like LCRs, entry restrictions and tariff protection are still viable in a world of "compressed development" (Whittaker et al., 2020). The automotive industry is perhaps one of the few industries where these types of import substitution industrial policies still have a role to play (Black et al., 2018: 18-19). Nevertheless, the importance and

[21] This point about distinct specifications was raised in almost all the interviews I conducted on the topic of localization of the auto industry in South Africa, with OEMs, MNC suppliers, local suppliers, industry associations and policy makers. Example of material specifications for plastic components: "Mercedes' definition of black plastic is completely different from BMW's. It's crazy.".

usefulness of these kinds of policies has decreased, and it is important to acknowledge the success of other less invasive, more 'soft touch' types of industrial policy. Tewari (2019: 134) documents the successful contribution of institutional support policies that facilitated group learning among suppliers and linked firms with each other in the Indian automotive component industry. She emphasizes the importance of polices that induce learning, rather than simply provide protection (ibid, 154). Another promising area for policy intervention is to assist local entrepreneurs who have previously worked for multinational component manufacturers or OEMs and want to start their own company based on the knowledge, contacts and capabilities acquired. Contreras et al. (2012), in their study of the automotive cluster in Hermosillo, Mexico, show that many of the newly established locally owned firms in that cluster have actually been established by former MNC employees and acquired access to the OEM supply chain through their previously established contacts.

Figure 4: Summary of industrial policies to support localization



This sub-section has established the centrality of government industrial policy as an explanatory factor for localization success or failure in the automotive industry of developing and emerging economies. The main industrial policy tools at the disposal of the local government are summarized in Figure 4. Interacting the lead firm-related automotive GVC factors with government industrial policy related factors, while always keeping in mind the centrality of economies of scale in this particular industry and thereby the local demand and production conditions, provides a powerful framework for understanding differential localization achievements across countries. Before applying this analytical framework to the individual country experiences, the next brief sub-section will elaborate a bit further on the centrality of firm level learning and technological effort, without which no kind of policy or favourable lead firm circumstances will lead to significant localization of the supply chain.

Everything is nothing without firm-level upgrading efforts

The philosopher Arthur Schopenhauer allegedly said: 'Health is not everything, but without health, everything is nothing'. In the context of localization efforts in the automotive industry, 'health' can be replaced with 'firm-level technological efforts for learning'. The extensive discussion of automotive GVC related factors and industrial policy has hopefully shown that a lot of different factors have to operate in a productive way, ideally steered to some extent by government policy, to create conducive conditions for localization. All these factors are a precondition for locally owned firms to be in a position to upgrade. The above factors are a necessary, but still not a sufficient condition for local firm upgrading and therefore localization success. Once the necessary conditions are in place, local firms must invest in technological upgrading. They must "accumulate buyer-specific know-how, build the required complementary assets and develop their absorptive capacities" (Kumaraswamy et al., 2012: 376). They have to learn and invest in technological effort to become competitive on quality, costs and lead time (Tewari, 2019: 142). This entails investments in new machinery and technology, an area where government intervention can assist. Kumaraswamy et al. (2012: 387) find that technological efforts in process, product, management, and system capabilities are a first step on the upgrading ladder. Once, they have acquired sufficient capabilities, the firms become interesting for MNCs for sourcing, as well as for JVs and design collaboration.

Domestic firms often start in the automotive aftermarket, and then work their way up the upgrading ladder through constant learning and technological effort. ADM Auto Components from India, for example, which started as a small brake-shoe manufacturer in the Indian aftermarket in 1993 has become a certified sub-supplier for Hyundai's tier-1 brake system supplier and for other OEMs (Tewari 2019, 137). Beyond this one firm example, close links to multinational buyer firms have proven to be a key requirement for domestic component suppliers in India, as shown by evidence in Kumaraswamy et al. (2012: 387) and in Tewari (2019: 137–8). The Argentine engine valve manufacturer Basso started in the domestic aftermarket several decades ago and moved up into the international aftermarket by suppling into the US, then upgraded into the local OEM market, and later into the international OEM market. Basso's story is also a story of technological effort and learning (González et al., 2012). Some firm-level capabilities, such as logistics and delivery skills, that are needed to move into the highest spheres of technological capabilities, are connected to producing on global scale volumes, and can therefore only be learnt through exporting and supplying global OEM platforms (Tewari 2019: 159). Qualitative firm level evidence from Saranga et al. (2019: 5) shows that to successfully catch-up with their competitors from the advanced economies indigenous component manufacturers in India had to go through three steps: 1. Forging of close relationships with buyers to upgrade process capabilities; 2. Investing in in-house R&D to offer higher value-added products and services; 3. Globalizing through mergers and acquisitions and expansion into key markets.

The observation that local firms have to make their own R&D and international M&A efforts to break the dependence from their buyers is in line with the extensive theoretical and empirical discussion in Lee (2019). There is no scope to go into much more detail on this point about firm-level learning and technological efforts in this paper. It has actually been a strategic choice

to focus more on the industry-level aspects that condition localization success or failure. In much of the GVC literature, the focus is predominantly on firm-level developments. In the automotive industry, it is key to understand developments beyond the firm level to explain localization outcomes, perhaps more than in other industries. Nevertheless, it is important to acknowledge that without firm-level technological efforts in learning, 'everything is nothing'. This point is made in much more detail elsewhere, for example in Whitfield et al. (2015).

5. Country case studies

In this section, the previously developed analytical framework, combining automotive GVC and industrial policy factors while always keeping in mind the overriding role of economies of scale in the industry, is applied to the different country case studies. The countries are discussed in the order of the categorization presented above in Table 2, going from more successful to less successful cases. In the discussion of individual country cases below, I make use of a broad range of literature on the selected countries. This literature has proven invaluable both for understanding differential performance across countries, but also for building the analytical framework in an iterative manner. Through the application of the framework to the country cases, it becomes clear that, while certainly not exhaustive, the framework provides a powerful tool for better understanding differential performance.

The performance spectrum and country categorization presented in Table 2 is not entirely static. While Egypt was in a slightly better position than Morocco 15 years ago with respect to production volumes, Morocco has managed to completely turn things around with the attraction of a large export-oriented Renault investment. This illustrates that things can change quite quickly. Nevertheless, issues of path dependency and legacy make the picture and the above categorization somewhat stable. The dividing line is mainly between those countries that have managed the transition from a protected import substituting auto industry to a globally competitive industry with significant localization, and those that have not or to a much lesser extent. Comparative successes and failures are difficult to reverse. Automotive GVC related factors then also do their bit to manifest the situation. A global OEM produces the same vehicle type, say a pick-up, in different locations. These production locations will differ by volumes. The largest production location will usually be the design partner for a new vehicle model, and hence the level of local content will be highest in that location. The other locations, and especially those with the lowest production volumes, will usually just source their components from the multinational tier-1 suppliers that have been chosen by the largest production location, i.e. through imports or follow sourcing.[22] As a result, while things can change, there is also a significant element of path dependency in the local content of a production location. Let us now turn to the discussion of the individual country cases.

[22] This point was made to me by the Purchasing Manager of the South African subsidiary of a global OEM, in an interview in May 2021.

Very successful case: South Korea

When factoring out Japan as an early mover in the automotive industry that already challenged European and American OEMs in the 1970s, South Korea is the most successful example of a developing/emerging country that has built up a national automotive industry. It has proven extremely difficult for vehicle manufacturers from late developing countries to compete with the established lead firms from the traditional auto countries of Western Europe, the US and Japan. The South Korean OEM Hyundai was the only lead firm in the Top 10 global vehicle manufacturers in 2017 that was not from those countries. Hyundai was the third-largest motor vehicle manufacturer in the world in 2017 (OICA).

South Korea's exceptionally successful experience in automotive, which included the localization of engines and transmissions production by the domestic OEMs, was driven by aggressive and determined industrial policy, including the auto policy with its focus on the people's car, a national car for the local market with high local content, and the Heavy and Chemical industries push (Lee et al., 2019). The former was implemented under the Long-Term Automobile Industry Development Plan in 1974. Lee et al. (2021: 16) emphasize that the domestic OEM Hyundai was only able to move into the OBM (Original Brand Manufacturer) function and develop its own technology and products for sophisticated components, such as engines, because it was under domestic ownership and under local control. Its JV partner Mitsubishi held less than 20 per cent in the overall venture and Hyundai therefore had total management control. Hyundai took the sole responsibility for key R&D projects such as engine development. Daewoo, in contrast, shared its management with General Motors and was less successful (Lee and Lim, 2001: 481). Hyundai's R&D expenditure devoted to engine development was large (ibid, 470). It licensed technology from Ricardo (UK) and was assisted in its R&D efforts by them (ibid, 481).

South Korea is a case of indigenous assembly. Its industrial policy was from the beginning strategically focused on nurturing indigenous assembly firms. These firms then went on to produce most of the components in-house, especially when tariffs were raised on component imports and local content requirements were increased. Strong component manufacturing firms only came into being when these large domestic assembly firms spun off some of their component manufacturing activities, the most prominent example being Hyundai Mobis (Ravenhill, 2005). Saranga et al. (2019: 10) point out that the build-up of fully integrated extremely capable domestic OEMs is the main difference between South Korea's and China's experience. While China has also seen the emergence of successful indigenous assemblers, as we will see below, they are still at an early stage of development compared to Hyundai, especially with respect to design and branding capabilities.

The fact that South Korea's catch-up lies in the rather distant past casts doubt on whether the lessons from its path are applicable to developing countries trying to develop their automotive industries today. South Korea built its domestic vertically integrated automotive industry under very favorable conditions which were conducive to strategic domestic industrial policy (Wade, 2018) and at a time when global production was not yet so geographically dispersed and the build-up of fully domestically integrated industries was still possible. Baldwin (2011) calls this

the time before globalization's "2nd unbundling". He argues that countries looking for inspiration on how to develop a domestic automotive industry in a world of GVCs should rather look at Thailand, a country which has managed to consolidate and develop its auto industry after globalization's 2nd unbundling (18). We take a closer look at the Thai experience below.

Nevertheless, some lessons are still important to keep in mind. South Korea managed to localize the design and manufacture of the automotive powertrain, which has large knock-on effects for overall localization.[23] The policies around the national car are certainly not a sufficient condition (see the experiences of Malaysia and Indonesia), but likely a necessary condition for nurturing domestic OEMs with design and branding capabilities that can compete against the major global OEMs. Relying on foreign OEMs for the build-up of a domestic automotive industry will always have limitations. Lastly and very importantly, South Korean industrial policy for the automotive industry featured strong preferential treatment for local firms and supported them financially, in their exporting endeavors and in their acquisition of modern technology (Doner, 2009: 267). Export performance as a reciprocal control mechanism for industrial policy support ensured discipline (Amsden, 1989) and that is what distinguishes the South Korean experience from many of the other country cases discussed below.

Relatively successful cases with significant localization

The second group of countries includes those that are highly internationally competitive, as evidenced by high vehicle and parts production and export volumes, while at the same time having managed to achieve significant localization. India and China have achieved this on the back of their large domestic markets. Thailand and Turkey in contrast have been the most successful countries when it comes to opening and expanding previously heavily protected auto industries, with sizeable but not large domestic markets. The main difference to South Korea is that all these countries' automotive industries are still predominantly run by foreign OEMs and MNC component firms.

India

Like so many other countries, India established an automotive industry under import substitution industrialization. But unlike e.g. in the Brazilian experience, assemblers, from the mid-1960s onwards, were not allowed to expand their vertically integrated component manufacturing activities, but were instead required to purchase components from "small, independent component suppliers" (Kumaraswamy et al., 2012: 371). As a result of that, India already had a long legacy of domestic component manufacturing before liberalization of the industry. As mentioned above, the liberalization experience of the automotive industry in India was more gradual than in most other countries. Some small steps were undertaken in the 1980s, when foreign assemblers were permitted. These steps were highly necessary, since the Indian automotive industry had remained small and inefficient, retarded by unproductive rent-seeking

[23] The CEO of a South African consultancy, which has been involved in the drafting of several rounds of automotive policies in South Africa, told me in an interview in March 2021 that in order to achieve local content levels of 60 per cent in South Africa (which is the target under the Automotive Masterplan 2035), the decisive factor will be whether the industry collectively manages to localize the production of the powertrain or not.

until then (Black et al., 2020: 13). In 1983, the most important assembler until today, Maruti Suzuki, a JV between the government and Suzuki (Japan), was established. It undertook significant supplier development efforts that resulted in a further strengthening of the domestic supply base, that other multinational firms could benefit from when they entered the country in the 1990s (Saranga et al., 2019: 3).

Economy-wide liberalization started in 1991. In the automotive industry, the government gradually loosened its commitment to segment the industry by not allowing any new foreign entrants to the PV and two-wheeler segments that had been in place since 1982, from 1993 until full abolition in 2000. Joint ventures were no longer enforced (Barnes, 2018: 204–5). Importation of CKD kits or components by multinational entrants remained forbidden until 1995 (Kumaraswamy et al., 2012: 372). In 1995, policy changed and multinational OEMs were allowed to import CKD kits and components, but only in exchange for case-by-case commitments on volume, local content and exports equivalent to imports, usually fixated in MoUs (Memorandum of Understanding) (ibid, 373). A uniform automotive policy was eventually introduced in 1997, which required new entrants to follow a local content schedule of 50 per cent to 70 per cent by the fifth year, as well as foreign exchange neutrality and an initial minimum investment requirement of $50 million to set up wholly owned subsidiaries (ibid). In 2002, the auto policy was updated again, and the industry was liberalized even more, allowing 100 per cent foreign ownership without local content and minimum investment requirements (ibid, 374). Nevertheless, India still has in place a 100 per cent tariff on imported cars (Black et al., 2020: 7).

Kumaraswamy et al., 2012 (390) conclude that India's comparably good performance was due to the long legacy of domestic component firms and the gradual process of liberalization. Local content and minimum investment requirements were kept in place for 11 years after the initial steps of liberalization were introduced in 1991. This contrasts sharply with many of the more abrupt liberalization experiences discussed below. In 2016, domestic firms accounted for more than 70 per cent of auto components revenues in the Indian automotive component manufacturing industry (Saranga et al., 2019: 2). All Indian OEMs, not only Maruti Suzuki, but also Hyundai, Honda, and Renault-Nissan, rely on a large number of Indian-owned tier-1 and tier-2 suppliers. Nevertheless, almost all the important multinational tier-1 suppliers are also operating in India, sometimes as wholly owned subsidiaries, and some as JVs (Barnes 2018). But, as discussed above, the presence of tier-1 MNCs rather reflects the attractiveness of the large Indian market and should not be seen as a failure. Many of them arrived in the early 2000s. Some of them formed JVs with domestic suppliers. Saranga et al. (2019: 4) present firm-level evidence that the presence of the MNC suppliers and the JVs forced domestic suppliers to upgrade their capabilities to enter or remain in the OEMs' Indian and global supply chains.

Overall, the Indian experience with its automotive industry has been comparably successful. It has even witnessed the continued existence of some nationally owned assembly companies like Tata Motors and Mahindra & Mahindra. However, the production numbers for a country the size of India are still disappointing today. India's total PV and LCV production in 2019 stood

at 4.2 million vehicles, while China reached 23.4 million (OICA). This is fully because of the same difference in domestic vehicle sales between India and China (OICA), and a reflection of the overall difference in China's and India's economic development. Automotive parts exports from India with $5.02 billion in 2019 also paled in comparison with China, which reached $33.6 billion in the same year.

China

Like India, China also went through a period of gradual liberalization. After initial liberalization and when assembly FDI began to dominate, the government stopped approving new FDI projects in assembly and encouraged the inflow of FDI in the components sector between 1994 and 1996. After 1996, in connection with the WTO accession process, more intense liberalization began to take place (Liu and Dicken, 2006: 1232).

China's exceptional economic transformation over the last four decades has made it the most attractive consumer market in the world, which has provided enormous bargaining power for the Chinese government to demand joint ventures and technology transfer from FDI. China has become a "must-invest situation" for global OEMs (Liu and Dicken, 2006: 1245). Entry of multinational OEMs is only allowed in the form of JVs (ibid, 1242). When the Chinese government realized that assembly FDI was getting too much and components FDI was lagging behind in the mid-1990s, it identified 60 key components that were considered "bottlenecks for raising car production quality, and recommended 170 local producers to foreign companies as candidates for the formation of joint ventures in parts making" (ibid, 1243).

Because of its unique bargaining power, China has managed to avoid denationalization despite its late start with an inefficient ISI-based auto industry. Saranga et al. (2019: 2) report that domestically owned firms control 55 per cent of the domestic market for automotive components in China. The country has witnessed the emergence of many indigenous component manufacturers and even of significant indigenous assembly firms with international ambitions, such as Geely, Chery and Great Wall (Chu, 2011). Lee et al. (2017: 67) argue that China benefitted from increasing modularity in the global auto industry, since this is what allowed Chery and Geely to develop their own cars while not having a significant share of the necessary capabilities themselves. They outsourced their body design and other major components to international module suppliers. The Chinese indigenous assemblers did not try to compete with global OEMs in other markets or in the area of high-end models, but focused on the low-end entry-vehicle niche market, which was growing significantly in the context of the overall Chinese growth experience. The indigenous assemblers used their knowledge of the local market to their advantage and incorporated customer feedback much faster than international OEMs could. Between 2003 and 2007, indigenous OEMs launched more than 170 different models in this niche market segment (ibid).

Geely and Chery introduced mostly imitated vehicles based on foreign models. In terms of manufacturing capabilities, they caught up quickly with the global OEM frontier. And even in the realm of R&D and product development capabilities, they caught up to some extent by

forming alliances and JVs with foreign companies, and most importantly by investing in their own in-house R&D capabilities. Outward FDI and M&As, such as Geely's acquisition of Volvo, marked further upgrading steps (Chu, 2011). They were assisted with local government funding and with R&D funding from the central government (Saranga et al., 2019: 2). Despite the success of some indigenous OEMs, the domestic market is still largely controlled by foreign OEMs (albeit in JVs) like Volkswagen (16.4 per cent of total cars sold in China), GM (12.0 per cent), Toyota (9.9 per cent), Nissan and Honda (6.0 per cent each). The largest Chinese assembler in terms of domestic sales is Geely, which has 5.7 per cent market share in China.[24]

Thailand

It is unfair to compare the average developing country with China and India. Other countries lack the luxury of a large domestic market that provides bargaining power to the government and economies of scale to local producers. The country that comes closest to being a model country for other developing countries aiming to establish a domestic automotive industry is arguably Thailand. It performs very favourably against other countries in its region (see Figure 5), which all started from similar or even better initial conditions (Doner, 1991). Thailand ranks high, not only in comparison with its neighbours, but also globally (see Figure 1 above), in terms of domestic vehicle production and sales, as well as in terms of parts and vehicle exports. Local content in pick-up trucks, the major vehicle category produced in Thailand, ranges from 60 to 80 per cent (Hassler, 2011: 433).

Figure 5: Comparative performance ASEAN

	Thailand	**Indonesia**	**Malaysia**	**Philippines**
Parts exports (bil. US$) 2019	7.39	1.71	1.07	0.89
Vehicle production (units) 2019	2,013,710	1,191,816	571,632	0
Vehicle sales (units) 2019	1,007,552	1,043,017	604,287	415,826
Auto trade balance (bil. US$) 2019	9.34	1.14	-3.20	-2.85
Vehicle exports (bil. US$) 2019	9.40	3.94	0.43	0.004
FVA in exports (%) 2015	46.72	18.08	56.22	34.23
DVA in foreign exports (%) 2015	1.07	1.50	0.98	1.47
Change in DVA/FVA 2005-2015 (%)	23.43	12.32	46.08	4.72

Author's own compilation. For data sources and more detailed description of indicators, see Appendix.

LCRs in the 1990s have proven essential in ensuring localization of the automotive supply chain in Thailand. They were abolished in 2000, but a 40 per cent local content requirement for free trade in ASEAN has been in place since 2003 (Hassler, 2009: 2237). The Thai government was very selective with its LCRs. It only targeted specific vehicle models and specific components so that local producers could capture economies of scale. Thailand has become one of the biggest producers of pick-ups and diesel engines in the world. Around two-

[24] Source of 2019 sales data for the Chinese market: "Marktpositionierung globaler Automobilhersteller 2020", Center of Automotive Management, Bergisch-Gladbach, Germany, 2020, https://auto-institut.de/automotiveperformance/marktpositionierung-der-globalen-automobilhersteller-2020-chancen-und-risiken-in-einem-weiterhin-turbulenten-marktumfeld-automotiveperformance-report-2020/. Accessed on 30/08/2020.

thirds of vehicles produced in Thailand are pick-up trucks. The Toyota Hilux VIGO is the main vehicle assembled in Thailand, and diesel engines for Toyota's global IMV platform are produced in and supplied from Thailand (Techakanont, 2011: 210). Pick-up trucks were given a favourable position on the domestic market through excise taxes. Government policy actively made it the dominant vehicle type (Hassler, 2009: 2238). The LCR programmes were in place from 1975 to 1999, with gradually increasing LCRs for pick-ups with diesel engines up to 70 per cent, 60 per cent for pick-ups with gasoline engines and slightly more than 50 per cent for passenger cars (Techakanont, 2011: 201–2). LCRs were not only applied at the vehicle level, but also at the component level. Mandatory local content shares for radiators, batteries, exhaust pipes and parts of diesel engines were introduced in the 1980s. The local content of diesel engines had to increase from 20 per cent local content in 1989 to 70 per cent in 1996 (ibid). At a time when other countries fully liberalized their automotive industries, Thailand introduced very stringent local content policies to accelerate localization.

Today, there are about 2,000 automotive component firms in Thailand, 600-700 of which are tier-1 suppliers (Bell and Monaco, 2021; Lee et al., 2021). Domestic firms dominate at the second and third tier, while half of the tier-1 suppliers are foreign JVs (Lee et al., 2021: 15). The assemblers are all foreign-owned JVs, predominantly Japanese (ibid). Despite relative success, many domestically owned supplier firms have also been pushed to the second and third tier since comprehensive liberalization in 2000 (Doner, 2009; Techakanont, 2011). While CBU tariffs are still high, component tariffs are much lower and can be further reduced via duty offsets (Barnes et al., 2017: 42). Tier-1 supplier relations have often been taken over by MNCs, while Thai suppliers have mostly been confined to producing the lower value added and more labour intensive parts (Hassler, 2011: 437). The share of FVA in automotive exports is rather high and the share of DVA in other countries' auto exports is rather low, as shown in Figure 5. FVA is even higher than in Indonesia and in the Philippines, but Thailand's overall component exports are much higher than those of these two countries, and Thailand has a very positive automotive trade balance. There are also some positive developments with respect to value added, as evidenced by the improvements of the DVA/FVA share between 2005 and 2015. There are even some indigenous suppliers involved in engine production (Techakanont, 2011). The fact that there are more than 1,000 automotive components companies at the lower tiers of the supply network is also a significant achievement that contrasts with other countries such as South Africa which have a much thinner lower tier base, with all the negative implications for economic development associated with that.

Doner (2009) argues that industrial policy in Thailand, in contrast to South Korea, did not support its indigenous component manufacturers enough. The government assumed that they would upgrade simply based on liberalization and increased economies of scale through integration into the ASEAN production network (251). Doner's claim is probably true, but given Thailand's limited domestic market size, especially compared to China and India, its overall automotive experience has been impressive, which is to a large extent due to gradual liberalization, market rationalization through the promotion of one major vehicle category, and strict LCRs. The Thai experience illustrates the importance of political economy factors in policy making. Without overshooting the scope of this paper, it shall suffice here to note that

selective and gradual introduction of local content requirements and later of the liberalization of the industry was not the outcome of a visionary strategy designed by the Thai government ex-ante, but rather the result of complicated political economy struggles. Doner (2009) describes these developments in detail. He shows that model rationalization did not really happen until the late 1980s and that the local content requirements also only came about to a meaningful extent in the mid-1980s, when there was a coalition of domestic interest groups in favor of further localization, including domestic capitalists, nationalist political forces and Japanese assemblers and suppliers with long-term commitments and sunk investments. This shows that how policies come about cannot be understood without the political economy dynamics behind them.[25]

Turkey

Turkey's experience with import-substitution industrialization in the automotive industry was similar to that of many other countries in the 1960s and 1970s. Production volumes, quality and technology levels were significantly below the level of international competitiveness. The government tried to move towards a more export-oriented strategy for the sector in response to the 1978 economic crisis but encountered opposition from politically well-connected capitalists in the industry. Nevertheless, imports were gradually liberalized throughout the late 1980s and early 1990s after the military had seized power and implemented more Washington Consensus type macroeconomic and trade policies. With the customs union agreement with the EU on the horizon, FDI inflows into the industry increased and production did too – from 150,000 units per year in the late 1980s to 450,000 units in 1993 (Black et al., 2020: 16). The customs union (CU) between Turkey and the EU eventually came into effect in 1996. Two developments ensured that the domestic capitalists managed to keep a foot in the industry despite liberalization. Firstly, foreign investors preferred to enter into JVs with domestic partners to better cooperate with the Turkish bureaucracy which was biased in favour of national interests (ibid, 17). Secondly, labour unions and domestic interests in the auto industry lobbied for a more gradual implementation of the customs union. The auto industry was deemed a 'sensitive sector', and tariffs on imports were only gradually lowered over a five-year transition period, and Turkey agreed with the EU that imports of used cars from the EU were blocked for 10 years (ibid, 25).

Investment increased dramatically in the context of the CU agreement with the EU, including investment from the Asian OEMs Honda, Hyundai, and Toyota to get a foothold in the European market (Black et al. 2020, 25). Without doubt, Turkey benefitted from its favourable location close to the EU and its sizeable domestic market when it came to the attractiveness for FDI (ibid, 27). Domestic component manufacturers used the period in the 1990s and at the start of the CU agreement, in which liberalization happened, but a bit more gradually than would have been the case without lobbying, to upgrade their technological capabilities. This is what distinguishes Turkey and also India from other countries, like Egypt, in which granted protection was not used for upgrading but only for rent-seeking. It was arguably the context of

[25] For a comparative discussion of the explanatory power of political economy factors in explaining the history of the automotive industries of India, Turkey, South Africa and Egypt, see Black et al. (2020).

the CU agreement with the EU and full liberalization on the horizon which provided a conducive environment to upgrading, as it meant 'upgrade or die' for domestic companies (ibid, 26).

Turkey distinguishes itself from Mexico, Brazil and even Thailand by the fact that it has some local participation at the assembly level. Several of the international OEMs still operate in JVs with local firms. The same is true at the tier-1 component manufacturing level (Black et al. 2020, 26-28). The automotive industry is Turkey's leading export sector and one of its largest manufacturing sectors. The domestic component manufacturing base is comparably strong, even though fully domestically owned firms are usually only found at the lower tier levels. In an analysis of the automotive cluster in Bursa, Özatağan (2011: 88) shows that more than 80 per cent of the automotive component manufacturing firms in the cluster are domestically owned. This can be ascribed to the buildup of a national component manufacturing base under the ISI phase, that was not lost during significant, but somewhat gradual liberalization (ibid; Black et al., 2020: 29). Özatağan (2011: 90) shows how domestic suppliers in Bursa benefitted from the interaction with OEMs throughout the 1980s and 1990s and developed significant product and process capabilities. In the context of the automobile becoming an ever more complicated product, lead firms relinquished some of their design and product development tasks to the lower tiers of the supply chain. This benefitted some of the very capable domestic suppliers, who then went on to develop product development and design capabilities. This happened in a context where the Turkish government offered significant incentives for R&D and many automotive firms moved some of their international design activities to the country. Ford Otomotiv and Tofas, for example, have significant R&D centres in Turkey (Black et al., 2020: 26).

Cases with large production and/or exports, but limited localization

The countries discussed in this category have also seen the emergence of internationally competitive automotive industries, with comparably large production and export numbers. In contrast to the countries above, however, they have experienced more limited localization, especially when it comes to the domestically owned component manufacturing base. This includes Brazil, Mexico and the countries of Central and Eastern Europe. The inclusion of the Latin American and Eastern European countries in this category, as opposed to China and India in the category above, reiterates the point already made in the policy section that the performance of the former has been comparatively worse than that of the latter. Brazil is the outlier in this category, since it is less internationally competitive than Mexico and Poland, Slovakia, Czech Republic, Hungary and Romania. It has much lower parts and vehicle exports, and its industry is mostly inward oriented towards the domestic market and the neighbouring markets of the Mercosur region. Mexico and the Eastern European countries, in contrast, are cases of peripheral integration into large regional production networks, i.e. NAFTA and Europe. This illustrates the importance of distinguishing two types of regional integration that was briefly touched in the introduction, namely peripheral integration into very uneven production networks (NAFTA & Europe) versus introduction into smaller, but more balanced regional production networks (ASEAN & Mercosur).

Brazil

Brazil's automotive industry is responsible for roughly 20 per cent of Brazil's industrial GDP and directly employs approximately 300,000 people. It has a production capacity of more than 4 million units, and 75 per cent of local production are for the domestic market (Ibusuki et al., 2012: 183–5). In 2019, total vehicle production was 2.9 million units. The domestic supplier base in Brazil is much shallower than that in China and India. Full trade liberalization of the industry was introduced in the early 1990s (Ibusuki et al. 2012, 190). Humphrey (2003: 137) documents that, in the context of that, the number of domestically owned companies among the 25 largest component manufacturers decreased from 12 in 1995 to three in 2001. There are no meaningful domestically owned assembly companies, since Brazil did not restrict foreign ownership during the time of the import substitution policies.

The major OEMs that arrived in Brazil during ISI are still there. They are GM, Fiat, Volkswagen and Ford. They still have significant local engineering and product development teams, which is a legacy of localization under ISI, and can be attributed to the fact that they dominate the local market, which ensures significant economies of scale to justify some local design and product development. Nevertheless, under liberalization, they relocated some of the their R&D and product development functions to their home countries (Ibusuki et al., 2012: 185–6). When the industry was liberalized, several other assemblers entered the Brazilian industry. These new entrants Toyota, Honda, PSA Peugeot-Citroen, Renault-Nissan, Hyundai and Daimler adapt their models for the Brazilian market, but reengineering does not happen locally. It happens abroad in the OEMs' design centres. The late entrants have only reached an overall market share of 25 per cent, which is too low to justify local design and product development (ibid, 187).

Design and product localization, especially of the traditional OEMs in Brazil, has contributed to overall localization of the supply chain, as evidenced by the low share of FVA in Brazilian automotive exports, see Figure 1. Industrial policy has facilitated design and product development (PD) localization. Tax incentives have favoured the small compact car segment, which has reached 53 per cent of the Brazilian market in 2009. In response to that, the traditional OEMs have localized design and PD for these models and small engines. Another feature of the Brazilian vehicle market is that Brazilian automobiles run on a unique type of fuel. In response to the government's policies of energy diversification, which started in the 1970s, Brazilian assemblers and suppliers have developed the 'flexfuel' system, which means that Brazilian automobiles can run on gasoline or ethanol, or a proportion of both. This has contributed to the development of local expertise in flexible engines, the design of specific powertrain components in line with this system, and has impacted positively on local material use (Ibusuki et al., 2012: 188). Such developments were of course also facilitated by the large Brazilian market and those of its neighbours, which created economies of scale that justified some localization. In that sense, Brazil has a significant advantage over countries like South Africa, as its domestic production is much more significant than that of South Africa (3 million units vs. 600,000), and so is demand from Mercosur compared to demand from the SADC region that surrounds South Africa.

But as mentioned and discussed above, local content in Brazil is not true local content, since it is local content generated by MNC subsidiaries, which is partly the result of the absence of ownership restrictions under ISI. In addition to that, low automotive parts exports (only one third of those of Turkey and India) and the negative automotive trade balance indicate limited international competitiveness. Brazil is trying to turn things around since the introduction of the 'Innovate-Autoparts' policy in 2013, which has raised taxes and tariffs on imports and incentivizes local component production and R&D, as well as local sourcing by OEMs (Saranga et al., 2019: 10). But it remains to be seen whether such kinds of policies can manage to reverse the damage that has already been done in the 1990s and 2000s.

Mexico

Mexico's automotive parts exports are the second largest in the sample of the 26 developing and emerging countries in Figure 1. They are only slightly lower than those of China ($34 billion vs. $31 billion). When it comes to vehicle exports, Mexico is number one in the entire sample, even higher than South Korea ($51 billion vs. $40 billion). Mexico has by far the most positive automotive trade balance together with South Korea, at $44.5 billion. However, these remarkable achievements are mostly because Mexico has become the low labour cost production hub for the US vehicle market. Foreign value added in its exports and domestic value added in other countries' automotive exports are among the highest and the lowest in the entire sample respectively. And this has basically not changed between 2005 and 2015. Crossa and Ebner (2020) argue that Mexico's integration into automotive production has provided nothing more than a 'mirage of development'. Mexico has specialized in the least automated and most labour intensive subsectors of automotive production, such as wiring harnesses and seat parts, which are mostly produced in the maquiladoras at the US border. The industry is controlled by large foreign-owned firms and the authors observe an "enclave pattern of territorial specialization" in the border states to the US (1221). This profile was already evident in the 1990s when Layan (2000: 137) observed that low-value labour intensive component production of electrical wiring, interior fittings and similar components, was dominant in the maquiladoras.

Similar to Brazil, Mexico's automotive industry also started out under ISI policies in the 1960s, which served as a "springboard" for the industry's development (Layan, 2000: 126). The US Big Three OEMs were the first movers into Mexico (ibid, 129). They specialized their production in small cars, small utility vans and small engines, to make use of the structure of local demand and the low labour costs. Labour costs make up a high cost share in small cars and labour intensive engine manufacture, which is the reason why these kinds of production were relocated to Mexico (ibid, 136). This is a very common production profile for peripheral markets. It was the same in Spain in the 1970s and 1980s (ibid, 140), and later in Eastern Europe, as we will see below. There is a powerful dynamic for peripheral countries in larger production regions to be pushed into this kind of position, as evidenced by both Mexico within NAFTA and the Eastern and Central European countries in the EU. Brazil within Mercosur and Thailand and others within ASEAN are integrated into much more equal and balanced production networks.

Crossa and Ebner's (2020) conclusion is perhaps a bit too bleak. In the case of Audi's new Q5 plant that opened in San José Chiapa in 2016, local content was at 65 per cent already at the start of production. Low production costs and high supplier capabilities locally, as well as the desire to avoid high transport costs made such a high local content share the most profitable option for the lead firm Audi (Welt 2015). Contreras et al. (2012), in their case study of the supplier park for the Ford Hermosillo plant, demonstrate that local firms manage to participate in such supplier parks and the extent of spillovers from multinational firms are significant. But most suppliers and especially those at the higher tier levels are multinational companies, which is both a result of the global dominance of follow sourcing, but also of the failure of the Mexican government to support local ownership and local capabilities under ISI as well as unfettered liberalization of the industry in the 1980s and 1990s. Most tenants in Audi's supplier park San José Chiapa are subsidiaries of multinational component firms from advanced countries.[26] The Mexican automotive industry still looks like a collection of foreign-owned enclaves today.

Central and Eastern Europe

Similarly to Mexico's integration into NAFTA, Central and Eastern European countries have been integrated into the European triad market as producers of low-end, high-volume models for European markets, and as producers of all kinds of components, including engines and transmissions, but also as producers of high-end, low-volume models for European markets. Flexible labour regulations and low wages make it possible to even produce the latter low-volume models for exports (Havas, 2000: 245–8). By the late 1990s, it was already evident that local content in these countries increased significantly (ibid, 255). At first, the new assembly plants of the OEMs in Hungary, Slovakia, Romania, Poland and Czech Republic were supplied from the OEMs' existing supply bases, but as local component sectors in those countries developed, local content increased. Just like in Mexico, this increase was almost completely based on follow sourcing of multinational OEMs. Increasing modularity necessitated the close proximity of several module and component suppliers, as explained in the analytical framework section above.

But the number of local firms was already on the decline in the late 1990s (Havas 2000, 255). Pavlínek (2020) finds that between 2005 and 2016, things did not change much for the better. The benefits from large FDI to the domestic firms were limited. Large domestic automotive firms in Eastern Europe only accounted for 20 per cent of newly created jobs, but for more than half of all job losses between 2005 and 2016 (535). Denationalization of the supplier base is a clear trend, even though these countries have increased their vehicle and parts production and volumes significantly. Czech Republic's total parts and vehicle exports amounted to $37.6 billion in 2019, followed by Slovakia ($28.2 billion), Poland ($21.2 billion), Hungary ($20.1 billion) and Romania ($12.4 billion) (see data from Figure 1). All of these countries, except for Poland and Romania (which a have a larger share of vehicle production for the domestic

[26] Source: https://www.audi-mediacenter.com/en/press-releases/audi-mexico-opens-supplier-park-in-san-jose-chiapa-6845. Accessed on 09/08/2020.

market), have among the highest share of FVA in their automotive exports in the 26-country sample. The picture is thus very similar to that of Mexico.

Pavlínek (2016) discusses the case of Slovakia in depth and shows that the development of domestic wages significantly lags the productivity increases in the industry, which is dominated by foreign-owned firms. Automotive lead firms play different countries in Central and Eastern Europe against each other to keep taxes and wages low, while appropriating large public investment incentives and shifting the burden of infrastructure building onto local governments. At the same time, Slovakia has recorded the highest annual GDP per capita growth among all OECD members between 2001 and 2011.

In their analysis of the Polish automotive component manufacturing industry, Domański and Gwosdz (2009: 459) also find a clear foreign dominance, especially at the first tier level. Nevertheless, there are some domestic firms that have been successful, especially in components such as stamped metal parts, plastic and rubber components, rolling bearings, forged parts, interior trim and electrical equipment. These are typical components for locally owned firms in developing and emerging countries, as discussed in the analytical framework above. The majority of domestically owned Polish component firms can supply to OEMs on a 'built-to-print' arrangement, but they lack design and product development capabilities. Domański and Gwosdz estimate that there were some 40-50 Polish tooling companies in the late 2000s, and several engineering firms that can offer design and engineering services for specialized automotive machinery and equipment in the areas of automatics, electronics, and transport equipment (472-3). A similar picture can be observed in Czech Republic. The death of the local supplier firms has not happened. There is some space for domestic automotive companies to participate in the European and global automotive value chains, but these supplier networks are dominated and governed by foreign MNCs. In Czechia, there are also very limited R&D activities in the MNC subsidiaries, with all the implications that has for localization prospects, as discussed above. The Eastern European countries are geographically close to the European OEMs' home countries, which lowers the need for R&D and PD relocation.

Intermediate cases with lower production/export volumes and weak local firm base

The countries discussed in this category have also experienced limited emergence of internationally competitive locally owned component firms. And in contrast to the previous category, they are characterized by lower vehicle and parts production and export volumes, indicating lower international competitiveness. The cases discussed are in the following order Malaysia and Indonesia (national car), Philippines, Vietnam, Argentina, South Africa, and Morocco. Morocco is the only case of regional peripheral integration in this category, namely in the European production network, while the other countries are cases of inward-orientation or integration into either ASEAN or Mercosur. South Africa is the oddball in the grouping, having developed an export-oriented industry despite being located far away from its major export destinations. It remains to be seen whether Morocco can replicate Turkey's success with localization, or whether its experience will be more like that of Central and Eastern Europe.

Malaysia and Indonesia

Malaysia's and Indonesia's cases are more similar to that of Brazil than to those of Mexico and Eastern Europe, since Malaysia and Indonesia are integrated in a much more balanced regional production network (ASEAN) and local production is predominantly for the domestic and regional markets. While Malaysia's and Indonesia's experiences have not been stories of denationalization, they still pale in comparison to Thailand for other reasons. The comparative data in Figure 5 shows that both Malaysia's and Indonesia's automotive parts and vehicle exports are small compared to Thailand. Indonesia's higher vehicle exports and very low FVA in automotive exports compare favourably to Malaysia. Its FVA is also much lower than that of Thailand but at much lower overall export levels. Thailand's total vehicle production is almost double that of Indonesia, despite Indonesia's large population, which is testament to Thailand's position as an export hub.

Just like South Korea, Malaysia tried to develop national assembly companies and a national car. But LCRs in Malaysia were not combined with discipline from either export or domestic markets (Lee et al., 2021: 17). The indigenous assemblers Proton and Perodua are not capable of producing their own engines and since liberalization of the industry in the context of WTO accession 2004, Japanese cars dominate the Malaysian market (ibid, 19). When Thailand liberalized its automotive industry, its local component firms were incentivized to acquire technological capabilities by producing for exports (Techakanont, 2011: 223). In contrast, Malaysia tried to emulate the South Korean experience by nurturing its own assemblers in Proton and Perodua, which never reached significant scale. In Korea, the local component manufacturing industry was largely created through spin-offs from the successful OEMs when they vertically disintegrated. Proton and Perodua never reached the scale to give such an impetus to the local auto industry in Malaysia. Instead, focusing on these national champions meant that Malaysia did not embrace becoming part of regional and global automotive supply chains, unlike Thailand (Baldwin, 2011: 19).

Vehicle production in Indonesia is dominated by Japanese OEMs. According to Barnes (2017: 226), Toyota held a market share of 37 per cent in PVs in 2010. Like Malaysia, Indonesia had a period in which it pushed its national car, the Timor Putra National. The project that was initiated in 1996 was a failure, and in 2001 the Timor-Kia JV was bankrupt. There were also appeals against the national car programme at the WTO. Indonesia eventually abolished the programme, and also the local content policy in 1999. However, the industry was never fully liberalized, and import duties have always remained in place (ibid, 226-7). Local component manufacturing firms are nevertheless weak. Component manufacturing, just like assembly, is dominated by Japanese FDI (ibid, 228). The MNCs conduct most of the manufacturing activities locally, as evidenced by the positive trade balance and the low FVA in exports, but it is not true local content. The domestically owned share of the industry remains weak.

Philippines

Unlike in Thailand, Malaysia and Indonesia, there is basically no vehicle production in the Philippines. The zero units of domestic production that OICA reports are not correct. There is

some local CKD production by Japanese OEMs but hovering around below 100,000 units. This was not always the case, as the industry has a long tradition in the Philippines. The usual policies around LCRs seen in other countries, including its ASEAN neighbours, were also implemented in the Philippines in the 1970s and early 1980s. But then the industry was liberalized in the late 1980s and automotive components tariffs were quickly reduced to almost zero, which went way beyond what Thailand, Indonesia and Malaysia did (Sturgeon et al., 2016: 25-26). Many of the more than 200 component firms that existed were undercut and vanished (ibid). More recent attempts to revive the industry have been unsuccessful, mainly because of low vehicle demand and therefore insufficient economies of scale for local vehicle and components production, as well as competition from more competitive locations like Thailand, which has developed into the regional hub (Bamber et al., 2019: 114).

Nevertheless, the country has integrated into the automotive components supply chain. This has happened on the back of the electronics and electrical (E&E) equipment sector, which has always been the most important manufacturing sector in the Philippines (Bamber et al. 2019, 111). Based on the manufacturing competence in E&E, wire harness production in export-processing zones has become a major activity in the Philippines. Following investment by wire harness MNCs, local electronics firms moved into the automotive sphere (ibid, 116-18). Bamber et al. argue that functional upgrading from the wire harness GVC into R&D and into automotive electronics has so far remained limited. There are some signs of improvement though. Some limited product upgrading into electronic radars, chassis, wheel and braking sensors can already be observed (Sturgeon et al., 2016: 43). These positive developments are even more significant in the aerospace industry. Bamber et al. (2019, 125) show that chain upgrading into the aerospace GVC was only possible because of the previous accumulation of capabilities and investment capital in the automotive GVC, which is testament to the significant linkage potential of the automotive industry.

According to Sturgeon et al. (2016, 27), there are no domestically owned tier-1 automotive component firms, but slightly more than 100 Filipino-owned tier 2 and tier 3 suppliers, of which 48 per cent are in metal working, 18 per cent in seat and trim, 10 per cent in rubber manufacturing, and 8 per cent in electrical. Only 330 of the several 10,000 parts of an automobile are produced in the Philippines (ibid, 39). The only significant automotive exports category is wiring harnesses. The wiring harness firms are predominantly foreign owned, and the Philippines serve as the low wage production hub of wiring harnesses for the Japanese auto market (ibid, 30-31).

Vietnam

Domestic vehicle assembly in Vietnam is excessively fragmented, according to Sturgeon et al. (2016: 18). In 2013, total PV production was below 200,000 units and shared among 14 different assembly plants. In contrast to that, Brazil had only slightly more assembly plants in 2010 (25), but more than 15 times the production volume of Vietnam (Ibusuki et al., 2012: 183). This situation completely precludes the capture of significant economies of scale by both local assemblers and components producers. Sturgeon et al. (2016) trace back the problem of

fragmented production to "the excessive issuance of investment licenses in 1995-1996" (18). The Vietnamese auto policy thus failed to achieve one of the key objectives of government policy discussed above, namely that of model rationalization. The local vehicle assemblers are uncompetitive in vehicle exports, as evidenced by the fact that vehicle exports from Vietnam are almost non-existent.

More recently, Vietnam has, however, been integrated into the Japanese OEMs' regional production networks, based on ASEAN intra-regional free trade. Antennas, accelerator pedals and exhaust recirculation valves for the Toyota Innovation International Multi-purpose Vehicle (IMV) platform are, for example, manufactured in Vietnam (Schroeder, 2020: 8). While these are rather simple components which suit Vietnam's comparative advantage, the country's automotive parts exports are already on par with those of Malaysia and Indonesia, and higher than those of the Philippines. Locally owned suppliers play a limited role, but the 40 per cent minimum local content under the ASEAN free trade agreement provide some incentive to include local firms (Schroeder 2020).

Argentina

Among all the countries in this category, Argentina has the lowest combined parts and vehicle exports. It is still worth discussing since it has significant domestic production and some lessons can be learnt from the industry's historical development. In contrast to countries like Thailand and Turkey, liberalization of the Argentinian automotive industry happened in a non-gradual unfettered way and hit local producers hard. Argentina's automotive industry is almost completely integrated with the Brazilian industry. Almost all cars produced in Argentina go to Brazil (González et al., 2012: 53). Local component producers flourished under protection until around 1990, when the industry was liberalized (ibid, 54). Automotive exports increased from $1 billion to $2.4 billion between 1995 and 2010, but imports increased even more from $2 billion to $8.7 billion (ibid, 55). Ten firms, of which nine are multinationals, including the locally operating OEMs that also produce parts in addition to vehicles, account for 70 per cent of total automotive components exports. The one national firm among the ten is Basso, the valve producer that upgraded from the local aftermarket into a globally competitive OEM supplier, and the case of which I briefly mentioned above.

The liberalization of the industry started in 1991. By 1998, almost 50 per cent of the automotive suppliers from 1991 had disappeared. Among the firms that survived, only 30 per cent were in domestic ownership by 1998. At the same time, productivity of the sector increased by 157 per cent between 1994 and 1999 – a familiar development that could also be observed in many other countries: Highly productive multinational component manufacturers replace less productive domestically owned firms. McDermott and Corredoira (2010: 310) document a sharp decline in the local production of many high-value-added engine and chassis subsystems and components. Miozzo (2000) traces how denationalization happened in response to uncareful liberalization and wiped out most of the domestic component manufacturing base already by the late 1990s.

South Africa

South Africa's combined automotive parts and vehicle exports in 2019 were higher than those of all other countries in this category. They even exceeded those of Brazil ($7.3 billion vs. $5.61). In contrast to Brazil, Argentina, Malaysia and the Philippines, South Africa had a positive automotive trade balance in 2019. All of this is a significant achievement given its unfavourable geographic location, far away from the major vehicle markets, and the limited domestic market. Since liberalization of the industry in the early 1990s, South Africa has implemented consistent automotive policies that have granted OEMs and component suppliers significant trade- and investment-related incentives. The industry is often pointed out as the single success story of manufacturing in South Africa since the end of apartheid. The government has attracted sizeable sums of investment by seven PV and LCV OEMs. The three German OEMs BMW, Mercedes-Benz and Volkswagen are using South Africa as an export hub for vehicles. Ford and Toyota, and to a smaller extent Nissan and Isuzu, are producing mainly pick-ups for the domestic and wider African markets, with some supra-regional exports as well, especially in the case of Ford and Toyota.

Nevertheless, the performance lags significantly behind other countries like Thailand. Both Barnes et al. (2017) as well as Bell and Monaco (2021) show that the Thai automotive industry compares very favourably to the development of the South African automotive industry, especially when it comes to overall vehicle and component production volumes, but also in export volumes, especially in components, as well as with respect to the localization of the industry. While Thailand has a large domestic supply base, at least at the lower tiers, South Africa has managed to attract significant multinational investment at the tier-1 level but has failed to build a locally owned sub-supplier base (Black et al., 2018). Current government policy, under the banner of the South African Automotive Masterplan 2035, is trying to change this, but whether it succeeds remains to be seen. Automotive component exports from South Africa are much lower than its vehicle exports, and undiversified in their composition. Catalytic converters (based on the local availability of platinum-group-metals), the production of which is foreign controlled, are the major automotive component export category.

The key problem is that overall production volumes are too low for further significant localization. Local domestic demand and demand from other African countries has so far been incapable of providing a further stimulus to production volumes. South Africa already exports more than 50 per cent of the domestically produced vehicles, mainly to Europe, and other distant markets. Total domestic PV and LCV production stood at 603,000 units in 2019 (NAAMSA 2020). The current iteration of the automotive policy had set a production target of one million vehicles by 2020. This target was clearly missed. Due to the Covid-19 pandemic, production in 2020 was much lower than in 2019, at 424,000 vehicles. Nevertheless, as the 2019 figure indicates, the target would have been missed by a lot anyway. The problem is that the South African government does not have much bargaining power to hold the industry, and especially the OEMs and tier-1 suppliers, which are all and mostly foreign-owned respectively, to account. South Africa is a small production location for all the OEMs involved in the country.

The very thin local supplier base, especially at the lower tier levels, is, however, a significant problem that must be tackled to magnify the developmental impact of having the industry in the country. Otherwise, the claims that the incentives provided to the foreign firms (investment cash grants of around 30 per cent) are too generous will not go away. Like many of the other countries discussed above, South Africa also had a very inefficient and fragmented industry that was developed through ISI-type policies during apartheid. The local content requirements were based on weight and not on value, and the insufficient economies of scale captured by an industry incapable of exporting before liberalization created a locally owned but extremely inefficient domestic industry. Liberalization, i.e. the reduction of tariffs and LCRs, was indispensable to sustain the industry in the country by making it globally competitive. However, compared to other countries, LCRs were arguably abolished too swiftly and tariff protection was quickly reduced to effectively zero.[27] Denationalization of the local component manufacturing industry was the result. While the attraction of MNC component investment was certainly needed to make the industry internationally competitive and ensure its continued existence, more gradual liberalization might have pulled more locally owned component makers along with them.

Morocco

The other African country with significant vehicle production, in addition to South Africa, is Morocco. In 2019, 395,000 vehicles were produced in Morocco. This is up from 18,500 units in 2003 (Hahn and Vidican-Auktor, 2017: 10). The rise of automotive production in Morocco is due to the investment of one single OEM, namely Renault (ibid, 13). Renault's main plant is in Tangier and produces the Dacia Dokker and the Lodgy, as well as some units of the Sandero, all based on the Renault/Dacia Logan platform discussed above. The Dacia factory has an integrated press shop, a body shop, and a paint shop. Its large production volumes are the reason why these activities can be localized.[28] The steel is imported from Europe and engines and gearboxes are imported from Renault Spain (Henry, 2020). More recently, PSA Peugeot-Citroen has also conducted significant investments in Morocco. PSA wants to produce 200,000 vehicles in Kenitra by 2023 (ibid).

In addition to the assembly investment by Renault and more recently by PSA, several multinational suppliers have also invested in Morocco. Some have invested to supply the local Dacia plants, but others have invested to supply components into Europe, independent of local vehicle production (Henry 2020). Local suppliers are mostly active in wiring, metal processing, plastic processing and seats and seating systems (Hahn and Vidican-Auktor, 2017: 14). This is, however, developing rapidly. All the significant supplier companies are foreign owned follow sourcing firms. Renault exports almost all its vehicle production. The largest export market is Europe, and within Europe France (ibid, 11). Renault's large investment was attracted by "extensive" government incentives, such as interest-free loans, land provision and tax exemptions, in the early 2000s. Low labour costs and the tariff-free access to the EU market

[27] OEMs could reduce import tariffs for vehicles and components to zero via import rebate credits earned through exporting (until 2012) and investing (from 2012) (Black et al., 2018).
[28] Most of the assembly plants in South Africa, in contrast, do not have local body pressing because volumes are not large enough.

were also part of the investment rationale (Henry, 2020). The EU Association Agreement came into effect in 2000. Renault's factory for the Logan platform in Romania was reaching its limits in the early 2000s and Morocco, where Renault was already conducting small-scale operations, was a good candidate for the expansion. The factory in Tangier was opened in February 2012 (Hahn and Vidican-Auktor, 2017: 17).

Like most other countries with an automotive industry today, the country has a long history of automotive production, which was established under the rationale of ISI back in the 1960s, also around the leadership of Renault (Hahn and Vidican-Auktor, 2017: 15). Currently, the automotive industry in Morocco is mostly a foreign owned implant. The extent of its spillover effects to locally owned firms and the local economy remain to be seen in the future. Current predictions estimate that based on the expansion of the Renault investment and the more recent PSA investment, production volumes might soon surpass those of South Africa and reach one million units in the coming years (Henry, 2020).

Cases of failure: Egypt, Nigeria, Pakistan, Colombia

In the category of cases of failure, I include those countries that have tried to sustain or expand their domestic automotive industry but have failed to generate significant production volumes. Examples of this are Egypt, Nigeria, Pakistan, and Colombia. Neither of these countries are included in Figure 1 since they do not belong to the top 50 global automotive parts exporters. Domestic PV and LCV production in these countries in 2019, according to OICA, was 60,000 units in Colombia, 180,000 units in Pakistan, 18,500 in Egypt, and zero in Nigeria. These numbers are not always accurate. While Colombia exported a bit less than $500 million worth of automotive parts and vehicles (90 per cent vehicles) in 2019, automotive exports in Pakistan, Egypt and Nigeria were basically zero. The automotive trade balances of all these countries are excessively negative. The above numbers are not the result of having decided to not pursue the development of an automotive industry. It would not be a problem if a country specializes in other manufacturing sectors and then does not produce automobiles domestically and imports them instead. But all these countries have actually intervened significantly in the sector and have tried to build a domestic automotive industry. The main problem is that they have failed to attract FDI.

In the case of Egypt, the industry, like in so many other countries, was protected behind high tariff walls until around 2000. The result was an inefficient small-scale industry without integrated production. In 2004, Egypt entered into a free trade agreement with the EU with the commitment to reduce tariffs to zero by 2019. Since 2004, vehicle imports have increased rapidly. Foreign assemblers have not invested and some, like in the case of Mercedes-Benz, have even fully removed their local CKD production. Hence, Egypt has not even climbed step one on the industrial upgrading ladder, introduced above in the analytical framework. Some domestic small-scale assemblers have lobbied against the free trade agreement's implications for the auto industry and implementation has been stymied through the introduction of several non-tariff barriers (Black et al., 2020: 19–23). In Nigeria, imports of second-hand vehicles render any local vehicle production uncompetitive. A recent attempt at introducing an

automotive policy to curb such imports has failed. Current negotiations on automotive policies in Egypt, but also in Ghana (where the policy is already being implemented) and Ethiopia look more promising (AAAM 2020). Overall, the lesson from the Egyptian and Nigerian experience, but also from Colombia and Pakistan, is that without the right conditions to attract FDI, and more specifically investment from the major global OEMs and component manufacturers, there will be no chance of developing a competitive local automotive industry.

6. Conclusion

Overarching dynamics in the automotive GVC around the phenomena of modularity, JIT/JIS supply and follow design & follow sourcing have made it more difficult for locally owned manufacturing firms in developing countries to participate in the GVC. The attraction of FDI in OEM assembly and component manufacturing is a necessary condition for the development of a competitive local automotive industry. Since the automotive GVC is a producer-driven GVC, the lead firms relocate to the country in question. This differs from e.g. the apparel GVC where lead firms outsource production and usually do not own the production facilities in developing countries. When the OEMs come to a new country or expand their existing investment in a country, they usually convince their main tier-1 suppliers to follow them into the country (follow sourcing). This applies to European, American but also to Asian OEMs. OEM sourcing patterns have converged a lot, independent of the origin of the OEMs. Follow sourcing is a consequence of both follow design and the extensive technological capabilities required for design cooperation, logistics, module and system supply, as well as JIS/JIT delivery. Thus, even when tier-1 suppliers are not willing to relocate, which might be the case because of low local production volumes, or because they already have a facility in a nearby country, the OEMs will rather source from that nearby facility or source from a different multinational tier-1 supplier that is already present in the country.

Locally owned component firms will only be chosen at the tier-1 level if they have the above-mentioned capabilities and if they have a global footprint. This is the reason why the denationalization of the component manufacturing industry at the tier-1 level is a global trend, and even applies to the comparably successful cases like Turkey and Thailand. Local firms might still manage to become tier-1 suppliers of components, but rarely of entire modules or systems. And those rare examples of locally owned component manufacturers that have managed to become globally competitive tier-1 suppliers have all gone through a long time of capabilities building and continuous upgrading, along the lines described by Saranga et al. (2019) and Lee (2019), which usually includes own in-house R&D activities and outward FDI. Examples of such firms can be found in China and India, where government protection before liberalization has provided a space for these firms to learn and where the large domestic market has provided niches of competitiveness, mostly in the low-end of the market, where low costs and knowledge of local conditions are key advantages to these firms.

The space for locally owned firms in developing countries is still a bit larger at the tier-2 or tier-3 supplier level, or at the tier-1 level if these firms only supply individual components and the OEM conducts the module or system assembly. The local firms then usually supply

components on a 'built-to-print' basis. Beyond the modules and systems, and those components that require proprietary technology, which only large international suppliers possess, nothing is set in stone. There is still a lot of space for local firms to benefit from the presence of an automotive industry and the inclusion of the country in the automotive GVC.

To think about the opportunities for localization, I have developed an analytical framework around three sets of explanatory factors: 1) Local demand and production conditions related to economies of scale, 2) automotive GVC factors and lead firm strategies, and 3) the industrial and trade policies implemented by the government. The interaction of these sets of factors create the outcomes for the local industry, for which I have proposed a ladder of industry-level upgrading across four steps: 1) the establishment or revival of national or regional auto assembly, 2) the move from largely imported components to increasing local sourcing, 3) the shift in local sourcing from multinational suppliers (follow sourcing) to locally owned suppliers, and 4) the aggressive localization of the production of the powertrain, and vehicle design, which locks in local content at high levels.

There is a limit to the amount of generalizations one can make about the interaction, especially of the different automotive GVC factors. There will always be a certain degree of randomness involved. Hence, this paper did not try to provide an all-encompassing analytical framework and understanding. Instead, it provides a framework for making sense of outcomes and explanatory factors – a framework to think about the interaction between the local automotive industry, as shaped by the dynamics of the global value chain and local policy decisions, and economic development outcomes in the country. The categorization and discussion of different country cases has substantiated the proposed analytical framework and provides useful lessons for developing countries trying to establish or deepen a local automotive supply chain today. Based on this exercise, I feel more comfortable to make some generalizations about stylized facts.

The range of factors associated with the GVC and lead firm decisions that affect localization include the extent of local demand, which makes local design and investment into tooling viable and also gives more bargaining power to the local government; labour costs; other local production cost factors, like energy costs, local infrastructure, and incentives provided by SEZs or EPZs; currency risks; transport and freight costs (especially in the case of bulky components with a "poor truck utilization rate"); design collaboration and JIS/JIT delivery both require geographical proximity to reduce transaction and logistics costs; and lastly policy factors such as import duties, taxes and other policy-related aspects. It is very important to distinguish between local sourcing from MNC subsidiaries and local sourcing from locally owned firms. It has very different implications for economic development. In addition to that, local content is often measured based on whether a component was assembled locally or not, without subtracting the imported content, usually raw material, or sub-components.

The localization of vehicle and component design, or at least local design adaptation, is positively related with local content. Local design adaptation takes the advantage away from the follow sourcing supplier and provides an opening for local design centres and even the

involvement of local firms. The Turkish government, for example, has used policy in terms of incentives for R&D expenditure to support the process of design localization. But we are also dealing with a chicken-and-egg problem here, since it is unclear whether local R&D centres are a cause of increased localization and local firm capabilities, or vice versa. Design localization is certainly more likely in places with larger domestic or regional demand. And there is also a lock-in effect. If one vehicle type, say a pick-up model for emerging economies, by one OEM is produced in three different countries, say in Thailand, South Africa and Argentina, then design and supplier selection – if it does not happen centrally in the OEM headquarter – will happen in the country with the largest production locally. This will in this case be the global pick-up hub Thailand. First-tier suppliers for design collaboration will be selected in Thailand, and then the subsidiaries of the same suppliers in Argentina and South Africa will be chosen accordingly. This is the essence of follow sourcing. Hence, the largest production locations will always have an advantage over the other locations. They are also more likely to see the emergence of local engine, transmission, and gearbox production. The area of the powertrain is the key area for localization. When the production of the powertrain components is localized, this has extensive knock-on effects on overall localization because of the large number of sub-components that can then also be manufactured locally.

One theme that was prominent throughout the discussion of automotive GVC factors is that several factors must be understood along the lines of a spectrum rather than as a binary issue. In the area of design, OEMs can introduce a global model in all their destination markets, or they can introduce one fully distinct locally design model in every location, which would be the other extreme. Between these two extremes, there is a range of compromises involving different extents of localization and communalization that OEMs usually opt for, based on their own strategies but also based on local conditions and policies. At the level of multinational component firms, a similar observation can be made with regards to their investment in a new location. Here, the spectrum goes from the installation of a fully integrated manufacturing facility, with a full set of tooling, to the other extreme, which would be just a local warehouse or an assembly plant which conducts last touches on imported components. Between these two poles, there is a set of compromises that a supplier can opt for, depending on several other factors like local demand, OEM requirements, local policy, and the availability of other production facilities nearby. Thirdly, there is also a spectrum between multinational supplier ownership and full local ownership. Suppliers can be wholly owned local subsidiaries of MNCs, they can be JVs between MNCs and local firms with varying ownership distributions, or they can be fully locally owned firms. The fact that these three issues operate along a spectrum and are not either-or issues, increases the possible variety of interaction between the different explanatory factors discussed, and makes it even more difficult to derive generalizations.

Another issue that adds further complexity is that factors and outcomes are further influenced by the type of component. The automobile is an extremely complex product with a large variety of different components, as illustrated by the overview in Table 1. Some stylized facts can still be derived. Electronics and telematics components are often easier to transport from far away because of their high value-to-weight ratio. They are mostly sourced from large volume plants

in Asia, where several countries have a comparative advantage in electronics and telematics manufacture. Their importance will increase even more in the future. Components that are often found locally and which are frequently manufactured by locally owned companies are those in the areas of castings, forgings, metal-pressing, rubber-processing, and injection moulding. Examples include fuel tanks, taillights, wheels, radiator caps, mirrors, interior trim, glass, shock absorbers etc.

One further thing that has become clear through the discussion of the different country cases is that, in the absence of policy, OEMs will opt for component imports and follow sourcing. Effective local policies need to be implemented to transform GVC participation into a learning opportunity for local firms. These policies include efforts at model rationalization through entry restrictions and minimum investment requirements, local content requirements and ownership limits, trade- and investment related incentive measures that can be tied to localization efforts, and creative types of industrial policies to support indigenous firm learning. All the countries discussed above that still have an automotive industry today had a period of ISI-type policies in the last century. The dividing line for where countries stand today is how they have managed liberalization. Have they managed to keep and/or build a local supply base or have they lost it? Of course, large countries like China and India have a big advantage because of their large domestic markets. But when comparing countries like Thailand and Turkey with countries like South Africa, Brazil and Argentina, it becomes clear that the more successful countries were more careful with the liberalization of the industry in the 1990s. While the latter three implemented immediate and sweeping liberalization of the industry, including the rapid abolition of LCRs, Thailand and Turkey, but also China and India, were much more gradual in their approach, and only liberalized more once further steps of localization and local capability building were completed.

Countries like Brazil and South Africa are currently trying to reverse the erosion of their local component manufacturing bases. Trying to do this requires a different strategic approach and different policies than nurturing a local base when establishing the industry for the first time, or say, when liberalizing comprehensively for the first time. The automotive industry in these two countries is already well established and is largely foreign dominated. It is not useful in that case to reinstall the old ISI-style policies. The OEMs would likely just leave, especially in a place like South Africa with an unfavourable geographic location. The best remedies seem to be increasing local production volumes in a joint effort between the local government and the industry associations together with the OEMs and the major MNC suppliers, and to provide incentives and apply policies that ensure that more local firms are involved when the local industry expands. Less-invasive policies like supplier development programmes, building supplier parks and SEZs, supporting promising local firms in their start-up efforts and helping them access technology and equipment, can also help to increase localization in these situations.

Countries that are only just building their automotive industry, perhaps on the base of a growing domestic market, should learn from the hasty liberalization experiences of the likes of Argentina and South Africa in the 1990s and be more gradual in their approaches. Of course,

liberalization of the industry is imperative for its upgrading efforts and to eventually become internationally competitive. However, the successful cases had LCRs longer than others, and they have based their incentives and support measures on localization. The overall point is that without government intervention and steering of the development of the industry, there will not be any localization. And localization is a key objective for the country's economic development. The emergence and survival of indigenous component manufacturing firms, which gradually upgrade into more sophisticated and technology-intensive component production, is perhaps the most important performance indicator for a developmental automotive industry.

Three important areas that have been touched in this paper, and whose importance I have emphasized, but which could not be discussed in detail are the following: 1) Technological efforts and firm-level learning, 2) Political economy aspects as explanatory factors, and 3) Linkages. All these aspects are crucial and deserve further attention, but they fall out of the scope of this paper. It was a deliberate choice to focus more on the industry level instead of on the firm level. Both are important, but the GVC literature often focuses more on the firm level. In the case of the automotive industry, it is crucial to understand developments at the industry level, both in terms of GVC factors, i.e. which OEMs and supplier MNCs have localized and what are their strategies, and in terms of government industrial policy for the sector. These industry-level factors and developments condition the opportunities for local firms. For the in-depth discussion of different country cases it is indispensable to include political economy analysis in the overall analysis. Here I have focused more on GVC factors and policies and how they have brought about different outcomes across countries. To understand how policies are developed, and how the bargaining between the local government and GVC lead firms as well as local actors occurs, political economy analysis is needed. This was not the focus of this paper. Lastly, the automotive industry has extensive linkages with other industries because of the variety of components and sub-components involved. To understand the impact of the industry on local economic development, an analysis of how these linkages are developed in the national economy is key. I address this in detail elsewhere (Wuttke, forthcoming).

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Appendix

Full list of indicators and data for Figure 1

	Total average rank	Auto parts exports in bil US$	Rank auto parts	Vehicle production in '000s	Rank vehicle production	Vehicle sales in '000s	Rank vehicle sales	Total auto trade balance in bil US$	Rank trade balance	Vehicle exports in bil US$	Rank vehicle exports	FVA in auto exports	Rank FVA	DVA in foreign auto exports	Rank DVA	Change in DVA/FVA ratio 2005-2015	Rank GVC upgrading
South Korea	**5.50**	18.98	**3**	3951	**3**	1795	**4**	44.46	**1**	40.45	**2**	27.25	**5**	1.77	**11**	0.15	**15**
China	**6.38**	33.63	**1**	23362	**1**	25769	**1**	-30.02	**29**	8.64	**8**	16.34	**1**	2.03	**9**	0.79	**1**
Turkey	**8.13**	4.87	**11**	1431	**8**	492	**12**	8.25	**7**	12.10	**6**	27.4	**6**	2.76	**7**	0.24	**8**
Mexico	**8.25**	30.84	**2**	3773	**4**	1360	**6**	44.44	**2**	50.63	**1**	48	**20**	1.33	**19**	0.16	**12**
Czechia	**9.88**	15.17	**4**	1428	**9**	281	**15**	22.11	**3**	22.44	**4**	54.28	**23**	5.26	**1**	-0.02	**20**
India	**10.00**	5.02	**9**	4195	**2**	3817	**2**	7.61	**8**	7.00	**10**	28.05	**7**	1.11	**20**	-0.06	**22**
Poland	**10.13**	14.35	**5**	643	**12**	656	**9**	1.97	**10**	6.84	**11**	39.32	**14**	4.07	**3**	0.09	**17**
Slovakia	**10.13**	5.02	**10**	1100	**11**	114	**21**	13.54	**4**	23.15	**3**	59.56	**26**	5.01	**2**	0.50	**4**
Thailand	**10.25**	7.39	**6**	2014	**6**	1008	**8**	9.34	**6**	9.40	**7**	46.72	**19**	1.07	**21**	0.23	**9**
Hungary	**11.25**	7.37	**7**	498	**15**	163	**20**	10.27	**5**	12.67	**5**	54.4	**24**	3.93	**4**	0.19	**10**
Romania	**11.63**	6.93	**8**	490	**16**	189	**18**	5.27	**9**	5.47	**13**	35.32	**10**	3.86	**5**	0.15	**14**
Indonesia	**11.63**	1.71	**15**	1192	**10**	1043	**7**	1.14	**13**	3.94	**14**	18.08	**2**	1.5	**16**	0.12	**16**
Brazil	**12.63**	1.79	**14**	2804	**5**	2788	**3**	-2.32	**22**	3.82	**15**	19.6	**4**	1.71	**12**	-0.47	**26**
Slovenia	**14.25**	1.14	**17**	199	**20**	85	**23**	1.50	**12**	3.76	**16**	46.19	**18**	3.48	**6**	0.65	**2**
South Africa	**14.50**	0.64	**20**	603	**13**	537	**11**	1.91	**11**	6.70	**12**	39.57	**15**	1.98	**10**	-0.32	**24**
Russia	**15.38**	0.63	**21**	1642	**7**	1779	**5**	-14.42	**28**	1.62	**18**	30.51	**8**	1.69	**13**	-0.21	**23**
Argentina	**16.13**	0.56	**22**	315	**18**	409	**14**	-3.57	**26**	0.27	**25**	18.34	**3**	1.42	**18**	0.58	**3**
Malaysia	**17.63**	1.07	**18**	572	**14**	604	**10**	-3.20	**25**	0.43	**21**	56.22	**25**	0.98	**23**	0.46	**5**
Morocco	**18.13**	0.32	**26**	395	**17**	166	**19**	0.39	**14**	3.44	**17**	40.34	**16**	1.54	**15**	-0.03	**21**
Singapore	**19.38**	1.88	**13**	0	**26**	91	**22**	-1.61	**20**	0.38	**23**	39.29	**13**	0.76	**25**	0.16	**13**
Philippines	**19.38**	0.89	**19**	0	**26**	416	**13**	-2.85	**23**	0.00	**29**	34.23	**9**	1.47	**17**	0.05	**19**
Tunisia	**19.63**	0.38	**24**	0	**26**	49	**26**	-0.44	**16**	0.02	**28**	37.66	**11**	2.13	**8**	0.05	**18**
Croatia	**19.75**	0.32	**27**	0	**26**	72	**24**	-0.98	**18**	0.41	**22**	38.57	**12**	1.04	**22**	0.27	**7**
Viet Nam	**19.88**	1.34	**16**	250	**19**	281	**16**	-2.91	**24**	0.03	**27**	52.93	**22**	0.96	**24**	0.19	**11**
Bulgaria	**20.50**	0.19	**29**	0	**26**	44	**27**	-0.85	**17**	0.31	**24**	50.59	**21**	1.59	**14**	0.36	**6**
Hong Kong	**23.50**	0.33	**25**	0	**26**	34	**28**	-1.70	**21**	0.55	**20**	44.91	**17**	0.68	**26**	-0.45	**25**

Year and data sources of the different indicators: Auto parts exports (2019; UN Comtrade commodity 8708); Vehicle production (2019; OICA, passenger vehicles and light commercial vehicles); Vehicle sales (2019; OICA, all vehicle types); Total auto trade balance (2019; UN Comtrade commodities 8703 and 8708); Vehicle exports (2019; UN Comtrade commodity 8703); FVA = foreign value added in automotive exports (2015; OECD TiVA database 2018, industry category 29 – motor vehicles); DVA = domestic value added in foreign automotive exports (2015; OECD TiVA database 2018, industry category 29 – motor vehicles); GVC upgrading = change in the ratio DVA/FVA from 2005 to 2015 (OECD TiVA database 2018, industry category 29 – motor vehicles).
The countries included in the list are all non-traditional automotive countries out of the top 50 global automotive parts exporters (UN Comtrade 2019, commodity 8708). Traditional automotive countries are all Western European countries, the US, Canada, Australia, and Japan. The original list and the ranking for all indicators except FVA, DVA and GVC upgrading, also included the United Arab Emirates, Belarus and Serbia. Since OECD TiVA data was not available for these countries, they were dropped from the table and the visualization. They ranked 12th, 23rd and 28th respectively in automotive parts exports out of all 29 non-traditional automotive countries.

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