MODUL_2022

Electric and Autonomous Vehicles

Rudolf PÁSTOR

Global value chain (GVC) in automotive industry

Modul_2022.

Electric and Autonomous Vehicles

Rudolf PÁSTOR

Global value chain (GVC) in automotive industry

TABLE OF CONTENTS

1. INTRODUCTION

Analysing the automotive sector is important for understanding the evolution of many economies in the EU. This is because of the sector's direct importance in terms of GDP and employment, its sensitivity to the economic cycle, as well as its extended role in the economy through supply chains. The aim of this course is to evaluate recent trends in the automotive industry and using a **global value chain (GVC) approach**. We evaluate the potential impact across countries and automotive sector. We conclude the course by studying the current trends, e,g, as **autonomous vehicles** transform the value chain.

The rise of **global value chains (CVCs)** is considered one of the most important features of the rapid economic globalization in recent decades. The economic and popular literature has described phenomena relating to the rise of GVCs from different perspectives, e.g. fragmentation, offshore sourcing, external orientation disintegration of production, global production sharing, vertical specialization, outsourcing, vertical production networks, trade in tasks, the second great unbundling, and so on.

Global value chains (GVCs) powered the surge of international trade after 1990 and **now account for almost half of all trade (52 % in 2020)**. This shift enabled an unprecedented economic convergence: poor countries grew rapidly and began to catch up with richer countries. Since the 2008 global financial crisis, however, the growth of trade has been sluggish and the expansion of GVCs has stalled. Meanwhile, serious threats have emerged to the model of trade-led growth. New technologies could draw production closer to the consumer and reduce the demand for labor. And conflicts among large countries could lead to a retrenchment or a segmentation of GVCs (World Bank, 2020).

Most research on GVCs focuses on manufacturing production; in other words, the breaking up of production processes into many discrete steps with a resulting explosion of trade in parts and components. But there are aspects of GVCs that go beyond manufacturing processes; in fact, value added and employment generation in GVCs are depending less and less on manufacturing production.

A radical shift is underway in global value chains as they increasingly move beyond traditional manufacturing processes to services and other intangible assets. Digitization is a leading factor in this transformation, which is being accelerated by the coronavirus disease (COVID-19) pandemic.

New technologies, changing consumer preferences and intensifying regulation will help reshape the automotive industry in the years ahead. Though autonomous vehicles may pose the ultimate test of automakers and their suppliers' adaptability, truly driverless cars are still many years away. The transition toward **electric vehicles (EVs)** and away from those with internal combustion engines (ICE) is a nearer-term, if no less significant, challenge. Auto companies will need to remain nimble to thrive amid this shift. The rise of EVs poses a particular risk for auto suppliers. Major systems that are essential to ICE vehicles engines are absent from EVs. Makers of exhaust systems, fuel systems, and transmissions face the

prospect of disruption as EVs become more mainstream. Those lacking financial flexibility and digital wherewithal are likely to struggle the most. Although PwC expects that adoption will grow at a modest pace for now, EVs' share of the automobile market will likely begin to expand more rapidly in the medium term. OEMs and suppliers alike should start preparing for that future today (PwC, 2019a).

Automobile manufacturers and their suppliers are making huge investments in partnerships and acquisitions so they're ready to produce tomorrow's vehicles. Whether you think that mass adoption of self-driving cars is right around the corner, or – as we firmly believe – still well beyond the horizon, it's indisputable that the decisions being made today will have a profound impact on the structure of the industry far into the future. There may be disagreement about when the car of the future will arrive, but there is a common **vision of it as connected, autonomous, shared and electric** (CASE). However, there is still little consensus on how the automotive industry of the future will be structured. What is certain is that disruptive changes are in store (PwC, 2019b).

This course provides an overview of the GVCs issue in the automotive industry, presents dimensions of the GVC analysis, focused on automotive value chain and examines changes associated with the reshaping the automotive industry through electric and autonomous vehicles.

The course is structured as follows: section 1 introduces the issue; section 2 is dealing with concepts and background, section 3 is focused on importance of the GVCs, section 4 explains what are GVCs as well as dimensions of the GVC analysis, section 5 clarifies measuring GVC participation, section 6 highlights analysis of specific GVCs and mapping the automotive industry, section 7 presents GVC in the automotive industry, final section deals with electric and automous vehicles and the impact on the automotive supply chain.

Participation in global value chains (GVCs), the international fragmentation of production, can lead to increased job creation and economic growth. In order to reap the gains from value chain participation, countries must put in place the right kind of trade and investment policies. The COVID-19 pandemic has highlighted the urgent need to understand the dependency of many countries on suppliers across the world.

This course targets, university students, development professionals or government officials interested in GVCs, businesses working or interested in working with GVCs, and individuals interested in learning about trade and GVCs.

1.1 THE GLOBAL VALUE CHAIN RESEARCH APPROACH

GVC research has attempted to capture a wider range of governance mechanism than these earlier formulations, and to link with research in industrial development studies and on global industries with practitioner interest in policy formulation for industrial development. For example Sturgeon (2009) has noted how an important aim of the shift to **GVC terminology**.

Two main aspects of GVC research as it has developed, since the publication of the key original statement in Gereffi et al. (2005), involve extending the theorization of governance of value chains and linking this to questions regarding industrial upgrading. Gereffi et. al. extended the notion of value chain governance by developing a transaction cost economics and organizational economics framework to understand the power relations shaping the links between suppliers and lead firms. In practice, the focus on industrial upgrading has become one of the most important aspects of GVC work, particularly in how it has been adopted to inform international policy frameworks for industrial and economic development (Pickles, Smith, 2016).

The GVC research approach uses the value chain as its organizational structure for describing and visualizing detailed industry studies. It is inclusive as it covers all manufacturing and service-related activities from conception through end use. While a single firm or geographic location can conduct these activities, in most cases they are divided among multiple firms in locations around the world, hence the term global value chain.

The **theoretical foundation of the approach is the GVC framework**, which can be broken into a two-part research process composed of value chain mapping and value chain analysis. The focus of this chapter is **mapping – identifying the firms, products, activities, stakeholders and geographic locations** involved in taking a good or service from concept through production to the final consumer. Simply put, it is the process of determining the 'who and what' to be analyzed. Value chain analysis looks at how and why these factors are linked together by analyzing the role certain factors (governance, institutions and interfirm relationships) play in influencing the location, development and competitiveness of a product or service. Understanding where, how, and by whom economic, social and environmental value is created and distributed along the chain provides critical information needed by economic developers to determine optimal interventions and leverage points to initiate change.

Developing an accurate and adequately detailed value chain map is critical because it provides the scope of what will be analyzed. If key pieces of the chain are omitted, results will provide an incomplete picture and may result in policy recommendations that are ineffective or counterproductive (Gereffi, Fernandez-Stark, 2016).

2. CONCEPTS AND BACKGROUND

Michael Porter first presented **the concept of value chains** in his influential 1985 book, Competitive Advantage: Creating and Sustaining Superior Performance. **Porter identifies a value chain as a set of activities that a firm performs to deliver a valuable product or service to the market** (Table 2.1). A value chain can be broken down into five primary activities:

- **Inbound logistics**: such as receiving raw materials, warehousing, and managing inventory;

− **Operations**: all activities in the process of converting raw materials into a finished product or services;

− **Outbound logistics**: such as delivering the final product or service to the end user;

− **Marketing and sales**: all strategies and activities aimed at incentivizing potential customers to purchase the final product or services, including distribution channel selection, advertising, and pricing;

− **Post-sale services**: all activities that intend to improve consumer experiences, such as customer services, repairs, or maintenance services

A value chain could also include secondary or support activities that facilitate the efficiency of the primary activities, such as procurement, technology research, product development, human resource management, and firm infrastructure building.

Porter notes that these activities form a firm's value chain, each creating and adding value at every stage toward the end product or service. He suggests that a firm must understand its own value chain to develop and sustain a competitive advantage (Porter, 1985).

1977	1985	1994	2000	2007
Commodity chains	**Porter's value chain**	**Global commodity chain**	**Global value chain**	**Global value network**
The basic idea was to trace all the sets of inputs and transformations that lead to an "ultimate consumable".	A value chain is a set of activities that a firm operating in a specific industry performs in order to deliver a valuable or for the market.	The concept of "global commodity chain" was later introduced for describing the apparel commodity chain spread across the globe. In the 2000s.	The shift is combining the analysis of trade and industrial organization as a value-added chain.	A more recent strand of research prefers to put the emphasis on the concept of "network" rather than "chain" because businesses are more interconnected.

Table 2.1 Evolution of Global Value Chain. Source: Calabrese (2018)

Supply chain is another commonly used term. Early discussions on supply chains were more logistics-oriented. Since the mid-1990s, however global manufacturing networks have become increasingly integrated and interdependent. As a result, supply chains have been increasingly associated with business functions and processes beyond logistics within and across companies.

The Council of Supply Chain Management Professions (CSCMP) defines a **supply chain as the links between companies which interchange materials and information in the logistics process**, stretching from acquiring unprocessed raw materials to delivering finished

goods to end users. These **links generally encompass three functions: (1) supply of materials to a manufacturer; (2) the manufacturing process; and (3) the distribution of finished goods to final customers through a network of distributors and retailers.** Similarly, Stacy Fredrick (2010 and 2014) defines supply chains as production-related input-output links.

The concept of global value chains (GVCs) or global supply chains (GSCs) is the international extension of these definitions, responding to the growing phenomenon of global production fragmentation—the fact that business functionalities and production activities along a value chain are increasingly carried out by various entities located in different countries. As a result, GVC-related international transactions have become an important aspect of cross-border trade, and GVCs have been recognized as an important driver of structural change in the world economy (Sturgeon and Memedovic, 2011).

Decreasing trade costs are among the major factors that have contributed to the recent GVC expansion. Trade costs include the whole range of costs that companies face to move goods or services from where they are produced to final consumers (OECD 2012). Global trade liberalization in the past few decades has significantly reduced costs associated with tariffs and some nontariff trade barriers. Regulatory reforms in transport and infrastructure sectors encouraged investment in roads and ports in many countries, improving logistical efficiencies.

2.1 COMPONENTS OF THE GLOBAL VALUE CHAIN MODEL

The first step in **value chain mapping** is identifying the structural parts of the chain. The model presented here is industry-neutral and scalable and includes a visual template and taxonomy for the **four key parts**: (1) **value-adding activities or business functions**; (2) **supply chain**; (3**) end markets**; and the (4) **supporting environment** (Figure 2.1). The focus of GVC research can be on physical products, a service, or an enabling technology that impact goods or services.

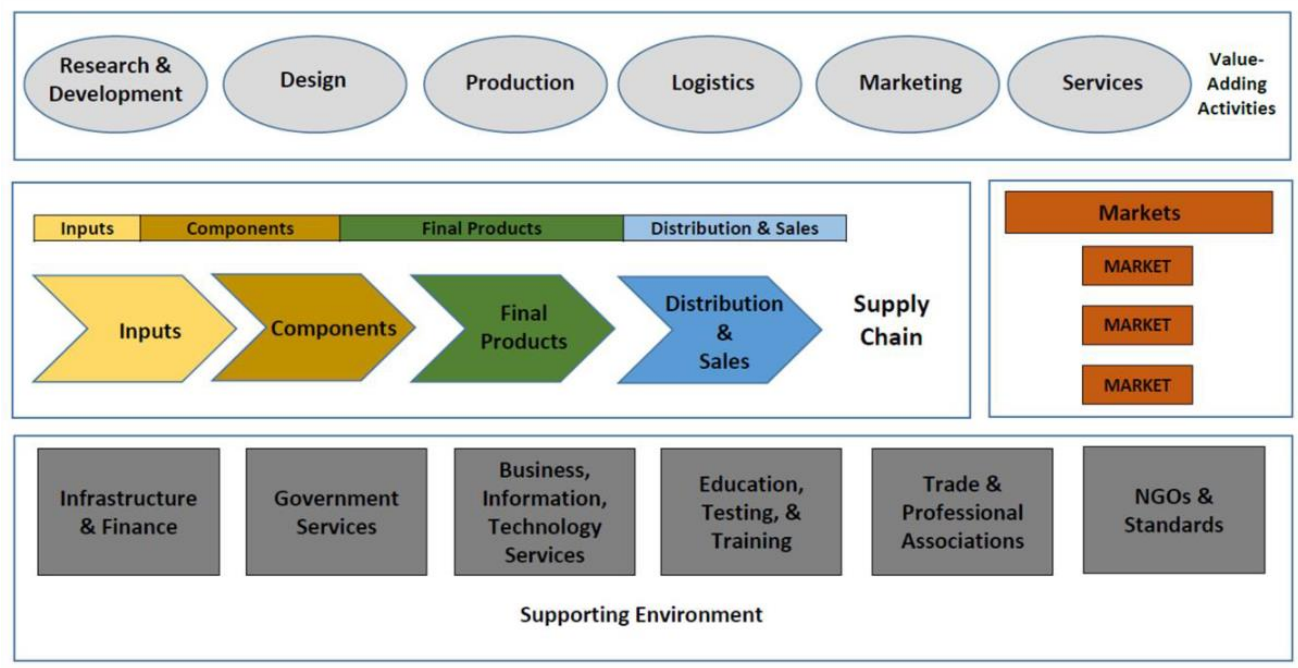

Figure 2.1 Parts of the global value chain model. Source: Gereffi, & Fernandez-Stark (2016)

Value-adding activities represent the six basic functions firms engage in to bring a product from concept through to creation, starting with **research** and **design** through **manufacturing** and **distribution**, and finally to **marketing**, **sales**, and services:

● ***Research*** includes activities related to improving or developing a new physical product or process as well as market and consumer research.

● ***Design*** includes both aesthetic and engineering-related product developments. Locations classified in design engage in activities such as new product development and creating prototypes. Software and modeling tools are important for this activity.

● ***Manufacturing*** locations have a production facility and are primarily engaged in making a product that is sold to other companies in the chain or to final consumers.

● ***Logistics and distribution*** locations are involved in transporting or storing products or input materials. Firms performing this function include wholesalers, intermediaries and distribution centers and warehouses.

● ***Marketing*** and sales activities are associated with branding, advertising and retailing; these locations typically do not make physical alterations. Activities are often performed at a headquarters location.

● ***Locations*** engaged in service-related activities provide general business or aftersales services such as customer support, repair or maintenance.

The second part is the supply chain, which represents the **input–output structure** of the products or flow of business interactions for the product or service being mapped. It has **four**

main stages: (1) **materials/inputs**; (2) **components/intermediates**; (3) **final products**; and (4) **distribution/sales**. A supporting industry stage can also be used to highlight the tools/equipment or auxiliary inputs needed along the chain. The visual flows from left to right, and it is helpful to use different colors (shown as shading here) to represent different stages in the chain. The model will have many 'layers' that provide more detail than the main stages. For example, each stage can be broken into sectors, which can be further disaggregated into subsectors or products. To avoid clutter, the main visual should focus on key stages and subsequent images can be included to show detailed flows as needed.

The third part of the model are the end markets of the final product or service. While this segment can be considered an extension of the supply chain, it is analytically useful to separate it. End market categories can be used to group products that share product, geographic and buyer-specific characteristics. For instance, in electronics it is useful to analyze consumer electronics separately from industrial, medical or automotive electronics (Gereffi, & Fernandez-Stark, 2016).

3. IMPORTANCE OF THE GLOBAL VALUE CHAINS

The global economy is increasingly structured around global value chains (GVCs) that account for a rising share of international trade, global GDP and employment. The evolution of GVCs in diverse sectors, such as commodities, apparel, electronics, tourism and business service outsourcing has significant implications in terms of global trade, production and employment and how developing country firms, producers and workers integrate into the global economy. GVCs link firms, workers and consumers around the world and often provide a stepping-stone for firms and workers in developing countries to participate into the global economy. For many countries, especially low-income countries, the ability to effectively insert into GVCs is a vital condition for development. This supposes an ability to access GVCs, to compete successfully and to "capture the gains" in terms of national economic development, capability building and generating more and better jobs to reduce unemployment and poverty. Thus, it is not only a matter of whether to participate in the global economy, but how to do so gainfully.

The GVC framework allows one to understand how global industries are organized by examining the structure and dynamics of different actors involved in a given industry. In today's globalized economy with very complex industry interactions, the GVC methodology is a useful tool to trace the shifting patterns of global production, link geographically dispersed activities and actors within a single industry, and determine the roles they play in developed and developing countries alike. The GVC framework focuses on the sequences of value added within an industry, from conception to production and end use. It examines the job descriptions, technologies, standards, regulations, products, processes, and markets in

specific industries and places, thus providing a holistic view of global industries both from the top down and the bottom up.

The comprehensive nature of the framework allows policy makers to answer questions regarding development issues that have not been addressed by previous paradigms. Additionally, it provides a means to explain the changed global-local dynamics that have emerged within the past 20 years. As policy makers and researchers alike have come to understand the pros and cons of the spread of globalization, the GVC framework has gained importance in tackling new industry realities such as the role of emerging economies like China, India and Brazil as new drivers of global value chains, the importance of international product and process certifications as preconditions of competitive success for export-oriented economies, the rise of demand-driven workforce development initiatives as integral to dynamic economic upgrading, and the proliferation of private regulations and standards, while also proving useful in the examination of social and environmental development concerns (Gereffi, Fernandez-Stark, 2017).

A range of institutions and governments have commissioned GVC studies to understand global industries and to guide the formulation of new programs and policies to promote economic development (Gereffi, Fernandez-Stark, 2016).

4. WHAT ARE GLOBAL VALUE CHAINS

The value chain describes the full range of activities that firms and workers perform to bring a product from its conception to end use and beyond. This **includes activities such as research and development (R&D), design, production, marketing, distribution and support to the final consumer.** The activities that comprise a value chain can be contained within a single firm or divided among different firms (globalvaluechains.org, 2011). In the context of globalization, the activities that constitute a value chain have generally been carried out in inter-firm networks on a global scale. By focusing on the sequences of tangible and intangible value-adding activities, from conception and production to end use, GVC analysis provides a holistic view of global industries – both from the top-down (for example, examining how lead firms “govern” their global-scale affiliate and supplier networks) and from the bottom-up (for example, asking how these business decisions affect the trajectory of economic and social “upgrading” or “downgrading” in specific countries and regions).

There are six basic dimensions that GVC methodology explores that are divided in global (top-down) and local elements (bottom-up) (See Figure 4.1a). The first set of dimensions refers to international elements, determined by the dynamics of the industry at a global level. The second set of dimensions explain how individual countries participate in GVCs. These six dimensions are: **(1) an input-output structure**, which describes the process of transforming raw materials into final products; **(2) the geographic scope**, which

explain how the industry is globally dispersed and in what countries the different GVC activities are carried out; **(3) a governance structure**, which explains how the value chain is controlled by firms. The local dimensions are: **(4) upgrading**, which describes the dynamic movement within the value chain by examining how producers shift between different stages of the chain Gereffi (1999) and Humphrey & Schmidt (2002) **(5) an institutional context** in which the industry value chain is embedded in local economic and social elements (Gereffi, (1995); and **(6) industry stakeholders**, which describes how the different local actors of the value chain interact to achieve industry upgrading.

The global value chain approach analyzes the global economy from these two contrasting vantage points: **"top-down" or global and "bottom-up" or local**. "Governance" of global value chains, a key concept of the top-down view, focuses mainly on lead firms and the organization of international industries. Upgrading, the main concept for the bottom-up perspective, focuses on the strategies used by countries, regions, and other economic stakeholders to maintain or improve their positions in the global economy.

Global value chains (GVCs) refer to international production sharing, a phenomenon where production is broken into activities and tasks carried out in different countries. They can be thought of a large-scale extension of division of labour dating back to Adam Smith's time. In the famed example attributed to Smith, the production of a pin was divided into a number of distinct operations inside a factory, each performed by a dedicated worker. **In GVCs, the operations are spread across national borders (instead of being confined to the same location)** and the products made are much more complex than a pin.

Cross-border production has been made possible by the liberalization of trade and investment, lower transport costs, advances in information and communication technology, and innovations in logistics (e.g. containerization). While cross-border production itself may not be new, it has expanded rapidly in many industries in recent decades. **This development has largely been driven by transnational corporations (TNCs)** in industrialized economies, which continuously restructure their businesses and reorganize/ relocate their operations for reasons of competition. The manifest example of relocation is the offshoring of labour-intensive stages of production from industrialized economies to low wage, labour abundant developing countries. Business operations are, however, also reshuffled among industrialized economies (UNIDO, 2019).

A global value chain breaks up the production process across countries. Firms specialize in a specific task and do not produce the whole product (Figure 4)

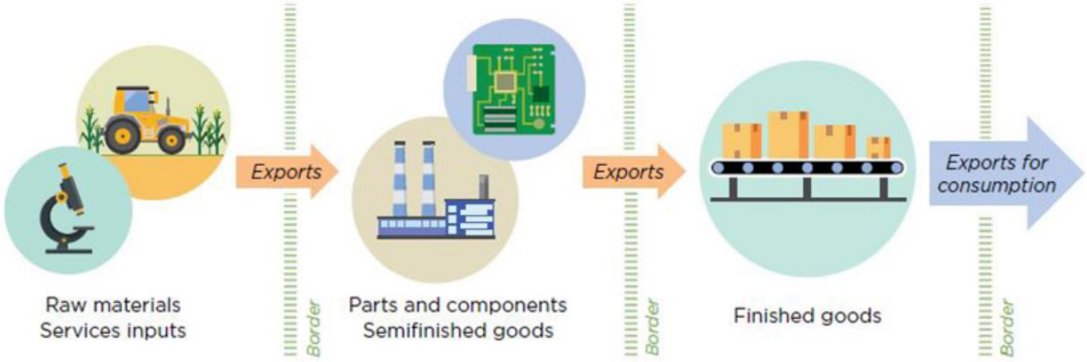

Figure 4. Why GVCs are important. Source: *World Bank Group (2020)*

4.1 DIMENSIONS OF THE GVC ANALYSIS

Six dimensions constitute global value chain analysis. They are discussed below from the researcher's perspective. **Six basic dimensions** that GVC methodology explores that are divided in global (top-down) and local elements (bottom-up) (Figure 4.1a).

Figure 4.1a Six Dimensions of the Global Value Chain Analysis. Source: *Gereffi, & Fernandez-Stark (2016)*

4.1.1 INPUT-OUTPUT STRUCTURE

a. Identify the main activities/segments in a global value chain.

A chain represents the entire input-output process that brings a product or service from initial conception to the consumer's hands. The main segments in the chain vary by industry, but typically include: research and design, inputs, production, distribution and marketing, and sales, and in some cases the recycling of products after use. This **input-output structure**

involves goods and services, as well as a range of supporting industries. The input-output structure is typically represented as a set of value chain boxes connected by arrows that show the flows of tangible and intangible goods and services, which are critical to mapping the value added at different stages in the chain, and to layering in information of particular interest to the researcher (e.g., jobs, wages, gender, and the firms participating at diverse stages of the chain).

In order to understand the entire chain, it is crucial to study the evolution of the industry, the trends that have shaped it, and its organization. Based on general knowledge about the industry, segments of the chain can be identified and differentiated by the value they add to the product or service. The researcher further develops this chain using secondary data and interviews. The role of the researcher is to link these pieces of information and create a united and self-explanatory chain that includes the principal activities of the industry. The segments of the chain illustrate how different value adding processes contributed to the product or service, and in turn, the differing returns netted for the chain actors behind them.

b. Identify the dynamic and structure of companies under each segment of the value chain.

Each of the segments identified in the previous step have specific characteristics and dynamics, such as particular sourcing practices or preferred suppliers. For example, in the fruits and vegetable value chain, the inputs for the “processing” segment may come from fruits that were intended for export but did not meet the quality controls or it may come from production grown exclusively for processing. It is important to identify the type of companies involved in the industry and their key characteristics: global or domestic; state-owned or private; large, medium, or small; etc. Identifying the firms that participate in the chain will help to understand its governance structure.

4.1.2 GEOGRAPHIC SCOPE

The globalization of industries has been facilitated by improvement in transportation and telecommunications infrastructure and driven by demand for the most competitive inputs in each segment of the value chain. Today, supply chains are globally dispersed and different activities are usually carried out in different parts of the world. In the global economy, countries participate in industries by leveraging their competitive advantages in assets. Usually developing countries offer low labor costs and raw materials, while rich nations, with highly educated talent, are behind R&D and product design. As a result, firms and workers in widely separated locations affect one another more than they have in the past (globalvaluechains.org, 2011).

Geographical analysis is first based on the analysis of global supply and demand. This is done by analysing the trade flows at each stage of the value chain using international trade

statistics databases such as United Nations Comtrade and information compiled using secondary sources of firm-data, industry publications and interviews with industry experts.

One of the main contributions of GVC analysis has been to map the shifts in the geographic scope of global industries. However, **GVCs operate at different geographic scales (local, national, regional, and global)** and they continue to evolve. New evidence suggests there may be a trend toward a regionalization of GVCs in response to a variety of factors, including the growing importance of large emerging economies and regional trade agreements.

4.1.3 GOVERNACE

Governance analysis allows one to understand how a chain is controlled and coordinated when certain actors in the chain have more power than others. Gereffi (1994) defined governance as “authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain. ”Initially in the global commodity chains framework, governance was described broadly in terms of “buyer-driven” or “producer-driven” chains (Gereffi,1994). Analysis of buyer-driven chains highlights the powerful role of large retailers, such as Walmart and Tesco, as well as highly successfully branded merchandisers (e.g., Nike, Reebok), in dictating the way the chains operate by requiring suppliers to meet certain standards and protocols, despite limited or no production capabilities. In contrast, producer-driven chains are more vertically integrated along all segments of the supply chain and leverage the technological or scale advantages of integrated suppliers. Understanding governance and how a value chain is controlled facilitates firm entry and development within global industries. In practice, governance analysis requires identification of the lead firms in the sector, their location, how they interact with their supply base and their source of influence and power over them (e.g. standards compliance).

A more elaborate **typology of five governance structures** has been identified in the GVC literature: **markets, modular, relational, captive, and hierarchy**. These structures are measured and determined by three variables: the complexity of the information shared between actors in the chain; how the information for production can be codified; and the level of supplier competence (Frederick & Gereffi, 2009; Gereffi et al., 2005).

Market: Market governance involves transactions that are relatively simple. Information on product specifications is easily transmitted, and suppliers can make products with minimal input from buyers. These arms-length exchanges require little or no formal cooperation between actors and the cost of switching to new partners is low for both producers and buyers. The central governance mechanism is price rather than a powerful lead firm.

Modular: Modular governance occurs when complex transactions are relatively easy to codify. Typically, suppliers in modular chains make products to a customer’s specifications and take full responsibility for process technology using generic machinery that spreads

investments across a wide customer base. This keeps switching costs low and limits transaction-specific investments, even though buyer-supplier interactions can be very complex. Linkages (or relationships) are more substantial than in simple markets because of the high volume of information flowing across the inter-firm link. Information technology and standards for exchanging information are both key to the functioning of modular governance.

Relational: Relational governance occurs when buyers and sellers rely on complex information that is not easily transmitted or learned. This results in frequent interactions and knowledge sharing between parties. Such linkages require trust and generate mutual reliance, which are regulated through reputation, social and spatial proximity, family and ethnic ties, and the like. Despite mutual dependence, lead firms still specify what is needed, and thus have the ability to exert some level of control over suppliers. Producers in relational chains are more likely to supply differentiated products based on quality, geographic origin or other unique characteristics. Relational linkages take time to build, so the costs and difficulties required to switch to a new partner tend to be high.

Captive: In these chains, small suppliers are dependent on one or a few buyers that often wield a great deal of power. Such networks feature a high degree of monitoring and control by the lead firm. The power asymmetry in captive networks forces suppliers to link to their buyer under conditions set by, and often specific to, that particular buyer, leading to thick ties and high switching costs for both parties. Since the core competence of the lead firms tends to be in areas outside of production, helping their suppliers upgrade their production capabilities does not encroach on this core competency, but benefits the lead firm by increasing the efficiency of its supply chain. Ethical leadership is important to ensure suppliers receive fair treatment and an equitable share of the market price.

Hierarchy: Hierarchical governance describes chains characterized by vertical integration and managerial control within lead firms that develop and manufacture products in-house. This usually occurs when product specifications cannot be codified, products are complex, or highly competent suppliers cannot be found. While less common than in the past, this sort of vertical integration remains an important feature of the global economy.

The form of governance can change as an industry evolves and matures, and governance patterns within an industry can vary from one stage or level of the chain to another. In addition, recent research has shown that many GVCs are characterized by multiple and interacting governance structures, and these affect opportunities and challenges for economic and social upgrading.

4.1.4 UPGRADING

Economic upgrading is defined as firms, countries or regions moving to higher value activities in GVCs in order to increase the benefits (e.g. security, profits, value-added, capabilities) from participating in global production (Gereffi, 2005).

Diverse mixes of government policies, institutions, corporate strategies, technologies, and worker skills are associated with upgrading success. **Within the GVC framework**, Humphrey and Schmitz (2002) identified **four types of upgrading**:

- **process upgrading**, which transforms inputs into more efficiently by reorganizing the production system or introducing superior technology;
- **product upgrading**, or moving into more sophisticated product lines;
- **functional upgrading**, which entails acquiring new functions (or abandoning existing functions) to increase the overall skill content of the activities;
- **chain or inter-sectoral upgrading**, where firms move into new but often related industries;

Furthermore, Fernandez Stark et al. (2014) identified several additional types of upgrading:

- **entry in the value chain**, where firms participate for the first time in national, regional or global value chains. This is the first and one of the most challenging upgrading trajectories;
- **backward linkages upgrading**, where local firms (domestic or foreign) in one industry being to supply tradable inputs and/or services to companies – usually MNCs – that are located in the country and are already inserted in a separate GVC;
- **end-market upgrading**, which can include moving into more sophisticated markets that require compliance with new, more rigorous standards or into larger markets that call for production on a larger scale and price accessibility.

Upgrading patterns differ by both industry and country based on the input-output structure of the value chain and the institutional context of each country. Certain industries require linear upgrading and countries must gain expertise in one segment of the value chain before upgrading into the next segment, as shown below for countries involved in the horticulture value chain.

The challenge of economic upgrading in GVCs is to identify the conditions under which developing and developed countries and firms can "climb the value chain" from basic assembly activities using low-cost and unskilled labor to more advanced forms of "full package" supply and integrated manufacturing. However, increasingly many of the highest value activities are located in pre- and post-production manufacturing services, which challenge host countries to develop appropriate workforce development strategies to supply these services locally. As seen in Figure 4.1.4a, **developed countries usually have a presence in high value added activities, while developing countries concentrate in lower value added activities** (Gerefi & Fernandez-Stark, 2016).

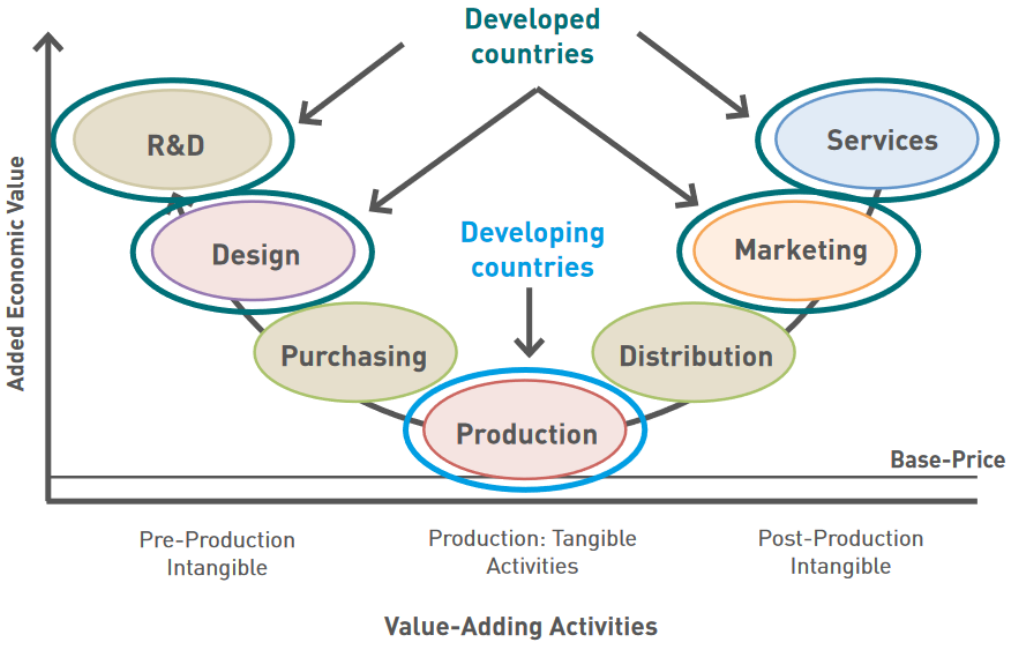

Figure 4.1.4a Smile Curve of High-Value Activities in Global Value Chains Source: Gereffi, & Fernandez-Stark (2016)

Porter's (1985) conclusions about the acquired competitive advantage can answer the question of **increasing the added value of the automotive industry**. For example, in Japan, it can be a quality supply of labour that is considered a source of innovation. A level change in the value chain in favour of creating higher added value can be achieved in four ways - by shifting strategies in global value chains:

1. **Process upgrading** – Evolutionary changes and higher process efficiency.

2. **Product upgrading** – Changes in the product portfolio to increase their value-added.

3. **Functional upgrading** – Application of activities with a higher rate of added value: research and development, sales/service, design, and marketing.

4. **Interchain upgrading** – Changes in the production base of companies that will allow entry into new global markets

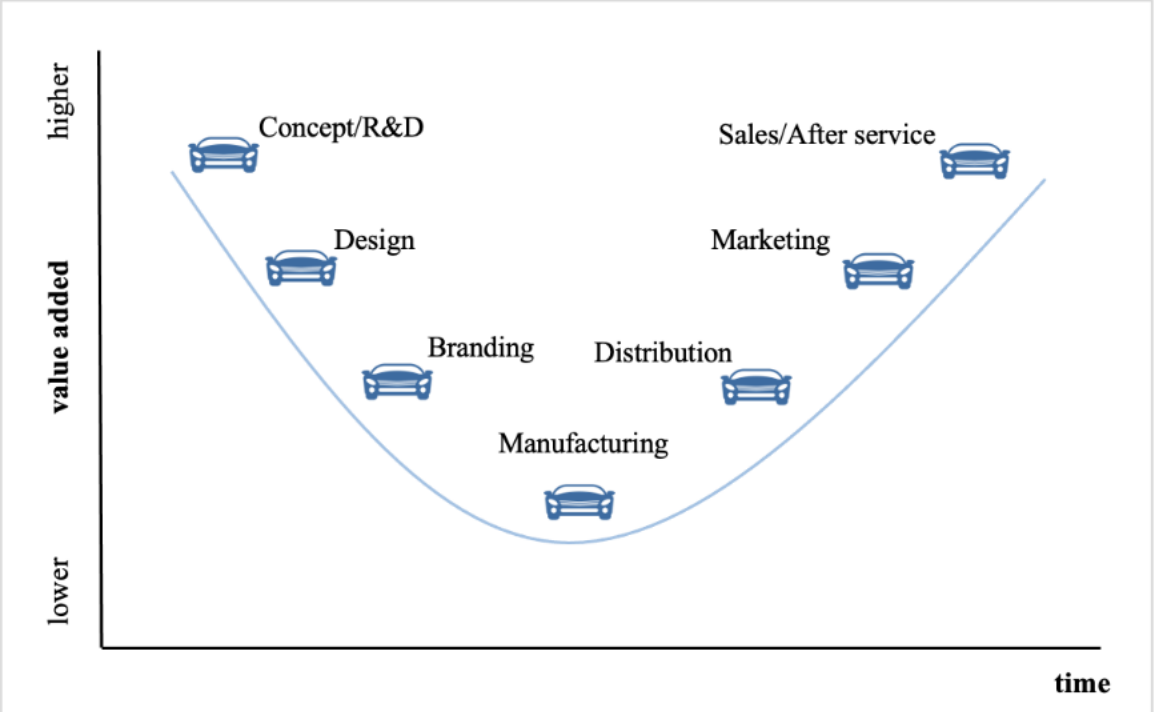

Figure 4.1.4b GVC in terms of value-added (individual processes). Source: Zabojnik (2022)

4.1.5 LOCAL INSTITUTIONAL CONTEXT

The **local institutional framework identifies how local, national and international conditions and policies shape a country's participation in each stage of the value chain** (Gereffi, 1995). GVCs are embedded within local economic, social and institutional dynamics. Insertion in GVCs depends significantly on these local conditions. Economic conditions include the availability of key inputs: labor costs, available infrastructure and access to other resources such as finance; social context governs the availability of labor and its skill level, such as female participation in the labor force and access to education; and finally institutions includes tax and labor regulation, subsidies, and education and innovation policy that can promote or hinder industry growth and development.

Because global value chains touch down in many different parts of the world, the use of this framework allows one to carry out more systematic comparative **(cross-national and cross-regional) analysis** to identify the impact of different features of the institutional context on relevant economic and social outcomes.

4.1.6 STAKEHOLDER ANYLYSIS

Analysis of the local dynamics in which a value chain is embedded requires examination of the stakeholders involved. All the industry actors are mapped in the value chain and their main role in the chain is explained. The **most common stakeholders in the value chain**

are: companies, industry associations, workers, educational institutions, government agencies including export promotion and investment attraction departments, ministries of foreign trade, economy and education amongst others.

In addition, it is important to consider how relations between these actors are governed at the local level and which institutions are in a position to drive change. Thus, this type of analysis is critical to identify the key players in the value chain. It became especially relevant for industry upgrading recommendations and the development of an industry growth strategy in which each stakeholder plays a role to contribute in the development of the sector (Gereffi, Fernandez-Stark, 2016).

5. MEASURING GVC PARTICIPATION

The emergence of GVCs has challenged the conventional use and interpretation of trade statistics and instigated the use of new data and methods. Traditional trade measures record flows of goods and services on a gross basis, meaning that the value of intermediate inputs is counted every time they cross a border for further processing. Therefore, in a world in which intermediate goods cross several borders before reaching the final consumer, gross exports can be subject to significant double-counting. This can lead to a misrepresentation of the contribution of different countries to global trade. To address these issues, researchers and practitioners have increasingly relied on the concept of trade in value added. As part of this, gross exports are broken down according to the country and industry of origin and destination of value added. In other words, value added is traced across borders and apportioned to the countries where it is produced and consumed (ECB, 2022).

Building on trade in value added data, several metrics have been developed in the literature to **track supply chains, including indicators of participation**. According to Antràs (2020), a GVC consists of “a series of stages involved in producing products and services that are sold to consumers, with each stage adding value”. Borin and Mancini (2015) offer a more specific definition of GVC trade, characterised by flows that cross at least two national borders. **Indicators of GVC participation track countries’ engagement in GVCs** and serve as proxies for the fragmentation of the production process. GVC participation is generally computed as the share of GVC-related trade over gross exports (ECB, 2022).

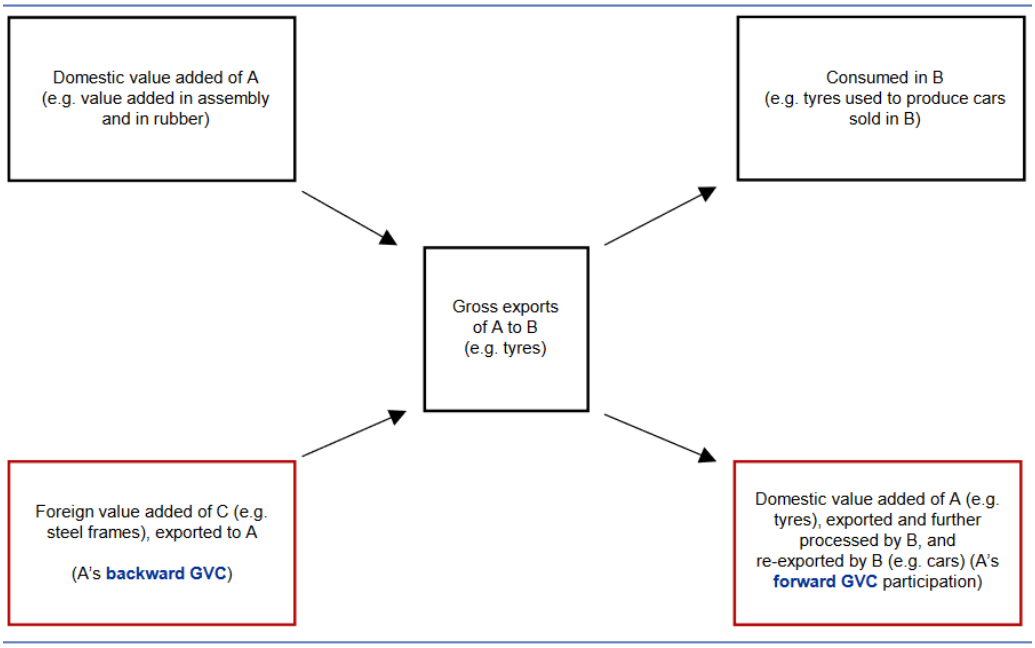

Figure 5.1a Decomposition of country A's exports to country B. Origin and destination of value added. Source: ECB (2022)

At the broadest level of disaggregation, individual countries can participate in GVCs by engaging in backward and/or forward linkages. Upstream or backward participation measures the share of foreign value added embedded in a country's total gross exports. The downstream or forward dimension refers instead to the share of the domestically produced value added embedded in a country's exports that is further re-exported by the destination country. In this respect, re-exported products flow downstream within the value chain. The diagram in **Figure 5.1a provides asimplified illustration of tyre production**. In the example, **country A is a manufacturer of tyres**. In order to produce its exports to B, **A can produce and assemble tyres domestically** (and hence rely on its own domestic value added), or import parts from abroad (i.e. embed value added from third countries in the form of inputs in its production). **Backward participation consists of the value added contained in parts (e.g. steel frames)** that A imports from a foreign partner C. **Forward participation is instead obtained by counting the domestic value added produced directly by A** (e.g. in the form of labour to **assemble the final product and value added contained in rubber produced in A**), embedded into its exports of tyres to B and further utilised by B in the production of exports to a third country D, for example in the form of cars. Measures of GVC participation take into account both backward and forward dimensions, such that in our stylised example, an overall indicator of participation for country A is obtained as the sum of backward (**value added in steel frames**) and forward value added trade (**value added in tyres used to produce cars** exported by B to D) (both highlighted with red boxes), expressed as a share of its total gross exports (ECB, 2022).

The type and extent of engagement in GVCs vary across countries. Figure 5.1b shows the backward and forward linkages of advanced and emerging economies in 1990 and in 2018.

The darker green and blues areas reflect higher values of participation across the two categories. Small, open economies or countries that are highly involved in the assembly and processing of goods, such as Mexico or countries in emerging Europe, tend to be located downstream in the value chain and have large backward linkages, originating from the fact that a large proportion of their exports consists of foreign value added. Commodity exporters such as Russia and countries in the Middle East and Africa are located upstream and instead exhibit high forward linkages. The latter reflects the fact that exports of commodities from these countries travel along the value chain and serve as inputs in other countries' production. Countries with high forward linkages are not limited to commodity exporters, however. The United States and several large euro area economies also exhibit high shares due to large exports of high value added services (including marketing activities and R&D) that are used as intermediate inputs in other countries.

For many advanced economies, backward and forward linkages have been rising over time (Figure 5.1b). This is an indication of the fact that they engage in GVCs in a multifaceted way, through both vertical and horizontal linkages. Movements along the value chain may also be the outcome of deliberate government policies. In countries such as China, Indonesia, Thailand and Malaysia, for example, forward participation has risen sharply over the past 30 years as a result of policies aimed at shoring up the domestic content of their production and exports. By contrast, economies in emerging Europe have continued to integrate themselves downstream into the supply chains of companies in Western Europe, such that the foreign content of their exports has increased more visibly. Countries in Latin America have also seen the foreign content of their exports rise over time. In general (with the exception of Mexico, which is highly integrated in US value chains), participation in GVCs remains low among countries in Latin America when compared with peers (ECB, 2022).

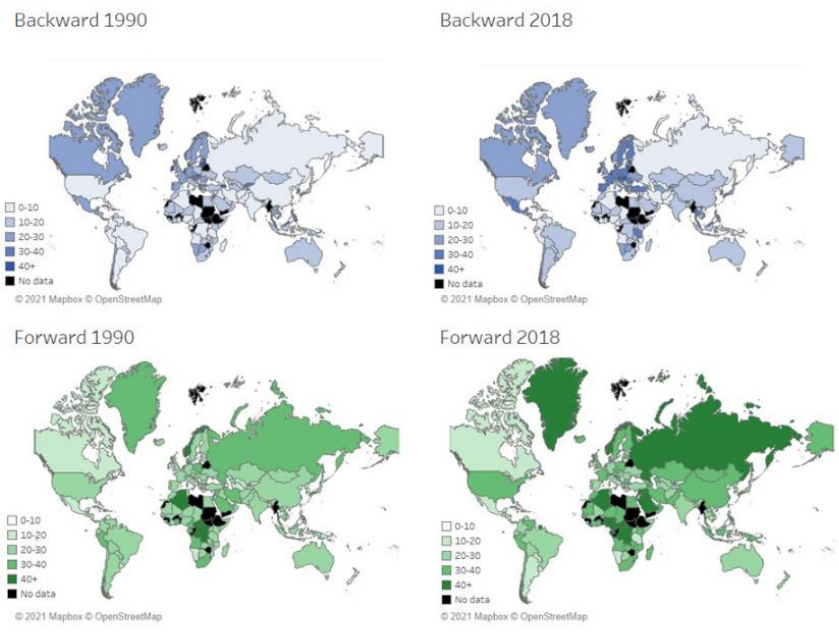

Figure 5.1b Backward and forward participation (share of gross exports. Source: *ECB (2022)*

6. ANALYSIS OF SPECIFIC GLOBAL VALUE CHAINS

The **industry 'motor vehicles'** is an industry where the unbundling of production has already been taken place for decades; hence, outsourcing/offshoring by companies have pushed the international fragmentation of production quite far in this industry. The value chain of motor vehicles is largely organized through a hierarchical structure, with the large automotive manufacturers positioned on top of the pyramid as lead firms responsible for design, branding, and final assembly. One level down, first-tier suppliers produce complete subsystems by cooperating with a large network of lower tier suppliers and subcontractors. Close relationships have developed especially between car assemblers and first tier suppliers as these last ones have taken up a larger role in the whole production process, including design.

These **suppliers have increasingly developed into global suppliers** since lead firms increasingly demand that their largest suppliers have a global presence and system design capabilities as a precondition to being considered as a source for a complex part or subsystem (Sturgeon, Florida, 2004).

Notwithstanding the global activities of lead firms and first tier suppliers, regional production is still very important in the motor vehicles industry. High transportation costs make intercontinental shipping very costly especially in downstream activities, e.g. complete cars or subsystems. In addition, political pressure may also motivate lead firms to locate production close to end markets; the high cost and visibility of automotive products can create the risk of a political backlash if imported vehicles become too large a share of total vehicles sold. This in turn creates pressure for supplier co-location within regional production systems for operational reasons, such as just-in-time production, design collaboration and the support of globally produced vehicle platforms (Van Biesebroeck, Sturgeon, 2010). As a result, the supplier network in the motor vehicles' industry consists of a large number of suppliers, some of them pure local suppliers (typically lower tier suppliers), others global suppliers with a local presence (top tier suppliers).

The regional organisation of the production process is clearly demonstrated when distinguishing the source country of imported intermediates. It becomes clear that intra-regional sourcing within the 3 main regional blocks is important in the motor vehicles industry. **European Union countries source the majority of their intermediates from other European countries**, while NAFTA partners largely source from within NAFTA. Also in Asia a clear regional integration has developed through the sourcing of intermediates largely from within the region.

GVCs are very prominent in the motor vehicles industry, which is reflected in the index of the length of GVCs across all industries. Except for a couple of countries, the index of the 'number of production stages' is above 2.5 (recall that the index for a final industry without production stages equals 1) illustrating the importance of vertical linkages between the motor vehicles industry and other industries. A significant part of these stages are located abroad, underlining the international (although regional instead of truly global) character of these motor vehicles

chains. Smaller countries display on average more international production stages, illustrating the fact that these countries depend more on (directly and indirectly) imported intermediates. Countries like Korea, China and Japan large numbers of domestic production stages reflecting very well the domestic organization structure of the motor vehicle industry in these countries.

The **participation of countries in motor vehicles' GVCs seems to be strongly driven by the importance of imported intermediates.** Large participation indexes especially for smaller (Eastern European) economies with important car assembly activities: Slovakia, Hungary, Czechia and Poland. Also countries like Mexico (maquiladores) undertake important car manufacturing activities based on intermediate products imported from abroad.

Also Germany shows a high relatively high participation in the car industry, reflecting its large car assembly activities as well its production of intermediates which are then exported to other countries.

The same observation also applies for Japan and the United States; both countries have important assembly activities but also produce large number of intermediates which are then exported for assembly in other countries.

Another indicator is measuring the distance to final demand. Countries with a high index, such as the Slovakia, Hungary or the Czechia in Europe, have companies that are on average located at the higher levels in the supplier networks of automotive industry, meaning that the intermediates that they produce are exported to other countries and included there in more downstream production activities. However, because of transportation costs these intermediates are only shipped to (a limited number of) countries nearby. At the other end, closer to end markets, a country like Mexico is rather specialised in the assembly of cars for the local market but also exported to other Latin American countries and to NAFTA. Hence a high participation rate and low distance to final demand index (OECD, 2012).

6.1 MAPPING THE AUTOMOTIVE INDUSTRY

In many respects, similar processes were taking place in Europe, where the auto industries of Central Europe were transformed and integrated into West European production systems in the course of the 1990s, creating a regional production system characterized by a high degree of regional integration and interdependence. In the early 1990s, following the collapse of their political and trading systems, governments in Central Europe looked to the European Union for FDI and for their long-term political future. They adopted hands-off industrial policies without attempting to develop a common Central European policy. In some respects, it was easier for Central European countries to trade with the EU than with each other. FDI was seen as the means to restructure ailing state-owned industries, and the main car producers in the region, e.g. Skoda in the former Czechoslovakia.

Integration between the motor industries of Western and Central Europe has taken two forms. First, there was an increasing two-way trade in vehicles. Central Europe offered both growing domestic markets and low-cost production sites to Western European assemblers (including firms from Japan and North America with operations in Western Europe) (Humphrey, Memedovic, 2003).

7. GLOBAL VALUE CHAINS IN THE AUTOMOTIVE INDUSTRY

7.1 THE EVOLUTION OF GVC IN AUTOMOTIVE INDUSTRY

In other writing, we have argued that the automotive industry is neither fully global, consisting of a set of linked, specialised clusters, nor tied to the narrow geography of nation states or specific localities, as is the case for some cultural and service industries (Sturgeon et al., 2008). Global integration has advanced as firms have sought to leverage engineering effort across products sold in multiple end markets. And, as suppliers have taken on a larger role in design, they have established their own design centres close to those of their major customers to facilitate collaboration. On the production side, the dominant trend is regional integration, a pattern that has been intensifying since the mid-1980s for both political and technical reasons. In North America, South America, Europe, Southern Africa, and Asia, regional parts production tends to feed final assembly plants producing largely for regional markets. Political pressure for local production has driven automakers to set up final assembly plants in many of the major established market areas and in the largest emerging market countries, such as Brazil, India, and China. Increasingly, lead firms demand that their largest suppliers have a global presence as a precondition to be considered for a new part (Sturgeon, Florida, 2004). Because centrally designed vehicles are manufactured in multiple regions, buyer-supplier relationships typically span multiple production regions.

Within regions, there is a gradual investment shift toward locations with lower operating costs: the Southern America and Mexico in North America; Spain and Eastern Europe in Europe; and South East Asia and China in Asia. Ironically, perhaps, it is primarily local firms that take advantage of such cost-cutting investments within regions (for example, the investments of Ford, GM, and Chrysler in Mexico; and Volkswagen and Peugeot in Eastern Europe), since the political pressure that drives inward investment is only relieved when jobs are created within the largest foreign markets (for example, Japanese automaker investments in North America and Europe have been concentrated in the USA, Canada, and Western Europe). Automotive parts, of course, are more heavily traded between regions than finished vehicles. Within countries, automotive production and employment are typically clustered in one or a few industrial regions. In some cases these clusters specialise in specific aspects of the business, such as vehicle design, final assembly, or the manufacture of parts that share a common characteristic, such as electronic content or labour intensity. Because of deep

investments in capital equipment and skills, regional automotive clusters tend to be very long-lived.

To sum up the complex economic geography of the automotive industry, we can say that global integration has proceeded the farthest at the level of buyer-supplier relationships, especially between automakers and their largest suppliers. Production tends to be organised regionally or nationally, with bulky, heavy, and model-specific GVCs in the automotive industry parts-production concentrated close to final assembly plants to assure timely delivery (for example, engines, transmission, seats and other interior parts), and lighter, more generic parts produced at a distance to take advantage of scale economies and low labour costs (for example, tyres, batteries, wire harnesses). Vehicle development is concentrated in a few design centres. As a result, local, national, and regional value chains in the automotive industry are ‘nested’ within the global organisational structures and business relationships of the largest firms.

7.2 CHARACTERISTICS OF AUTOMOTIVE VALUE CHAIN

The automotive value chain can be characterized as an automaker-driven network. This is because, common to many capital and technology intensive industries, automobile production systems are, to a great extent, controlled by the automakers. The automakers also own car brands whose value is maintained by massive investment in sales and marketing, after-sales services and quality assurance. The **value chain consists of a complex mixture of firms of different sizes, types and geographic scope, producing an enormous variety of products from simple parts to technologically complex systems.** Thus, the present automotive value chain has evolved into a complex, multi-tiered supplier structure with a high degree of outsourcing. Automotive value chains specifically comprise the following players: standardizers, material suppliers, component specialists, integrators, assemblers and distributors.

Standardizers, who are often automakers, conduct marketing research, develop the vehicle concept and design the specifications of the vehicle including its key modules and systems, heavily investing in research and development and process engineering. A first-tier supplier could be a standardizer by cooperating with the automakers in designing components and modules. Thailand has been the location of choice to date for standardizers, and R&D centres have been established by automakers in Thailand for the design of engines and localization of specifications. This is mainly due to the growing importance of the Thai market and Thailand’s role as a regional production hub, where a localized R&D function is necessary to comply with local needs and trends, such as the green car policy, enacted in Thailand and other countries in the region. Standardizers have not as yet been established in other countries in the subregion.

Material suppliers provide various raw materials to automakers and their suppliers for parts and components production. Those materials include steels and metals, textiles, glasses,

plastics, rubbers and chemicals. From the data currently available from the author's interviews with automakers and suppliers in the subregion, materials for automotive parts and components production are mainly sourced from Thailand (both Thai and foreign nationals) and supplemented by imports from other ASEAN countries, in particular Indonesia and Malaysia, and in some cases Australia, China, Europe, India, Japan, the Republic of Korea and North America. The automotive industry in the subregion still has to rely on imported materials from countries where advanced production technology and know-how are available.

Components specialists manufacture, according to the specification and requirement given by the standardizers, and deliver the required goods to integrators or assemblers for the purpose of module and system production or the final assembly of vehicles. The components specialists can be further categorized as either first-tier suppliers that deliver components directly to the assemblers and lower-tier suppliers that provide components to other suppliers or integrators. The lower-tier suppliers — most of them are smaller enterprises — tend to manufacture simpler and more labour-intensive (UN ESCAP, 2013).

7.3 THE INCREASING ROLE OF LARGE SUPPLIERS

One of the main **drivers of global integration** has been the **consolidation and globalisation of the supply base**. In the past, multinational firms either exported parts to offshore affiliates or relied on local suppliers in each location, but today global suppliers have emerged in a range of industries, including motor vehicles. Since the mid-1980s and through the 1990s, suppliers took on a much larger role in the industry, often making radical leaps in competence and spatial coverage through the acquisition of firms with complementary assets and geographies. Supplier consolidation at the worldwide level has not progressed as far as in North America, but it has picked up speed in recent years as the formation of new global lead firms and groups, such as DaimlerChrysler in 1999 (a deal that was undone in 2007), Nissan-Renault in 1998, and Hyundai-Kia in 1999 lead to some slow and partial consolidation and integration of formerly distinct supply bases. With the recent economic crisis, some of these acquired companies are now being sold off, Saab and Volvo are two examples, partially reversing this trend. On the other hand, some of the industry's largest mergers, such as the alliance between Renault and Nissan, appear to be quite stable.

As automakers set up final assembly plants in new locations and tried to leverage common platforms over multiple products, and in multiple markets, they pressured their existing suppliers to move abroad with them. Increasingly, the ability to produce in all major production regions has become a precondition to be considered for a project. However, what is emerging in the automotive industry is more complex than a seamless and unified global supply base, given the competing pressures of centralised sourcing (for **cost-reduction and scale**) and regional production (for **just-in-time** and local content). The need for full co-location of parts with final assembly varies by type of component, or even in stages of production for a single complex component or sub-system. Suppliers with a global presence can try to concentrate their volume production of specific components in one or two locations and ship them to plants

close to their customers' final assembly plants where modules and sub-systems are built up and sent to nearby final assembly plants as needed.

What should be clear from this discussion is that the economic geography of the automotive industry cannot be reduced to a set of national industries or a simple network of clusters. Business relationships now span the globe at several levels of the value chain. Automakers and first-tier suppliers have certainly forged such relationships, and as the fewer, larger suppliers that have survived have come to serve a wider range of customers, these relationships have become very diverse. With consolidation and crisis, we must question the staying power of smaller, lower-tier, local suppliers, however well supported they are by local institutions and inter-firm networks, especially since many upstream materials suppliers, such as the automotive paint supplier PPG, are also huge companies with global operations (Sturgeon, Biesebroeck, 2011).

7.4 WHY REGIONAL PRODUCTION?

Since the late 1980s, trade and foreign direct investment have accelerated dramatically in many industries. Specifically, a combination of real and potential market growth with a huge surplus of low-cost, adequately skilled labour in the largest countries in the developing world, such as China, India, and Brazil, has attracted waves of investment, both to supply burgeoning local markets and for export back to developed economies.

The latter has been enabled and encouraged by the liberalisation of trade and investment rules under an ascendant World Trade Organization (WTO). Yet regional production has remained very durable in the automotive industry. Because lead firms in the automotive industry are few in number and very powerful, they have the strength to drive supplier co-location at the regional, national, and local levels for operational reasons, such as just-in-time production, design collaboration, and the support of globally produced vehicle platforms. But politics also motivates lead firms to locate production close to end markets, and this creates additional pressure for supplier co-location within regional-scale production systems.

While consumer tastes and purchasing power, driving conditions, and the nature of personal transportation can vary widely by country, local idiosyncrasies in markets and distribution systems are common in many industries, and it is possible to feed fragmented and variegated distribution systems from centralised production platforms, as long as product variations are relatively superficial. The continued strength of regional production in the automotive industry, then, is one of its most striking features. The regional organisation of vehicle production stands in stark contrast to other important high-volume, consumer-oriented manufacturing industries, especially apparel and electronics, which have developed global-scale patterns of integration that concentrate production for world markets in fewer locations.

Why is political pressure for local production felt so acutely in the automotive industry? The high cost and visibility of automotive products, especially passenger vehicles, among the

general population can create risks of a political backlash if imported vehicles become too large a share of total vehicles sold. This situations heightened when local lead firms are threatened by imports. In our view, the willingness of governments to prop up or otherwise protect local automotive firms is comparable to industries such as agriculture, energy, steel, utilities, military equipment, and commercial aircraft. As a result, lead firms in these industries have adjusted their sourcing and production strategies to include a large measure of local and regional production that firms in other industries have not. This explains why Japanese, German, and Korean automakers in North America have not concentrated their production in Mexico, despite lower operating costs and a free trade agreement with the USA (Sturgeon et al., 2008). Japanese automakers have also shifted European production to Eastern Europe later and less aggressively than US and European lead firms, and have even moved to China later than their European and American competitors have (Sturgeon, Biesebroeck, 2011).

7.5 THE AUTOMOTIVE VALUE CHAIN IN 2025: FOUR PLAUSIBLE SCENARIOS

The **automotive value chain in 2025** will be determined by a multitude of high-impact drivers. Where developments are most uncertain from today's point of view, scenario-based thinking can support decision-making.

We suggest four quintessential **scenarios to describe the future automotive value chain**. High-influence drivers for the automotive value chain Since the characteristics of the drivers shaping the automotive future and the direction of their development cannot be predicted precisely, and are even highly uncertain in many instances, it is necessary to think in scenarios. In order to derive plausible future scenarios from the wealth of observations, the possible drivers and their effects need to be made more transparent. We looked at a wide variety of drivers with direct or indirect impact on the future development of the automotive value chain. These drivers can be grouped into the areas of social change, technology advancement, economic shifts, environmental trends, and political developments (Figure 7.5.1a).

The drivers were in turn evaluated as to their degree of uncertainty and their impact on the **Original Equipment Manufacturer (OEM's)** automotive value chain, in areas such as R&D, procurement, manufacturing, or logistics As an example, let's have a more detailed look at 3D printing: 3D printing is a high- impact but uncertain driver. It has a potential impact on various links in the supply chain. It reduces the time to build prototypes or even entire devices and thus supports the process of innovation. Assuming adequately trained employees, the number of suppliers could be reduced by producing a variety of parts in-house. This, together with shorter lead-times, also affects manufacturing and logistics. Parts and components can be printed directly wherever they are required and do not need to be transported. Lighter and less costly products reduce inventory and handling costs, shorter lead times reduce supply chain complexity. However, the future deployment of 3D printing is highly uncertain: production costs are too high, and production speed is still too slow to allow for a large-scale implementation.

By contrast, drivers such as “customers’ and regulators’ safety awareness”, appear much more certain. In terms of impact we can think of alternative powertrains as being a high-impact driver, while material wealth seems to play a less significant role.

Visualizing all the various drivers as a cloud (Figure 7.5.1b) quickly shows patterns and highlights constructing future scenarios it is necessary to focus on the most relevant drivers, i.e. drivers with the highest degree of uncertainty and the greatest impact. These drivers are the significant ones for unfolding distinct and meaningful scenarios. One **example for such a driver is "alternative powertrains" (such as battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), range extenders (REX) or fuel cell (FC)),** owing to the major changes required in the workforce, logistics channels, and manufacturing processes, and also an unpredictable market breakthrough. Another example is “connectedness of cars”, as the potential for new business models is huge but currently still very uncertain when it comes to the actual monetization of technological possibilities, not to mention future regulation. By applying the well-proven methods of the Deloitte Center for the Long View, these critical uncertainties were used to shape four quintessential scenarios.

Figure 7.5 1a Clustes of identified drivers. Source: Deloitte (2020)

Figure 7.5.1b Driver evaluation according to degree of impact and degree of uncertainty. Source: *Deloitte (2020)*

On the following figure 7.5.1c we can see four scenarios for 2025.

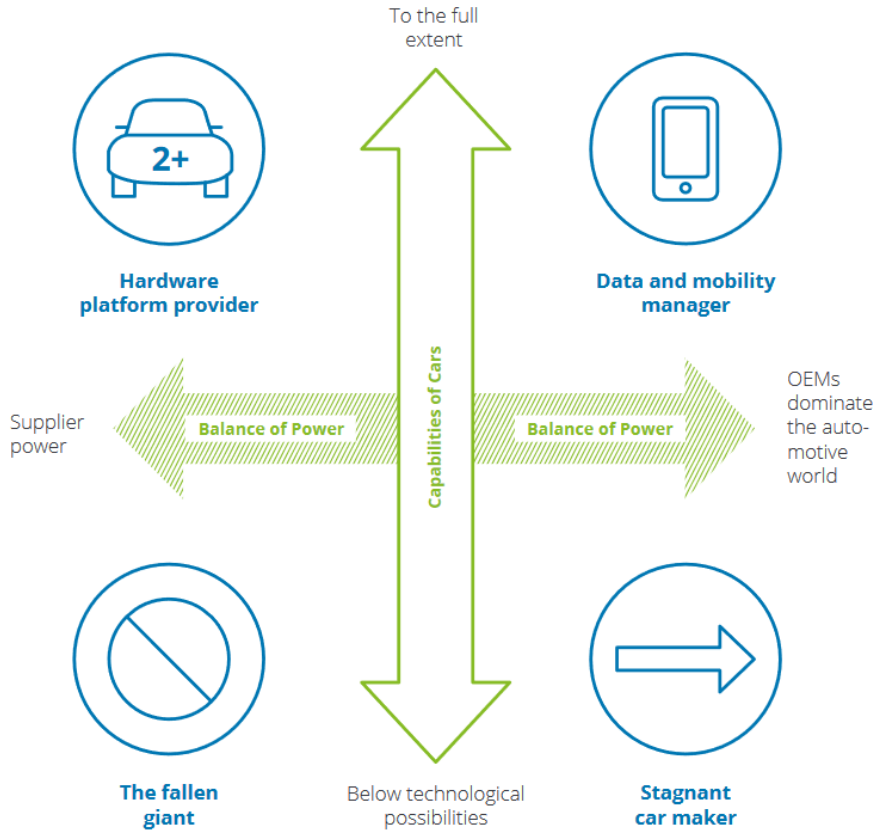

Figure 7.5.1c Four scenarios for 2025. Source: Deloitte (2020)

Scenario 1 - "Data and mobility manager":

In this world, connectivity has become a differentiator. E-mobility (including battery as well as plug-in hybrid electric vehicles, range extenders and fuel cell), autonomous driving, and integrated mobility are a common reality for the broad public. OEMs are able to set the standards and are the dominant players in the automotive industry, offering a rich portfolio of products and services. Innovative automotive outsiders have to play according to the rules set by OEMs. In particular premium brands and status play a decisive role in consumers' buying behavior. OEMs offer an attractive workplace for talent.

Scenario 2 - "Stagnant car maker":

Massive lobbying by OEMs has prevented potential new high-tech players from entering the market. However, this defensive strategy has also slowed down technical development, with the result that many potential innovations have not been rolled out to the market, with regulations, for example, limiting the deployment of technology. Dramatic accidents with immature autonomous cars have also resulted in a loss of consumer acceptance.

Scenario 3 - The fallen giant":

The car is a mere means of transportation and brand attractiveness has diminished. The technology hype has cooled down, which has put an end to the rise of the high-tech car. As mobility has become a commodity, the profit margin has decreased and OEMs are focusing on improving processes and on cost efficiency. Industry outsiders such as Uber have entered the market and are forging exclusive alliances with suppliers to provide affordable mass mobility. Since private car ownership has decreased, fleet management has become of significant importance for OEMs. New talent is hard to come by, due to the loss in the attractiveness of OEMs.

Scenario 4 - "Hardware platform provider":

IT players have disrupted the automotive value chain. OEMs have mainly become the suppliers of white-label cars to the internet giants. In this world, OEMs can play a relevant role only if they provide a superior platform for 'infotainment' and mobility services and / or retain a strong brand image. Since OEMs are not able to fully cash in the revenue potential, the margin per vehicle decreases.

As indicated by the results of the simulations, the core business of OEMs will undergo significant changes over the next decade. Current market shares and profits are greatly endangered by new mobility concepts and increasing competition. As pointed out in our forecast for e-mobility, alternative drives are highly likely to gain significant market shares up to 2025 and beyond. Owing to the reduced need for human labor in the production of e-cars and further efficiency measures, there is substantial pressure for workforce reduction. However, there are several future scenarios in which the OEM can successfully compete – and even increase revenues and operating profits by up to 70%. Based on the investigations in this study, there are **four potential futures for OEMs** (Deloitte, 2020):

1. **Become a technology leader** with strong branding through massive investment in new business models

2. Achieve at least **mid-term stability of your market position through joint collaboration and lobbying with other OEMs** to protect know-how and influence against emerging IT giants

3. Try to survive by f**ocusing on efficiency improvements, niche markets, and company vehicle business** to compete in a tough market environment with financially potent competitors

4. Set up **strategic partnerships with IT giants**. The production of high-quality and cost-effective vehicle platforms combined with a strong brand image will result in a mobility offering that leads the white label market

8. ELECTRIC AND AUTOMOTIVE VEHICLES AND THE IMPACT ON THE AUTOMOTIVE SUPPLY CHAIN

8.1 ELECTRIC VEHICLES AND THE AUTOMOTIVE SUPPLY CHAIN

Adoption of **electric vehicles (EVs) will have a profound impact on the automotive supply chain**. Even if some markets, such as the U.S., remain heavily **internal combustion engine (ICE)** -focused in the near term, the global shift to EVs should be top of mind for suppliers everywhere. Indeed, PwC analysis shows that EVs may represent approximately 14% global new vehicle sales in Europe and China by 2025 — up from 1% in 2017. Many suppliers that provide components for vehicles powered by internal combustion engines may face a significant threat if they cannot adapt. **Key differences between the makeup of EVs and ICE vehicles** reveal which supplier subsectors are most at risk.

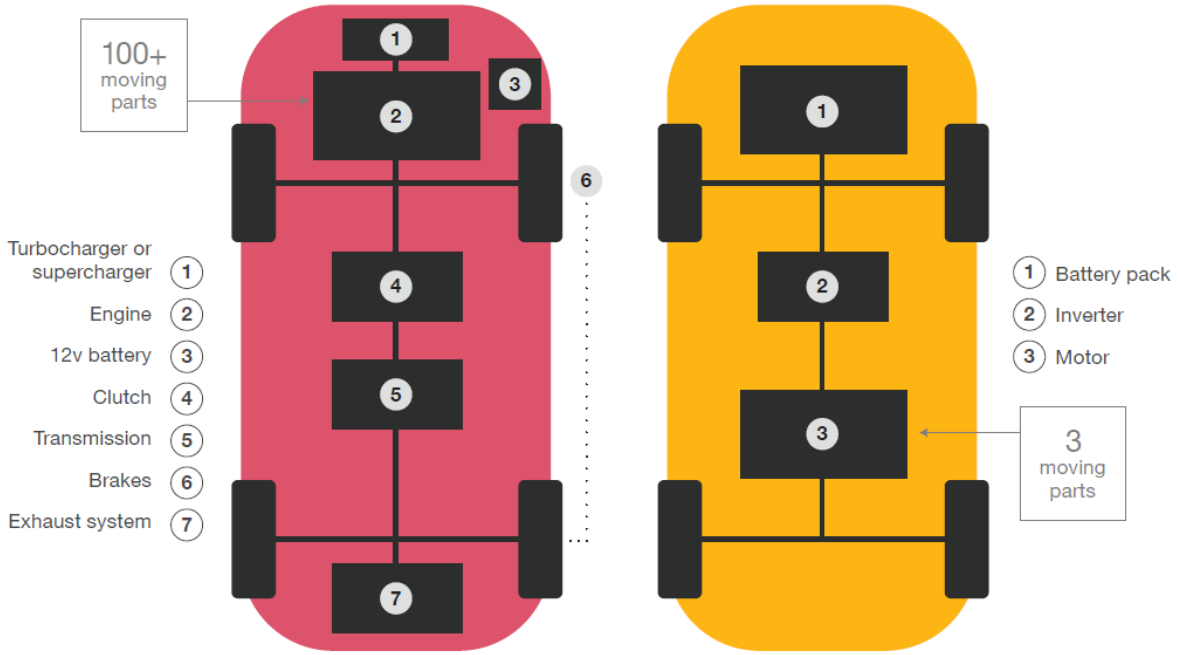

Figure 8.1 EVs lack many systems essential to ICE vehicles. Source: PwC (2019a)

In contrast, **suppliers are likely to face significant challenges as EVs enter the mainstream**. There are two main reasons for this:

• EVs are radically simpler in mechanical terms... The electric motors that power EVs comprise far fewer components than a traditional ICE. In fact, the UBS Group compared the Chevrolet Bolt's engine to a four-cylinder internal-combustion engine and found that the electric motor had three moving parts, compared to the ICE's 113 (Figure 8.1). In addition, most EVs have single-speed transmissions and have no need for turbo- or superchargers to provide additional oxygen to the engine or exhaust systems to remove waste gases.

•…But they're much more complicated in other ways. PwC Strategy anticipates that the share of a car's value attributable to the powertrain and electronics will rise significantly by 2025, to a combined 52% from 44% in 2015, at the expense of the chassis, body, and interior components, driven in part by a **shift toward EVs** (increasing in-car connectivity and advancements in driver-assist technology are also factors). The lithium-ion battery pack alone can account for up to 50% of the value of today's EVs. **Battery prices have fallen steadily** in recent years and that share will likely be much lower over time. But even so, these batteries are primarily made by companies outside the traditional auto supply chain, creating new competition for legacy suppliers. The fact that some **EV battery suppliers** are developing expertise in manufacturing electric powertrains further illustrates the risk.

These changes will naturally shrink suppliers' potential addressable market as EV adoption rises. The share of EVs' value added by component suppliers might total 35% to 40%, compared with 50% to 55% of an ICE-powered car (PwC, 2019a).

Improving technology and tightening regulations on emissions from ICEs is about to propel electric vehicles (EVs) from a niche to the mainstream. After more than a century of reliance on fossil fuels, however, the route from petrol power to volts will be a tough one for carmakers to navigate (The Economist, 2017).

8.1.1 THE GROWTH OF ELECTRIC CAR MARKET

Electric car markets are seeing exponential growth as sales exceeded 10 million in 2022. The share of electric cars in total sales has more than tripled in three years, from around 4% in 2020 to 14% in 2022 (Figure 8.1.1). EV sales are expected to continue strongly through 2023. Over 2,3 million electric cars we sold in the first quarter, about 25% more than in the same period last year. We currently expect to see 14 million in sales by the end of 2023, representing a 35% year-on-year increase with new purchases accelerating in the second half of this year. As a result, electric cars could account for 18% of total car sales across the full calendar year.

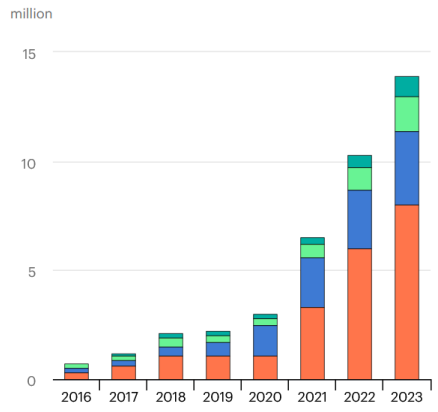

Figure 8.1.1 Electric car sales, 2016 – 2023. Source: IEA (2023)

8.2 AUTONOMOUS VEHICLES AND THE AUTOMOTIVE SUPPLY CHAIN

Though ongoing investments in **electric vehicles (EVs)** may be well-timed to satisfy shifting consumer and regulator demand for cleaner cars, outsized spending on **autonomous vehicles (AV)** development is likely driven by two complementary impulses. These are, on the one hand, a belief that companies that push decisively into the AV space early will be best positioned to tap its massive potential, and, on the other, the fear that opportunities will be scarce for those who are left behind. Automakers' stated intent may be to gain some measure of control over highly unpredictable future costs, or secure a stable or growing share of industry profit amid the rise of self-driving vehicles, but the odds are good that many of these investments will prove distracting or worse (PwC, 2019b).

AVs will give rise to new business models — and **change existing ones** — within the transportation sector once they become prevalent. The **array of sensors and software that will allow these vehicles to navigate streets** and highways with **little to no engagement from a human driver** are astronomically expensive today and will continue to add greatly to the cost of cars and trucks equipped with them for the foreseeable future. Such vehicles will likely remain out of reach for the average car buyer for quite some time. Instead, we expect AVs to be very attractive to ride-hailing operators, since they will both reduce labor costs and increase asset utilization. But because of their significantly higher upfront cost compared with traditional vehicles, we expect most AVs will be purchased (at least initially) by companies that manage large fleets. Who will step in to fill this position in the value chain remains to be seen. **Automotive companies** have already begun to invest in this future, laying the groundwork through bets on software and sensor technology and via partnerships with suppliers and TNCs that can provide capabilities they don't have. Whether the headlong rush toward this future has been wise is certainly a question OEMs and suppliers will have to contend with before long, especially if vehicle sales falter or key automotive markets experience an economic downturn. But regardless of their prudence, these investments are helping to bring about changes in the structure of the automotive industry that will have long-lasting consequences and for which auto companies must prepare (PwC, 2019b).

8.2.1 NEW LINKS IN THE VALUE CHAIN

Among the biggest of these changes is the emergence of **new players in the automotive ecosystem**, including **makers of electrical systems and batteries for EVs**, **sensors** to enable **advanced driver assist systems** (and eventually autonomous driving) and **AV software**. Today, these categories are relatively distinct, without much overlap between them. But because auto companies are operating in a highly uncertain environment, with fear of being left behind and hunger for **future growth opportunities** driving decision making, the temptation to try to do it all is real.

The risk is misallocation or destruction of capital as companies seek to compete in areas where they have a poor chance of success. The characteristics needed to succeed as an

OEM — scale, technical capabilities, capital structure and so on — are radically different for those required to develop AV software. Yet because of a desire to gain an advantage in a transforming industry (or simply to protect their current position), **OEMs have begun making investments up and down the value chain.**

As alluring as this strategy may seem, it can be a costly mistake. Companies that jump in without careful consideration of the capabilities required to succeed at different points in the value chain risk setting themselves up for failure. An examination of how each player is structured and what they do best should illustrate this point (Figure 8.2.1).

Traditional auto suppliers, which build components and subassemblies, are manufacturing businesses integrated into complex global supply chains. They are asset-heavy and capital intensive, and must master research and development, procurement and factory operations to be successful.

AV software suppliers, on the other hand, are generally young companies and often rely on venture capital and similar early-stage funding to cover operating expenses. Compared to manufacturers, their physical assets are negligible. Their relatively small workforces have the deep technical expertise needed to develop artificial intelligence systems and integrate them into hardware (i.e., vehicles) manufactured by third parties. They also need flexible and forward-looking safety, risk and compliance functions to manage an ever-shifting and still-nascent regulatory landscape.

OEMs typically have a global manufacturing footprint and huge numbers of workers, customers and shareholders. Their capital structures generally include significant amounts of debt, often issued by captive finance units that make loans to buyers of the OEM's vehicles. Thanks also to vehicle warranties that can last for years, they tend to have long-lasting relationships with their customers. These companies manage sprawling supply chains and sophisticated manufacturing operations and are also among the world leaders in R&D spending.

Fleet managers' role in the value chain will likely morph substantially as AVs become more mainstream, since (as discussed above) we believe it's unlikely that widespread private ownership of self-driving cars is likely. In such a scenario, fleet managers will possess large numbers of very expensive vehicles, which they will be responsible for cleaning and servicing on behalf of their TNC clients. Having the right digital solutions to make sure vehicles are in the right place and ready for use will be key. This will likely require a widely scattered physical footprint and workforce.

TNCs will provide the AV-enabled "robotaxi" service of the future. They will need sophisticated digital platforms to connect vehicles and riders. As current ride-hailing businesses illustrate, this is a complex task, requiring carefully designed pricing strategies, effective marketing and strong data analytics capabilities. The evolution of AV regulation will have much to say about the shape of TNCs' future workforce — today's ride-hailing drivers

may ultimately be replaced by “safety engineers” positioned to take the wheel in an emergency.

As this comparison illustrates, there is often very little overlap in the capabilities required to succeed at one point in the value chain and those above and below it. This is an important — and, unfortunately, underappreciated — issue for an evolving industry. The question facing auto companies today is whether they should embrace their current strengths or seek to **reposition themselves in the value chain**. It must be noted that there are few examples from other, comparable industries of companies successfully “doing it all.” To take aerospace as an example, the small handful of airframe makers do not also manufacture avionics or jet engines, nor do they operate airlines. The differences in scale, capabilities and capital structures required are too great for one company to successfully compete in all of those areas. The same will likely prove true for auto OEMs, for example — software development and fleet management are too disconnected from their core strengths in manufacturing for one company to excel in all three (PwC, 2019b).

	Traditional parts suppliers	AV software suppliers	OEMs	Fleet managers	TNCs
Description	• Provides components/ sub-assemblies • Could be build-to-print or build-to-specification	• Develops and assembles autonomous solution – software and associated sensor suite	• Vehicle assembly • Sales and service • Vehicle financing • Aftermarket	• Vehicle acquisition and sourcing • Leasing to TNCs/ robotaxi providers	• Provide mobility as a service to customers
Capabilities Required	• Product R&D • Manufacturing • Procurement • Supply chain management • Aftersales • Demand forecast and financial planning	• Advanced software R&D including AI • System integration • Safety and regulation • Risk and compliance	• Product R&D • Manufacturing, operations and supply chain • Sales and marketing • Aftermarket • Risk and compliance • Warranty management • Capital allocation	• Asset and Inventory Mgmt. • Fleet management and vehicle maintenance • Warehousing • Digital solutions to manage supply chain • Vehicle remarketing and recycling	• Supply (driver) management • Demand management and customer acquisition • Customer service • Price and promotion Management • Advanced analytics and software development

Figure 8.2.1 Key capabilities and financial structure for automotive value chain. Source: PwC (2019b)

8.2.2 IMPLICATIONS FOR SUPPLIERS

Suppliers may also need to adapt to new industry success factors. They face fierce competition for full-stack solutions that may likely lead to a consolidation of players. To compete, suppliers must be focused and nimble. They might benefit from **offering different delivery models to OEM customers**, from stand-alone hardware solutions to fully integrated hardware–software solutions. In return, new opportunities may open up for developing joint business models closer to end customers, potentially including the possibility of revenue sharing.

For state-of-the-art **autonomous driving (AD) solutions**, companies will need access to large amounts of fleet data to train algorithms to achieve low-enough failure rates. While OEMs have fleet access and only need to find suitable technology to extract data from their customer fleets, suppliers must depend on partners or key customers to gain access. Consequently, it is mission critical for suppliers seeking to develop state-of-the-art AD systems to recruit a close lead customer early on for codevelopment and fleet access.

A lack of access to substantial amounts of fleet data, funding, and sufficient talent will probably limit the number of companies that can successfully offer full-stack AD systems. The result may be a “winner takes most” market dynamic. Companies with the best access to data and funding will likely enjoy a strong competitive advantage over those that do not have this information, since they will have a better chance to advance their technology and get ahead of their competitors.

As a result, the number of successful suppliers or tech companies delivering a full AD system could likely remain limited to a handful of companies, in both the West and China. For the first generation of AD systems, joint development of software and the required chips may help the full system achieve better performance and efficiency, with a lower risk of late integration issues. This could further limit the number of potential industry winners.

Achieving long-term success may also require suppliers to articulate their competitive advantage, value proposition, and strategies. They should decide whether or not to become a full-stack player for the most advanced systems or concentrate on dedicated areas of the stack, which could be either hardware components or software elements. The McKinsey research shows that a targeted approach may yield higher returns for many suppliers and potentially offer substantial and attractive value pools (McKinsey, 2023).

8.2.3 SUCCEEDING IN THE PASSENGER CAR MARKET

To succeed in the **autonomous passenger car market**, OEMs and suppliers will likely need to change how they operate. This may require a new approach to R&D that focuses on software-driven development processes, a plan to make use of fleet data, and flexible, feature-rich offerings across vehicle segments that consider consumers’ varying price points. Decoupling the development of hardware components and software for AD platforms could allow automakers and suppliers to keep design costs more feasible, since the AV architecture could then be reused.

To win over consumers, auto companies could also develop a customer-centered, go-to-market strategy. Moreover, leaders might explore **different ownership models** and sales methods with the end-to-end (E2E) business case in mind, taking into account the entire life cycle of the autonomous vehicle. Finally, leaders may also need to create an organization that will support all of the above changes (McKinsey, 2023).

TEST QUESTIONS

1.) What is the value chain (VC)? Define the Michael Porter's concept of value chains and primary activities?
2.) Name the key parts of the global value chain (GVC) model?
3.) Explain six basic dimensions of GVC analysis (top-down and bottom-up)?
4.) At which geographic scales are GVCs operating?
5.) Describe the typology of five governance structure identified in the GVC literature?
6.) Identify four types of upgrading? Explain on the example of the automotive industry?
7.) Explain the smile curve of high-value activities in GVCs on the example of automotive industry?
8.) Identify main stakeholders in the value chain?
9.) Describe the participation in GVCs on the example of tyre production?
10.) What are the four types of upgrading within the GVC framework?
11.) Outline main scenarios of the future automotive value chain?
12.) What are the main differences between production of electric and internal combustion vehicles?
13.) Characterize the recent situation on the electric car market?
14.) Describe new players in the automotive ecosystem in the production of electric vehicles?
15.) Describe new players in the automotive ecosystem in the production of autonomous vehicles?
16.) What are the implication for suppliers of autonomous car production?

REFERENCES

[1] Gereffi, G. and Fernandez-Stark, K. *Global Value Chain Analysis.* A Primer, 2nd Edition, Duke University, July 2016

[2] World Bank (2020). *Trading for Development in the Age of Global Value Chains*, World Development Report 2020. URL: https://www.worldbank.org/en/publication/wdr2020

[3] Pickles, J. and Smith, A. *Articulations of Capital. Global production Networks and Regional Transformations*, Wiley Blackwell, 2016. ISBN: 978-1-118-63290-1

[4] Porter, M. E. *The Competitive Advantage: Creating and Sustaining Superior Performance.* New York: free Press, 1985

[5] Calabrese, G.G. *Global value chain in the automotive industry: challenges and new trends*. 2018. URL: https://edisciplinas.usp.br/pluginfile.php/4325260/mod_folder/content/0/Calabrese%20-%20Automotive%20GVC.pdf

[6] Sturgeon, T.J. and Memedovic, O. *Mapping Global Value Chains: Intermediate Goods Trade and Structural Change in the World Economy.* UNIDO Development Policy and Strategic Research Branch Working Paper, issue 5 Posted: 2010. URL: https://www.usitc.gov/publications/332/journals/concepts_approaches_in_gvc_research_final_april_18.pdf

[7] OECD (2012). *Mapping the global value chains*, The OECD Conference Centre, Paris, December 2012. URL: https://www.oecd.org/dac/aft/MappingGlobalValueChains_web_usb.pdf

[8] Gereffi, G. and Fernandez-Stark. *Global Value Chains Analysis: A Tool to Promote Economic Development.* LSE. October, 2017 URL: https://blogs.lse.ac.uk/gild/2017/10/30/global-value-chains-analysis-a-tool-to-promote-economic-development/

[9] Seric, A. and Siong Tong, Y. *What are global value chains and why do they matter?* Industrial Analytics Platform UNIDO, 2019. URL: https://iap.unido.org/articles/what-are-global-value-chains-and-why-do-they-matter

[10] World Bank (2020). *Trading for Development in the Age of Global Value Chains*, World Development Report 2020. URL: https://www.worldbank.org/en/publication/wdr2020

[11] Gereffi, G. and Korzeniewitz, M. *Introduction: Commodity Chains and Global Capitalism*. Westport, CT: Praeger, 1994

[12] Frederick, S. and Gereffi, G. *Value Chain Governance: Briefing Paper*, 2009

[13] Gereffi, G., Humphrey, J. and Sturgeon, T. J. *The Governance of Global Value Chains. Review of International Political Economy*, 2005, 12, 78-104. URL: http://dx.doi.org/10.1080/09692290500049805

[14] Humphrey, J. and Memedovic, O. *The Global Automotive Industry Value Chain: What Prospects for Upgrading by Developing Countries*, UNIDO, 2003. URL: https://www.unido.org/sites/default/files/200912/Global_automotive_industry_value_chain_0.pdf

[15] Humphrey, J. and Schmitz, H. *Governance in Global Value Chains*, 2001. Institute of Development Studies Bulletin 32 (3)

[16] Zabojnik, S. *GVCs in Central Europe — A Perspective of the Automotive Sector after COVID-19*, 2022, Ekonóm, Bratislava, ISBN: ISBN 978-80-225-4949-3

[17] Sturgeon, T. J. and Florida, R. *Gloablisation, Deverticalisation and Employment in the Motor, Vehicle Industry"* in M. Kenny (ed.) Locating Global Advantage: Industry Dynamics in a Globalising Economy, Palo Alto, Stanford University Press, 2004

[18] Sturgeon, T. J. and Van Biesebroeck, J. *Global value chains in the automotive industry: an enhanced role for developing countries?* Int. J. Technological Learning, Innovation and Development, Vol. 4, Nos. 1/2/3, 2011.

URL: https://ujr.mx/documentos/CGV%20EN%20INDUSTRIA%20AUTOMOTRIZ.pdf

[19] Sturgeon, T. J. *Global value chains and economic globalization*. Industrial Performance Center, Massachusetts Institute of Technology, May 2023

URL: https://ec.europa.eu/eurostat/documents/7828051/8076042/Sturgeon-report-Eurostat.pdf

[20] UN ESCAP (2013). *Expansion of Global Value Chains in Asian Developing Countries: Automotive Case Study in the Mekong Subregion.* URL: https://www.unescap.org/sites/default/files/0%20-%20Full%20report.pdf

[21] Vlčková, J. *How to benefit from global value chains – implications for the V4 countries.* Vysoká škola ekonomická, Nakladatelství Oeconomica – 2015. ISBN 978-80-245-2111-4. URL:

https://www.unescap.org/sites/default/d8files/event-documents/Module-1%20Understanding%20GVC.pdf

[22] Sturgeon, T. J. and Memedovic. *Mapping global value chains - intermediate goods trade and structural change in the world economy*, September 2020

[23] UNIDO (2019). *What are global value chains and why do they matter?* 2019. URL:

[24] Banerjee, B. Zeman, J. *Determinants of Global Value Chain Participation: Cross-country Analysis*, NBS, 2020

URL: https://nbs.sk/_img/documents/publik/wp_1_2020_zeman_determinants_of_gvc_en.pdf

[25] PwC (2019a). *Merge ahead: Electric vehicles and the impact ont he automotive suppy chain.* PWC, 2019. URL: https://www.pwc.com/us/en/industrial-products/publications/assets/pwc-merge-ahead-electric-vehicles-supply-chain.pdf

[26] PwC (2019b). *Changing lanes: As autonomous vehicles transform the value chain, what moves will you make?* PWC, 2019. URL: https://www.pwc.com/us/en/industrial-products/publications/assets/pwc-changing-lanes-mobility-value-chain.pdf

[27] Deloitte (2020), *The Future of the Automotive Value Chain*, Deloitte, 2020. URL: https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/manufacturing/deloitte-uk-mfg-automotive-value-chain-2025.pdf

[28] The Economist (2017). *Electric cars are set to arrive far more speedily than anticipated.* February 18th 2017. URL: https://www.economist.com/business/2017/02/18/electric-cars-are-set-to-arrive-far-more-speedily-than-anticipated?

[29] IEA (2023). *Electric Vegicles*. URL: https://www.iea.org/energy-system/transport/electric-vehicles

[30] McKinsey (2023). *Autonomous driving's future: Convenient and connected.* URL:

https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/autonomous-drivings-future-convenient-and-connected

Modul_2022.

Electric and Autonomous Vehicles

Rudolf PÁSTOR

Global value chain (GVC) in automotive industry

ISBN

Financial support was provided by the DRIVEN project (Grant agreement No. 2020-1-SK01-KA203-078349) under Erasmus+ Call 2020 Round 1 KA2 - Cooperation for innovation and the exchange of good practices.