



**The impact of global supply chains on
employment and production system :
A summary.**

A Franco-Brazilian comparison of the aeronautic and
automotive industries

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Introduction

This document highlights the main results of a 348-page report entitled “The impact of global supply chains on employment and production systems: a Franco-Brazilian comparison of the aeronautic and automotive industries,” submitted in January 2018 to the ILO.¹ Chapter 1 evaluates academic analyses based on global supply chains (GSCs) and defines GSCs as spaces created by large manufacturing corporations operating from their national territories, spaces with several dimensions: a techno-productive dimension, a strategic dimension and a capital valorisation dimension.

Chapter 2 describes the economics of the aeronautic and automotive industries and identifies the main determinants of supply and demand. The discussion focusses on Interactions between the GSCs and their national territories. We insist on the importance of the distinction between GSCs that emanate from developed countries (such as France) and those that emanate from emerging countries (such as Brazil).

Chapter 3 highlights the essential role played by public policy in the development of the two industries in France and in Brazil. In the southwest of France, the aeronautic industry works closely with regional government, especially in organizing and financing R&D, and also in providing training. In Brazil, government supports both industries through BNDES, the national bank for economic and social development, and through government purchases of aeronautical products.

Chapter 4 describes changes in the organization of the GSCs of aeronautical and automotive corporations in the two countries, focussing on the accelerating trend towards internationalization. Aeronautical OEMs have cut back on the number of their suppliers. Remaining suppliers have been made responsible for work packages (WP) in the framework of risk sharing partnerships, with suppliers obliged to take on more and more financial commitments. Automakers in France have speeded up offshoring by moving the whole manufacturing process abroad, and not just specific segments of production. The pace of offshoring and the choice of foreign locations differ from one corporation to

¹ The full report in French is available on the internet site of the IRES at <http://www.ires.fr/etudes-recherches-ouvrages/rapports-de-l-ires/item/5645-rapport-01-2018-l-impact-des-chaines-mondiales-d-approvisionnement-sur-l-emploi-et-les-systemes-productifs>. Research was coordinated by C. Sauviat and C. Serfati (Ires). Researchers were K. Guillas-Cavandan (Ires), M. J. Barbieri Ferreira (FCA-Unicamp), R. A. Z. Borghi (IE-Unicamp), C. Hiratuka (IE-Unicamp), and F. Sarti (IE-Unicamp).

another. French automotive suppliers have also contributed to changes in GSCs, partly in response to pressure from OEMs. Suppliers have chosen to diversify their clienteles and to strengthen their R&D know-how; these challenges have strengthened suppliers' position in relation to automakers.

Chapter 5 analyses the three forces that drive change in GSCs: globalisation of production, R&D and decisions concerning sourcing (internal sourcing or outsourcing); disruptive innovations; the increasing influence of financial objectives on the strategies of large manufacturing corporations.

Chapter 6 examines the impact of changes in GSCs on employment and on work. The situations in France and in Brazil are compared using national databases published by Eurostat and information published by corporations. The automotive and aeronautic industries have followed different paths, but both are marked by a trend of employment international. Nonetheless, keeping jobs in France is a major concern for French unions and public authorities in the automotive sector, and this issue was dealt with in recent collective bargaining agreements. In contrast, in Brazil, the main concern is wage levels and maintaining workers' purchasing power.

Comparison of aeronautic and automotive GSCs in France and in Brazil shows that the conditions required for economic and social upgrading are strongly linked to public policy. This issue reaches far beyond the time horizon of the firms who participate in GSCs. Current transformations of GSCs pose the question of the relationship between large corporations and their home countries, a relationship that plays a decisive role in national employment trends and collective bargaining.

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Chapter 1

An assessment of analyses based on GSCs

(Global Supply Chains)

This first chapter evaluates the strengths and drawbacks of approaches based on GSCs. We assess their capacity to describe the radical changes that have taken place in international production of goods and services. The concept of GSCs originated in academic circles. The ILO chose to use this term out of the many used to describe international fragmentation of production.² The term GSC was gradually adopted by international economic institutions in the analytical frameworks they use to formulate recommendations. However, some dimensions of GSCs have been neglected in the literature. We consider "supply chains" to be spaces characterized by three dimensions: a techno-productive dimension, a strategic dimension and capital valorisation dimension. This definition highlights the predominant role of corporations.

1 The predominant role of large corporations

According to UNCTAD, MNEs control some 80% of international trade. About one third of international trade takes place within firms, that is, between subsidiaries of the same corporation. The share is much larger in developing countries (UNCTAD, 2013). It should be noted that a small number of MNEs carry out a large share of world R&D and world production (EU Industrial R&D Investment Scoreboard, 2017).³ Hence, the contours and structure of GSCs are determined to a large extent by the strategies of large multinational corporations.

It is therefore useful to view GSCs as integrated global spaces created by financial groups with manufacturing activities. Such spaces are global in that they open up a strategic horizon for augmenting the value of capital that reaches far beyond national borders and undermines national regulations. Such spaces are integrated in that they are made up of hundreds, even thousands, of subsidiaries (production, R&D, finance, etc.) whose

² Cf. Chapter 1 of the report.

³ In 2016, the 50 largest MNEs accounted for 40% of the total R&D expenditures of the world's 2,500 largest firms (source: 2017 EU Industrial R&D Investment Scoreboard).

activities are coordinated and controlled by a central body (the parent company or a holding company) that manages resources to ensure that the capital valorisation process is profitable both financially and economically (Serfati, 2008). The integrated worldwide spaces created by large MNEs interact extensively with spaces of international production and international trade. The two types of spaces are not identical, however, since those created by MNEs are internal and organized in order to pursue MNE strategies, while international production and trade are based on national territories with legal boundaries and hence correspond to specific macroeconomic conditions and labour relations.

Analyses based on oligopoly theory can be used to account for the central role of large corporations in GSCs. In his research, S. Hymer (1970) has shown the dual nature of foreign direct investment (FDI): It makes it possible to transfer capital and technology between countries; it also limits competition between firms located in different countries. However, oligopoly theory must be adapted to fit the present situation. Competitive pressures, which emanate from emerging countries (Freund, Sidhu, 2017) or result from major technological innovations, vary in strength depending on the sector. Oligopolies are more or less stable and open to new competitors, and they are made up of a larger or smaller number of firms. Analyses must allow for these differences. However, the fact remains that a small number of giant firms dominate the economy.⁴ To sum up, intensification of competition can change the players present on the world stage and the balance of power within GSCs (see below), but it has much less impact on concentration in most sectors, including those marked by rapid technological change such as computer programmes and information technology (UNCTAD, 2017).

In any case, large MNEs have created GSCs in order to reinforce their “vertical” monopoly power, that is, power over their suppliers, as well as their “horizontal” power in competition with companies that make similar products and sell on similar markets. In many sectors, consolidation of oligopolies and reinforcement of barriers to entry have accompanied the development of GSCs.

⁴ Cf. "Business in America: Too much of a good thing," *The Economist*, 26 March 2016.

Through their dominant position in GSCs, large corporations can obtain rents from several sources (Davies *et alii*, 2017). Several techniques may be used to achieve this goal:

- a) Holding financial and intellectual property rights (patents, licences, etc.), a component of corporate assets that has been growing over recent decades, held by the parent company or by subsidiaries created specifically to gain access to tax havens;
- b) Power over consumers on final markets, leading to “monopoly pricing” based on different factors (reputation, marketing, concessions of government regulated activities, etc.);
- c) Corporations’ control over their GSCs and their capacity to dominate suppliers, which allows them to capture part of value added, in particular through pressure during negotiations on prices.

Generally, a rent can be defined as a regular income stream that stems from holding property rights or having power over other agents. Although the distinction between rents and profits earned by firms through production of goods and services seems to be widely accepted in theory, it is difficult to draw the line in practice. It is paradoxical that the literature on GSCs focusses on “value chains” but rarely cites empirical data that would lend more substance to analyses of the distribution and the transfer of value among firms within GSCs. (Exceptions are a few often cited pioneering studies on Apple and Nokia.) Researchers are confronted with a contradiction that cannot be resolved with currently available data. They are studying a process of value creation that is becoming more and more “collective” within GSCs. At the same time, the contours of the firms they observe are still clearly delineated by property rights, and therefore those firms take care to keep their data confidential.

The question is not only academic. National regulatory agencies face similar difficulties when they want to determine if monetary flows in the worldwide space of large multinational corporations constitute earnings due to activities necessary to production (acquisition of inputs, etc.) or if they are designed for fiscal optimization (OECD, 2013; UNCTAD 2015, Chapters 4 and 5). Firms have a number of tools at their disposal that

enable them to make money flows between their subsidiaries opaque (transfer prices, creation of special entities situated in countries with low tax rates, etc.).

2. The three dimensions of GSCs

Our review of the literature on GSCs and its limits has led us to adopt a broad definition which characterizes GSCs as having three dimensions.

2.1 A techno-productive dimension

The expression “supply chain” is commonly used to designate a sequence of production operations. It starts at conception and development of the product or system, goes through the production process including acquisition of inputs (raw materials, tools, equipment), and finishes with distribution, maintenance and the end of the product’s life. The parts and modules produced at each step of the process are assembled to make a final product. This dimension is based on a form of technological interdependence that is often referred to as a “chain.” It should be noted that senior management of firms have only recently become aware of this techno-productive dimension of supply chains. Indeed, it was only in the 1990s that the concept “supply chain” replaced the concept “logistics”; this was due to the combined influence of production offshoring and improvements in management technologies (notably the use of ERPs, Enterprise Resource Planning systems).⁵

A technico-productive system cannot be measured with the standard tools of national accounts, since its output requires inputs from several different industries (United Nations, 2003).

2.2 A strategic dimension

Industrial economics, particularly in France, has explored this dimension using the concept of mesosystem (De Bandt, 1989). This approach stresses the dynamic properties inherent to any system: internal coherence, interdependence between agents, the ability to reproduce, etc. The industries this study focusses on are marked by strong systemic interdependence between firms and also between firms and public institutions that deal with research and regulations.

⁵ Cf. Adam Robinson, “The Evolution and History of Supply Chain Management,” <http://cerasis.com/2015/01/23/history-of-supply-chain-management/>

In order to study industrial strategies or governance, it is necessary to detect and observe asymmetrical power relationships: between companies – generally labelled *market power* by industrial economists – and between large corporations and their clients, whether they be companies or final consumers. However, since the bulk of world production takes place within GSCs, it is useful to add the concept of *relational power* to that of market power.

Relational power is the source of profits that large corporations derive from *relational capital*. This is made up of resources that stem from relations with clients, suppliers, R&D partners (OECD, 2008) and governmental institutions. Along with *human capital* and *structural capital* (routines, procedures, databases, etc.), relational capital is a major component of the intangible assets of large publicly listed corporations and of the capital gains on share value (that is, goodwill) that accrue in the case of acquisitions and mergers. However, the “return on relational capital” that accrues to large corporations exists not only on the stock market. When the capital valorisation dimension of GSCs is considered (their third dimension, discussed below), corporations can also earn returns on relational capital in the form of value transfers, often referred to by economists as *rent seeking*.

2.3 A capital valorisation dimension

In a market economy framework, the creation of value and its appropriation by private parties is the main goal of economic agents. This process is carried out to a great extent through networks (OECD, 1992). By creating the concept of value chain, M. Porter (1985) opened up the way to analysing firms within their competitive environment. However, in the current context characterized by segmentation of production, value is added through cooperation between firms. This cooperation – described as “alliance capitalism” by J. Dunning (1995) – is necessary to carry products through to their final markets (especially for complex products or systems).

Defining GSCs as a space of value creation leads to questions about modes of value creation, and also about how the value that composes a product is shared out once it has gone through all the phases of transformation and reached final sale. The added value dimension of GSCs is not identical to their techno-productive dimension, unless one considers, as orthodox economists do, that money, as the expression of value, is added *ex post* to an economy where products are exchanged. On the contrary, the added value

dimension overlaps with the techno-productive dimension without completely coinciding with it. Nonetheless, the techno-productive dimension, where conception and production of products take place, is essential to value creation.

3. The limits of public policy in achieving upgrading

The preponderance of GSCs in international economic relations poses new questions for public policy, especially concerning development. With some exaggeration, the concept of upgrading is sometimes considered a central paradigm (Barrientos *et alii*, 2011). It is defined on the microeconomic level as the process whereby the economic agents involved in supply chains – firms and workers – shift from lower to higher value added activities (and skills) (*idem.*, p. 323). On the macroeconomic level, it implies the possibility for producers in developing countries to move up the value chain by acquiring a position on segments or products with higher value added that generate higher revenues (Gibbon, Ponte, 2005). The main question for national economies is to determine if social upgrading goes along with economic upgrading (Barrientos *et alii*, 2011).

In the literature, countries' choice between building or joining GSCs seems to be a purely rhetorical or theoretical question: Developing countries have consistently joined rather than built GSCs (Baldwin, 2014; Cattaneo *et alii*, 2013). Indeed, when MNEs set up production abroad, they engage in *technology lending* (Baldwin 2014, p. 26), which enables the host country to industrialize instantaneously. In this sense, development policies that recommend creation of new industries as a way to accomplish insertion in the global economy (see for example, D. Rodrik) ignore the current *importance* of GSCs. Baldwin considers the great difference in performance between China and Brazil to be due to the fact that China is completely integrated into exports of manufactured products – and hence integrated into GSCs – while Brazil's exports are made with Brazilian inputs, Brazilian technology and based on Brazilian policies (*idem*, p. 10). Our study shows, on the contrary, that growth of the aeronautic and automotive industries of Brazil continues to depend to a great extent on imported products and on foreign companies.

Rodrik (2012) does not contest the need to focus on segments rather than whole industries or the need to rely on financing from foreign rather than national investors. However, the context of globalization of economic activity makes development more difficult for poor

countries. Development requires institutions (for training, etc.) and infrastructures; it takes much longer to set these up than to join an existing GSC. Creation and consolidation of such institutions and infrastructures require industrial policies based on public-private partnerships (Rodrik, 2013, p. 56). Indeed, it is impossible to account for China's success in taking advantage of GSCs without understanding the "myriad state policies Chinese policy makers used to crowd in investments that would not otherwise have been made" (ibid., p. 47).

Developing countries' public policies concerning upgrading and integration into GSCs raise two types of questions. First, the terminology is highly ambiguous, since GSCs are not formal organizations that countries can become a member of (unlike the WTO, the World Bank or the IMF). When developing countries are called upon to "join" GSCs, just what "joining" means is not clear. In addition, it is misleading to affirm that developing countries should "join" GSCs since it is firms and not countries that must act. This type of confusion between the microeconomic and macroeconomic levels can be harmful when it is contained in recommendations addressed to governments. The latter, by definition, aim to promote economic and social development, goals that are much broader than the goals of firms.

Another problem in the literature on GSCs is that it focusses on developing and emerging countries, paying little attention to the impact of GSCs on developed countries. The large MNEs of OECD countries derive many advantages from their control over GSCs, but it is not sure that these advantages benefit their countries of origin. Indeed, the positive macroeconomic and macrosocial effects of firms' activities on economic growth over the decades following the Second World War have faded away to a large extent. Beginning in the 1980s, developed countries' MNEs externalized and delocalized their activities, a shift that resulted in upgrading for developing countries. The impact of these changes on wages and employment in developed countries is a subject of debate. Productivity gains resulting from GSCs (Bernhart, Pollack, 2015; Salazar-Xirinachs *et alii*, 2015) increased returns on capital and the incomes of very highly qualified workers whose share in added value creation increased in OECD countries, to the detriment of the vast majority of workers (Timmer *et alii*, 2014).

Chapter 2

Industrial economics and the dynamics of supply and demand in aeronautic and automotive industries

An industrial economics approach is essential to an understanding of similarities and differences between GSCs in the two sectors. Their characteristics of GSCs in these two sectors can explain the main trends in global supply and demand and in the development of the aircraft and automotive markets in France and Brazil.

1. The economics of the two industries

In both industries, barriers to entry are high, be they financial (sunk costs), technological or regulatory. In aeronautics, production of airplanes requires extremely high levels of technological and organizational competence. Airplanes are classified as “complex products and systems” (COPS) (Hobday *et alii*, 2005), with certain intrinsic traits. They are characterized by a high degree of technological uncertainty and by production on a small scale, especially for military equipment; these traits increase cost, the duration of R&D and levels of risk. Cars can also be considered a complex product, even though their technological intensity, as measured by the weight of R&D expenditures, makes them medium (high) technology products in comparison to high technology products such as aircraft. In both industries, technological and organizational complexity have been augmented by the development of modular production. This type of production entails two particular characteristics: First, the systems that constitute the end product are composed of modules that are independent and can be changed without harming system integrity; second, interfaces are essential.

Technological complexity and financial costs explain why final assembly is carried out exclusively by traditional manufacturers, that is, aircraft and carmakers, labelled OEMs (Original Equipment Manufacturers). As system integrators, they occupy a uniquely favourable position in relation to other large firms that belong to their GSCs⁶. Their position is reinforced by regulatory requirements (concerning security, the environment,

⁶ Only producers of aircraft engines – sometimes considered to be OEMs – are in a position as advantageous as that of OEMs, even in the end-product market, since airlines choose their engines. This is very different from the automobile industry, where OEMs design and produce engines for vehicles.

etc.) and certification procedures that only OEMs master today. The interviews conducted for this study confirm this observation. OEMs are hence present upstream in GSCs in the two sectors – in R&D and interactions with regulatory agencies – but they are also present downstream, since they alone have access to the end market. In aeronautics, maintenance and repairs (Maintenance, Repair, Overhaul or MRO) of the existing fleet of airplanes is a growing and very profitable part of their activity (20% for Boeing). In the automotive industry, OEMs exercise even greater control over the end market. Distribution networks (sales of new and used cars, spare parts, maintenance and repair services) and financing activities (new cars, rentals) carried out by corporations' banks constitute formidable barriers to entry. This explains the intensity of competition centred on brand image (marketing and publicity) between the firms present on the market, a form of competition that makes car manufacturers the biggest users of publicity in the economy.

The rise to power of suppliers is an important change in GSCs in the two industries. Technological innovations, a factor of competitive edge, are mostly due to suppliers: engines, composite materials, etc. in the aeronautic industry; new materials, energy storage, etc. in the automotive industry. In both industries, supply activities are more profitable than OEMs. Moreover, concentration has resulted in creation of “mega-suppliers.” Nonetheless, with a few rare exceptions, suppliers' sales are much lower than those of the main aeronautical or automotive OEMs.

Some analysts foresee an irreversible decline in the position of OEMs within GSCs along with a growing predominance of Tier 1 suppliers in the two industries, but this prediction will not necessarily be borne out. The structural advantages of OEMs cited above could be reinforced by the power that results from their relations with regulatory agencies. Regulations are continually changing: concerning resistance to shocks, braking systems, road holding, etc. in automotive manufacturing; concerning data management in aeronautics. Similarly, norms for environmental protection (pollutant emissions) are becoming stricter and stricter all over the world (Japan, Europe, United States, China, and India); this raises barriers to entry for new competitors in relation to existing OEMs.

In fact, given the more marked international division of labour due to fragmentation of production processes, relations between OEMs and Tier 1 suppliers require more interdependence between the large firms that participate in GSCs, an interdependence that

makes value creation more and more collective. Interaction in competition and cooperation persists between OEMs and Tier 1 suppliers. Specialists in industrial economics and the authorities who control competition sometimes view these relations as a form of collusion. What is at stake in relations between OEMs and Tier 1 suppliers is the distribution of value, since those relations affect the intra-GSC transfers that are determined by the balance of power between OEMs and their suppliers.

Both industries are oligopolies, although they are of different sizes. The automotive oligopoly is made up of a larger number of firms. It has accepted a few new firms, from Korea two decades ago, and from China more recently. The aeronautic oligopoly is made of four OEMs, a number that could shrink to two over coming years because of the control exercised by Airbus (in 2017) and Boeing (underway in 2018) on production of regional airplanes.⁷ In this industry, Tier 1 suppliers' markets are highly concentrated in several segments.

2. The determinants of supply and demand

Unlike the global automotive market, the global aircraft market has registered strong growth that has been little affected by economic crises. While aircraft supply in both Brazil and France is dominated by national OEMs that operate worldwide, Brazil has no national car manufacturer.

2.1 Major worldwide trends

Growth follows contrasting patterns in the two industries. Between 2000 and 2015, the number of cars sold rose by 55%, while the number of airplanes in operation doubled over the same period.

The sizes of the two industries are also quite different, with the automotive industry occupying a much large place in the world economy (Table 1).

⁷ Airbus controls the aircraft production programme of Bombardier, the largest producer on this market segment; Boeing controls that of Embraer, the second largest.

Table 1. Indicators of worldwide supply, demand and R&D in aeronautic and automotive industries

Indicators	Aeronautic industry	Automotive industry
Growth of world markets (2000-2015)	+100 %	+55 %
Sales revenues 2016 (euros billions)	475 *	2 162 **
R&D expenditures 2016 (euros billions)	29.2*	94.8 **
Sales revenues 2017 of the two main OEMs (dollars billions)	Boeing: 93.4 Airbus: 82.8	VW: 285 Toyota: 260.6
Volume of demand 2016	Limited: 2,262 new airplanes sold Concentrated: 280 client companies (9 pf them account for 27% of sales)	Mass consumption: 93.9 million new vehicles sold Demand highly individualized

* Aerospace and defence.

** Automotive and other transport (except aerospace).

Source: Authors' calculations based on data from manufacturers' associations, company annual reports, EU R&D Industrial Scoreboard, *R&D Magazine*.

The structure of supply and demand in the two industries is also very different. The most important segments of aeronautic⁸ production and exports – single aisle, double aisle and jumbo jet – are dominated by a small number of large developed countries: the United States, France, the United Kingdom, and Germany. The market for civilian airplanes is dominated by the Airbus-Boeing duopoly. Japan and a few emerging countries – Brazil, China, Russia – have succeeded in getting a few percentage points of the world market, but only in the limited segment of regional aircraft, which represents 2% of the total value of worldwide production.

In the aeronautic industry, demand is limited to some two thousand airplanes per year, and it is quite concentrated. In 2015, nine airline companies accounted for more than 28% of total sales. In 2016, the top three companies in sales of passenger seats accounted for 72% of sales in the United States, 57% in the Middle East, 51% in Latin American, 43% in Europe, 36% in Africa and 33% in Asia and the Pacific.

⁸ This study deals only with civilian aeronautic industry.

Nonetheless, low cost carriers (LCCs) have not only radically transformed the transportation market,⁹ but also influenced the decisions of Boeing, Airbus and their competitors to launch new airplane models. LCCs could even cause a revolution in the aeronautic industry and hence in its GSC, with their incentives for manufacturers to develop electric airplanes for regional flight. Finally, new competitors could revolutionize demand; for example, Uber has been encouraging development of four-passenger vertical take-off airplanes designed for transportation “on demand” (Chapter 5).¹⁰

Supply and demand are very different in the automotive industry, with sales of nearly 91 million cars worldwide in 2015. The same year, developed countries carried out nearly half – 48% – of world motor vehicle production, while the BRICs accounted for more than 36%. Production in the BRICs registered the highest growth, with those countries accounting for 84% of the increase in production between 2000 and 2015. The most striking new development is the sudden appearance of China, now the largest car manufacturer, with 27% of global production. China is also the world’s largest domestic market for automotive, representing 27% of global sales in 2015.

2.2 The aeronautic industry in France and Brazil

In both countries, aeronautic production is dominated by national manufacturers operating as OEMs on a world scale: Airbus in France¹¹ and Embraer in Brazil. In France, a few large corporations – Airbus, Thalès, Safran, Zodiac – accounted for more than 30% of industry sales in 2015, according to GIFAS, the association of French aerospace companies (Table 2).

These corporations nonetheless rely on many small and medium-sized companies, with 5,000 employees or less. In this respect, aeronautics is one of the few manufacturing industries in France that still has a dense network of companies.

In Brazil, the industry is still more concentrated. Between 2002 and 2015, Embraer accounted for 82.7% of the country’s aeronautic exports, a slightly larger percentage than

⁹ In Europe, the market share of LCCs rose from 17% in 2005 to 32% in 2013.

¹⁰ Cf. *Uber, Fast-Forwarding to a Future of On-Demand Urban Air Transportation*, October 27, 2016. <https://www.uber.com/elevate.pdf>

¹¹ The corporate headquarters of Airbus is located in the Netherlands. By agreement, France and Germany play equal roles in management, and they have equal shares of personnel. Questions arising from this form of governance are dealt with below.

its 80% share of sales revenues of the Brazilian aeronautic industry over the same period. In 2011, the Brazilian corporation employed 45% of the industry's labour force, down from the 53.9% share it employed in 2008. There is only one other Brazilian OEM: Helibras is a subsidiary of Airbus; it resulted from the Brazilian government's decision to develop production of military helicopters within national territory.

Table 2. The predominance of large aeronautical corporations in France

2015	Number of employees in France (1)	Sales in France (2)	Company employees in France / total aeronautic employees in France (3)	Company sales in France / total aeronautic sales in France (4)
Airbus France	50,810	8,024	28.2	16.4
Thales	33,455	3,420.5	18.6	7.0
Safran	41,588	3,965	23.1	8.1
Zodiac	6,741	0.588	3.7	0.0
Total of 4 companies	132,594	15,410	73.7	31.4
GIFAS data	180,000	49,024	100.0	100.0

NOTE: Data on sales published by GIFAS, the French association of aerospace manufacturers, include activities that are central to airplane production but are not classified by INSEE, the French national statistical institute, as part of aerospace manufacturing (NAF 30.3). This concerns notably built-in electronics, often classified in NAF 2651 ("Manufacture of scientific instruments for measuring, testing and navigation"), and engineering, classified as NAF 7112. Hence, GIFAS figures are closer than INSEE figures to those used by large corporations in the industry.

Source: Table constructed by authors using figures from corporate annual reports and statistics published by GIFAS.

Comparison of industry products in Brazil and France confirms the existence of a large gap between the two countries. The French aeronautic industry produces all types of military and civilian aircraft. It also makes engines: Safran especially produces engines for military and civilian airplanes, helicopters and spacecraft propulsion. According to GIFAS, in 2016, 47.8% of industry revenues went to OEMs, 36.9% to suppliers (avionics, landing gear, etc.) and 15.3% to engine manufacturers. French companies are well-positioned in the markets for engines (CFM, a GE-Safran joint venture), electronic equipment (Thales), business airplanes (Dassault) and commercial airplanes and helicopters (Airbus). Airbus is a European multinational corporation that is mostly French and German.

In contrast, Brazilian companies produce commercial airplanes exclusively for the regional transport segment of the market (between 70 and 130 passenger seats), which accounts for only 2% of world sales of civilian aircraft. Brazil has become the world leader on this market segment, with 52% of all sales, compared to 23% for Bombardier, 10% for COMAC, 8% for Mitsubishi and 7% for Sukhoi. The Brazilian manufacturer also sells business airplanes, a very small part – less than 0.5% – of the civil aeronautic market. It also sells military aircraft, thanks to purchases from the national armed forces. With government support, the Brazilian OEM has given rise to a dynamic regional business cluster (São José dos Campos, in the state of São Paulo) with over 70 companies. It has also helped to reinforce the national industrial base but only in relation to certain activities.

The two countries occupy very different positions in aeronautics, but, in both, this industry is absolutely crucial to national technological capacities. First, the share of aeronautics in High Technology (HT)¹² exports has risen continuously: Between 1990 and 2016, it went from 31% to 50% in France and from 41% to 74% in Brazil. Second, in both countries, the aeronautic industry has a large balance of trade surplus, unlike other HT products whose balance of trade deficits have been growing.

Hence, aeronautics is essential to manufacturing performance on world markets for both France and Brazil. This is the result of public policies that have been based for decades on the idea that airplane production is a strategic industry and important for military strength.

2.3 The automotive industry in France and in Brazil

The French automotive industry revolves around two large national manufacturers: Renault and PSA. According to the international professional automotive association (OICA or IOMVM), in 2015, the two companies ranked respectively 10th and 11th in the world by number of vehicles produced. Each of them now has only five assembly plants located in France, where two foreign companies, Smart/Daimler and Toyota, also have

¹² In the NACE Rev. 2 nomenclature, the following industries are classified as HT: pharmaceuticals (21); manufacture of computer, electronic and optical products (26); aerospace manufacturing (30.3). Source: Eurostat website.

plants (Table 3). Together, the two French corporations dominate the national market, with more than half of sales in 2015.

Table 3. Locations of automotive assembly plants in France in 2016

Company & location	Production	Number of employees (excluding temporary workers)
PSA		
Sochaux	347,000	9,043
Mulhouse	272,000	6,243
Poissy	234,600	4,773
Sevelnord	79,100	2,800
Rennes	55,700	4,025
Renault		
Douai	163,000	3,549
Maubeuge	162,254	1,627
Flins	160,545	2,315
Batilly	132,824	2,224
Sandouville	121,655	1,863
Toyota France		
Onnaing	237,000	3,000
Smart France (Mercedes)		
Hambach	85,000	800

Source: Company annual reports and company reports on the workforce that are mandatory under French law (bilans sociaux), press articles.

Automotive suppliers are more heterogeneous than OEMs. Among the Tier 1, some are large major French corporations (Faurecia, Valeo, and Plastic Omnium); many others are subsidiaries of foreign corporations.

Between 2000 and 2016, automotive production in France dropped by 39%, with France slipping from 4th to 10th place in the world. Beginning in 2008, the country registered a trade deficit that has since grown continuously, a sign of ongoing erosion of national

production. These figures reflect French manufacturers' transfer of automotive assembly away from their national territory. This process began earlier and has been more pronounced for Renault than for PSA. The shift abroad is correlated with transfer of activities towards countries with lower labour costs, notably in Central and Eastern Europe. Consequently, France's trade deficit with this region has grown very quickly. Initially, French manufacturers claimed that their transfer of production to Eastern European countries was aimed at profiting from growth in the region's markets following their integration into the European Union in 2004. However, this market growth did not take place. French assembly plants in these countries turned towards exports: to France, to other western European countries and to North Africa. French companies also expanded production outside Central and Eastern Europe. Production started in Spain and Turkey in the 1960s, and, more recently, in Morocco, resulting in higher trade deficits. All the countries that have benefitted from transfers of production capacity have lower labour costs than France or other countries in Western Europe.¹³ In Spain, for example, several competitiveness agreements negotiated with trade unions – based on wage moderation and increased flexibility of work schedules and employment contracts – have favoured production there, rather than in France. In all of these countries, labour legislation authorizes precarious forms of employment.

In Brazil, the automotive industry weighs much more heavily in the national economy than in France. It accounted for 20.4% of Brazilian manufacturing GDP in 2014, compared to only 4.6% in France in 2015. However, unlike the automotive industry in France or large emerging countries like China and India, the Brazilian automotive industry has always been dominated by foreign manufacturers (Table 4). Similarly, Brazil has a few Tier 1 automotive suppliers, but they have gradually come to be dominated by foreign companies.

¹³ In Morocco, the minimum wage is 238 €.

Table 4. The 12 main automotive manufacturers in Brazil in 2015

Company	Country of origin	Production	Market share in Brazil	Imports/Sales	Exports/Production	Number of factories
Fiat (FCA)	Italy	485,288	20%	15%	12%	2
GM	United States	361,779	16%	15%	20%	7
VW	Germany	422,530	15%	10%	30%	4
Ford	United States	240,597	11%	19%	0%	3
Renault	France	175,459	8%	16%	19%	2
Toyota	Japan	170,569	7%	11%	23%	4
Hyundai	Korea	165,934	7%	0%	0%	2
Honda	Japan	148,074	6%	5%	1%	3
Nissan	Japan	47,061	3%	35%	6%	2
Peugeot	France	69,712	2%	27%	36%	1
Daimler	Germany	0	2%	n.a.	n.a.	2
BMW	Germany	0	1%	75%	n.a.	1

Source: Based on Sturgeon *et alii* (2017)

Hence, in Brazil, the automotive industry depends essentially on the strategies of large foreign firms, both carmakers and automotive suppliers. There is an asymmetrical power relationship between Brazilian subsidiaries of multinational companies and their parent companies. Brazilian automotive production depends heavily on the domestic market. Exports represent a fraction of total production, reaching a peak of 35.5% in 2005. Furthermore, most Brazilian exports – 63.3% – go to Argentina and most Brazilian imports – 54.7% – come from Argentina. Hence, international integration of Brazilian automotive production is limited essentially to the Americas.

The dynamics of demand are different in France and in Brazil. While the French automotive market is based mostly on renewal, that is, replacement of cars and purchases of second cars rather than first purchases (Jullien and Pardi, 2015), the Brazilian market is based on first purchases. In France, the density of automotive ownership is high: 598

vehicles per 1,000 inhabitants. The rate of household ownership of vehicles is also high, at 82.9%, although it has been declining since 2012. Demand for cars depends above all on household incomes; the average age of buyers in France was 55.3 years old in 2015, because the average price of a new car – 22,100 euros – was high. Nonetheless, over half – 52% – of new car purchases are due to companies and car rental companies who want to renew their fleets. Finally, over half of new car registrations in 2016 – 52.1% according to the French association of carmakers, CCFA – are for diesel engines. The share of diesel engines is 57% for registrations of new cars belonging to private individuals. Manufacturers orient production to satisfy the richest clientele, that is, companies and households that are well off. They neglect the majority of the population who have no choice but to purchase used cars, a market that is triple the size of the market for new cars.¹⁴ In recent years, leasing has replaced ordinary credit in the financing of car purchases, a sea change in traditional practice.

Unlike the French market, the Brazilian automotive market is dominated by first purchases; the rate of car ownership is relatively low – 206 vehicles for 1,000 inhabitants – and varies greatly from one region to another. The prices of new cars are very high; the cheapest model – a Chery QQ Smile – costs 30,000 Rs, that is, 7,800 euros, the equivalent of more than two years (27.7 months) of earnings at the minimum wage. The market is dominated by vehicles with small engines (less than 1,000 cc); in the 1990s, the government subsidized sales of such vehicles through tax incentives. The share of small-engine vehicles in total sales reached a peak of 70% in 2001; subsequently, it began to drop because manufacturers adopted a strategy of producing vehicles with higher value added. Several factors contributed to a rise in demand and also to a shift towards models with higher value added: A rise in real incomes and an increase in formal sector employment facilitated access to credit for a growing fraction of the population and led to a drop in interest rates and an increase in the duration of loans.¹⁵ The Brazilian automotive market is dominated by vehicles with flex-fuel engines that run equally well on petrol or ethanol produced from sugar cane. This type of vehicle accounts for 90% of

¹⁴ In 2015, private individuals purchased 2.9 used cars for every new car (CCFA, 2016).

¹⁵ The number of formal sector workers rose from 31.4 million in 2004 to 48.9 million in 2014. Over the same period, loans to private individuals rose from 6.7% of GDP to 27.6%.

sales (Anfavea, 2017). The rest run on diesel (8%) or gasoline (4%). Electric vehicles – pure or hybrid – account for a very small share of sales (0.1%). Vehicle sharing and other alternative forms of mobility are just beginning to appear in large cities.

Chapter 3

The essential role of public policy

The state plays an essential role in French aeronautic industry, with public institutions (ONERA, CNAS) providing crucial support to the industry's R&D. The French government gives much more financial support to aeronautics than to other industries. The European Union also provides financing. The state is also present in aeronautics through its interventions in the process of certification and regulations concerning security and safety in air transport. The DGAC, a service of the ministry of ecology, plays a three-fold role as navigation controller, economic regulator and institution in charge of industry oversight. The state also helps aeronautical companies to recruit and train personnel. In Brazil, the state played a crucial role in the creation, development and internationalization of the national industry, by making purchases itself and providing financing for programmes that support technological development.

1. State support for aeronautics in southwest France

In this report, the interaction between public policy and the aeronautic industry is illustrated by the example of the Greater Southwest of France.¹⁶ This region has about as many aeronautic jobs as the Ile-de-France region; both have the largest share of aeronautic jobs in the country. According to GIFAS, about 28% of national aeronautic employment was located in the Greater Southwest in 2012. Whatever their sector of activity, companies in the region are highly dependent on the aeronautic industry (Table 5).

¹⁶ INSEE, the national statistical institute, refers to the region as the "Grand Sud-Ouest." It is made up of two sub-regions, formerly known as Aquitaine and Midi-Pyrénées.

Table 5. Number of companies and share of sales to the aeronautic industry

	Number of companies, end 2015	Share of sales to aeronautical firms (%)
Manufacturing	660	83
Trade, logistics and support	82	77
Specialized services	322	62
Grand Sud-Ouest	1,064	76
<i>Former Midi-Pyrénées region</i>	686	76
<i>Former Aquitaine region</i>	378	76

Source: Authors' calculations using data from Cambon (2017).

At the end of 2015, the aerospace industry employed 129,332 people in the Greater Southwest: 33% worked for a few large lead corporations and 67% for subcontractors. Companies in the service sector, mainly engineering activities and related technical consultancy, account for 30% of total employment. The aeronautic industry of the Greater Southwest exports. Nonetheless, sales are often within the region itself and also to other regions of France. More than one fourth of sales are to foreign clients, including nearly 10% to North American clients

The aeronautic supply chain in the Greater Southwest is highly integrated.¹⁷ About three quarters of the manufacturing firms that employ more than 250 workers – and more than 80% of service sector firms, mainly engineering activities and related technical consultancy– declare that they have a pluriannual contract with their main client. This remarkably high rate of long-term relationships highlights the fact that stability is crucial to subcontractors. They depend on the aeronautic industry alone and have few opportunities for diversification.

The manufacturers and the service firms that make up the Greater Southwest's aeronautic supply chain are not global to the same extent. Several factors may explain this difference. Manufacturers subcontract outside France much more than service sector firms, due to the fact that countries with low labour costs have many unskilled workers. Furthermore, the governments of countries that purchase aircraft often request compensation in the form of manufacturing employment (Morocco, Tunisia, etc.). Offshore subcontracting is

¹⁷ This section is based on the INSEE's annual survey.

facilitated by the fact that the products concerned are standardized parts that can be mass produced before being transported to the country of the lead corporation for assembly into subsystems. On the contrary, service firms find it difficult to provide specialized intellectual services when they are located far from the lead company. Nonetheless, our interviewees sometimes mentioned engineering activities (for example, production of computer programmes) in emerging countries in Asia and central and eastern Europe.

In 2017, transportation equipment (mainly aeronautics) made up 74.3% of the exports and 61.6% of the imports of France's Greater Southwest,¹⁸ proportions far superior to the national average. The region has a trade surplus with many countries, but it has a trade deficit with countries that are major producers of aeronautical products (Germany, the United States, the United Kingdom). Exchange with areas outside the Great Southwest is highly concentrated: In 2012, Airbus accounted for more than half of the region's trade with foreign countries.¹⁹

INSEE surveys reveal tensions between OEMs and suppliers. Subcontracting firms complain about an imbalance of power. They are dissatisfied with payment deadlines, the way intellectual property rights are handled, how they are associated with product design and the time horizon of their clients' commitments. Manufacturing firms experience more difficulties than service firms.

Generally, subcontractors feel that they are on a weak footing in relation to their lead firm. The aerospace industry's regional Council on Strategy (CSFR) addresses manufacturers' fears concerning tensions within the GSC and makes recommendations designed to resolve those tensions.²⁰ Two are mentioned here. First, the creation of "clusters of firms" in order to strengthen trust between Tier 1 firms and small and medium-sized firms, since tensions are the most pronounced within the lowest ranks of the supply chain (Tiers 2, 3 and 4). The goal is to restore trust. Industrial economists consider trust to be indispensable when a contract is incomplete, since "values can be a powerful vector of coordination" (Favereau , 2010, p. 124). The Council's second

¹⁸ Cf. Les chiffres clés de l'Occitanie, 2017 third quarter, <http://lekiosque.finances.gouv>

¹⁹ Source: "Le Plan régional d'internationalisation des Entreprises en Midi-Pyrénées 2013-2014," no date.

²⁰ CSFR stands for Conseil stratégique de filière régionale or "Regional Industry Council on Strategy." These bodies are tripartite, with representation from government, employers and workers. Another important institution in the region, Aerospace Valley, is a cluster focused on research and technology (R&T).

recommendation is to not reduce the market to a “price signal,” as firms habitually do. Focused on analysing large corporations’ offshoring operations, the Council advises MNEs to take all of the costs that result from offshoring into account: transport costs, costs resulting from quality deterioration (a problem mentioned in several interviews), administrative costs, etc. Allowing for these costs greatly decreases the apparent benefits resulting from low labour costs in emerging countries.

2. Unfailing state support for the aeronautic industry in Brazil: government purchases and financing

As in the other large countries that dominate the world market for aeronautics, public policy – in particular financing from the ministry of defence – has been crucial to creation, development and internationalization of the Brazilian industry. Government procurement has facilitated development of high-level technologies. However, the economic crises that have struck Brazil over recent decades – for example in 2013 and 2014 – have caused the government defence budget to fluctuate more widely than in France.

Government support for civil aeronautics is also considerable, even though it is monitored by the WTO. On 15 February 2017, Brazil filed a complaint against Embraer’s direct competitor for benefitting from subsidies that did not respect WTO rules. Brazilian government financing of exports comes from two main sources. First, BNDES (the national bank for economic and social development), one of the largest development banks in the world, devotes most of its budget – 90% – to supporting aeronautical exports. The BNDES budget has steadily diminished over the last ten years, but the reputation Embraer has acquired on international markets has enabled the company to gain access to national and international private financing. Second, Brazilian aeronautical firms benefit from the PROEX-Equalização programme of the public-owned Banco do Brasil, which subsidizes interest payments on loans granted on the national market in order to align interest rates with those of international markets (Ferreira, 2016). In addition, the federal government has launched programmes through FINEP to support technological development in aeronautics. However, the budget of these programmes is quite small.

By international standards, there is little support in Brazil for R&D and innovation. What little there is goes through government purchases, notably from the armed forces. There exist government research centres, some of which, such as DCTA, are devoted to

aeronautics and aerospace. Support is concentrated essentially in the Brazilian state of São Paulo, where the São José Technology Park is located; 90% of Brazilian aeronautical firms are located in the area and 95% of the industry's employees work there. This industrial cluster is the result of the combined efforts of Embraer and the government. In 2014, a “programme for development of the aeronautic supply chain” was set up. It is run jointly by Embraer, the Brazilian government's industrial development agency (ABDI)²¹ and the Technology Park. The goal of the programme is to raise firms' awareness of the importance of a solid supply chain. However, it has a very small budget.

3. More limited state support for the French automotive industry

In France, the automotive industry has attracted much less support from the government than the aeronautic industry. Our interviewees from the French government's Directorate General for Enterprise (DGE) state that little attention was paid to supply chains in government circles before the 2008-2009 crisis.

Because automotive companies are relatively old and have already developed capacities for expansion and innovation, the national government has never felt the need to help consolidate the industry, unlike sectors such as aeronautics, energy, telecommunications and computer technologies. Nonetheless, the French government has intervened momentarily, at times of crisis. First, Renault was nationalized after the Second World War. Then the state gave financial aid to the firm in the middle of the 1980s. Later the state came to the rescue of PSA, first in 2012 and then again in 2014.²² Today, the French state is a long-term shareholder in both major car manufacturers, 15% of Renault's capital and 14% of PSA's. The French government also took action during the economic crisis of 2008-2009 by adopting measures specifically for the automotive industry. Some of these measures were designed to consolidate the industry, something contributed to a (temporary) revival of the 'filière' concept in the wake of the 2008 crisis.

The numerous state initiatives at the time of the 2008 crisis complicated industry governance. Unlike the aeronautic industry, the automotive industry is handicapped by

²¹ This federal government agency was created to develop strategic actions designed to encourage investment in production, innovation and national industrial competitiveness.

²² In 2014, the French government – along with the Chinese company, Dongfeng – bought shares in PSA, which was almost bankrupt at the time, in order to avoid massive layoffs.

the coexistence of two distinct manufacturers' organizations: one for automakers (CCFA) and one for automotive suppliers (FIEV). The industry's two competing automakers have become increasingly estranged from the French state due to offshoring. The industry's large suppliers have become less and less dependent on a French clientele. In this context, the strengthening of a "French automotive filière" looks rather difficult. Renault's alliances with Asian corporations, first Nissan, and, more recently, Mitsubishi, are hardly intended to make the industry more "French." PSA's buyout of Opel may bring the company to move decision-making centres to Germany.

Furthermore, its share of the capital of the two automakers and its presence in their governing bodies do not enable the French government to influence corporate strategies. Government representatives are passive spectators rather than agents with a clear vision of industrial policy. Their position is as ambiguous as grand proclamations about the interest of the company for French society as a whole in the company. The French government is a shareholder, but it does not have a strategy for the industry. Its vote carries little weight in the boards of the two corporations, whose membership is closely controlled by corporate managers.

4. Constant state support for the automotive industry in Brazil, but little resistance to foreign corporations

Unlike the French government, the Brazilian government has always played an active and central role in the automotive industry because of its importance in the national economy. Government intervention includes: policies designed to support the industry, generally through negotiations with foreign manufacturers; negotiation of regional international trade agreements (Mercosur); regulations concerning security; loans granted on favourable terms by BNDES.

However, except for the import-substitution programme adopted by the Brazilian government in the 1950s, public policy did not require anything in return from automakers in terms of production or local technological competence until the beginning of the 2010s. Policies concerning flex-fuel, launched in 1975 in reaction to the oil crisis, illustrate the practice of unconditional support for the industry. The flex-fuel programme was intended to promote use of ethanol made from sugar cane as motor fuel through strong fiscal incentives, some of which benefitted carmakers. This policy encouraged

development of local engineering skills. Technological know-how acquired by Brazilian subsidiaries of large Tier 1 parts suppliers (Bosch, Magneti Marelli) enabled them to develop a new kind of motor. The new technology spread quickly: In 2012, 95% of the private cars produced in Brazil were equipped with the new type of engine. This success has both advantages and drawbacks. On the one hand, this innovation enabled Brazil to create and develop endogenous technological know-how. On the other hand, it put a stop to research on other technologies or their application, locking Brazil into a single form of technology.

At the end of 2012, the Brazilian government launched a pluriannual programme for the period 2013 to 2017 called “Inovar Auto,” part of a vast programme called “BrazilMaior,” launched in August 2011. One of Inovar Auto’s goals was to limit the strong increase in imports due to appreciation of the national currency in relation to the dollar and the euro. The programme also aimed to stimulate R&D investment, whose low level is threatening the competitiveness of Brazil’s automakers who are faced with Asian companies that are new to the Brazilian market. An important measure was a 30% increase in the federal tax on manufactured goods (IPI) that applied to all cars – whether they were manufactured in Brazil or imported – and depended on engine power. Car manufacturers who adopted goals for energy efficiency and who made a commitment to technological innovation (for example, an increase in R&D expenditures) might be exempted from this tax. These rules might not be considered very demanding, but they constituted a turning point in Brazilian public policy concerning automotive (Marx and Mello, 2014). However, the program has not succeeded in stimulating investment by manufacturers. They sell cars made in Europe and the United States on the Brazilian market in an attempt to compensate for the fall in demand and unused productive capacity. Once the Brazilian economy went into recession in 2014, domestic demand fell abruptly, along with sales and production of vehicles and parts. The “Inovar Auto” programme was accused of being protectionist in suits brought before the WTO by the European Union and Japan. The WTO ruled that some of the Brazilian measures, especially the link between subsidies and investments and local content requirements, violated the principles of free exchange upheld by the organization. The WTO ruled that these measures should be abandoned; Brazil has appealed the ruling.

The most serious shortcoming of the Inovar programme is that it does not deal with development of electric vehicles, an area where Brazil is far behind other countries, especially Korea and China. Brazil cannot hope to become an important player in automotive if it does not develop know-how in electric vehicles. The Brazilian automotive industry risks remaining a producer of entry level cars. The industry could be trapped in a mature form of technology (flex-fuel) that will not sell outside of Brazil. The country might have to import electric vehicles, having lost the opportunity to improve and consolidate its position in the GSC.

In both France and Brazil, the state has lost its power to initiate action in an industry controlled by multinational automotive corporations whose leaders are no longer committed to the interests of their countries of origin. In Brazil, the explanation for these trends is simple. The government never had much power over foreign manufacturers, especially within the framework established by the WTO. Indeed, policies adopted by the Brazilian government often protected the interests of multinational corporations. In France, the state as shareholder has no power to stop manufacturers from shifting their activities abroad, in a context of reconfiguration of world production and markets.

Chapter 4

Changes in Global Supply Chains

As pointed out above, GSCs are for the most part created by large corporations. Hence, reducing the analysis simply at the industry level (e.g. the ‘aeronautic’ or the ‘automotive’ GSC) is insufficient although most of the literature does so. Our study of the GSCs of Airbus, Embraer, Renault and PSA confirms that GSCs should be viewed as strategic spaces.

1. Significant differences between the GSCs of Airbus and Embraer

Airbus’s GSC is based on shifting final assembly lines (FAL) abroad, where products are destined for local or regional markets: in the Americas or Asia. Embraer’s strategy, on the contrary, is centred on Brazil, a domestic base for exports. While Airbus controls its relations with its main suppliers, Embraer is a world leader that is in a subordinate position vis-à-vis its mostly non-Brazilian suppliers.

1.1 Airbus’s GSC: Offshoring assembly plants and controlling the supply chain

Airbus has four final assembly sites. Two of them were recently set up outside Europe: one in the United States in Mobile, and one in China in Tianjin. However, the corporation’s assembly lines in France and Germany produce much more than those located in the United States or China (Table 6).

At Airbus, a lot of intrafirm trade takes place, especially between the two European final assembly lines, located in Toulouse and Hamburg. Corporate activities are shared out between plants on the basis of each nation’s financial contribution. The activities that produce the most added value are carried out in Germany, France and Great Britain.²³ Even though it has waned somewhat, French domination of Airbus remains strong. Growth in production of the A320, which represents 80% of the company’s sales, has benefitted Hamburg factories. The A350 is produced only in Toulouse. Hamburg

²³ Final assembly and production of airplane fuselage are carried out in Germany and France. Production of wings, another activity with high added value, is carried out in Great Britain, a country that has had expertise in this area for a long time.

factories have gradually mastered the most essential systems: hydraulics, mechanics and the A380's electrical system.

Table 6. Airbus's final assembly lines

	Year of creation	Models assembled : the A320 family and other models	Production (per year)	Share of annual production of A320	Number of assembly lines	Number of employees	Initial investment	Models exported
Toulouse (France)	1969	A320, A 330, A350, A380	264	47.7	2	11,500	n.a.	All A330s, A380s for clients in some regions, A319s, A320s
Hamburg (Germany)	2009	A318, A319, A320, A321	192	34.7	3 +1 (announced for end 2015)	12,500	n.a.	All A321s, A380 for clients in some regions, A319s, A320s
Tianjin (China)	2008	A319, A320, A330 (finishing and furnishing)	48	8.7	1	1,300 (including Airbus Helicopter)	600 million \$	A319s, A320s
Mobile (USA)	2015	A319, A320, A321	48 (2018)	9.0	1	260 (September 2015), 1000 expected by end of 2016	600 million \$	A319s, A320s, A321s

Source: Authors' compilations of information from Airbus website and aircraft industry publications.

Airbus's GSC has undergone significant changes over recent years. Some changes are due to developments that are not specific to aeronautics: a drop in production costs due to shortening of the development process, demand for better quality, the need to reduce environmental impact and globalisation of supply chains. Other changes are due to factors that are specific to aeronautics. The drop in the number of Tier 1 suppliers – for example, 200 for the A350 and only 90 for the A320 – has resulted in suppliers taking on greater responsibility. This change has been formalized through risk sharing partnerships (RSPs),

whereby suppliers become involved in financing manufacturers' programmes. Suppliers must participate in the financing of R&D. Furthermore, suppliers are not paid until aircraft are sold, that is, several years after R&D begins. This type of contractual relationship with suppliers is peculiar to aeronautics. It was developed by Embraer, Airbus and other large corporations at a time when they were faced with grave financial difficulties. Risk sharing later spread to relations between Tier 1 and Tier 2 suppliers and even to firms further downstream in GSCs. Through RSPs, financial concerns and associated risks penetrated into GSCs, as illustrated by the situation of Latécoère which is analysed in our report.

1.2 Embraer's GSC: limited internationalisation and subordination to suppliers

During the 1990s, the Brazilian company Embraer targeted the market for airplanes with 100 to 120 seats with its "E-jet" family of airplanes. The company created a supply chain whose Tier 1 companies are all foreign, due to its dependence on suppliers of essential sub-systems.

Figure 1. Embraer : E-Jets Risk Partners



Source: Embraer, no date.

In recent years, the Brazilian corporation has made three strategic changes in its supply chain. First, certain critical activities were re-insourced: aerostructures, wings (hitherto made by Kawasaki) and landing gear (Gomes, 2012) and also computer programmes for

system integration and flight commands. This move was motivated by the corporation's desire to become less dependent on large suppliers and re-acquire capacities it deems critical, as well as seeking to create more value.

The two other strategic changes put in place by Embraer concern globalisation of its supply chain. The corporation set up a business aircraft factory in the United States; its production accounted for 55% of Embraer's sales from 2009 to 2016. The corporation has also set up two factories in Portugal with the help of public subsidies, including some from the European Union. One makes parts and assembles business aircraft; the other produces parts and components made from composite materials. In 2016, 14% of Embraer's total employees were working abroad, compared to 4% in 2008.

In the 2000s, the corporation launched a programme (PIABS) designed to give incentives to its Tier 1 suppliers to set up production in Brazil, with financial support from BNDES. In 2014, people employed by subsidiaries of foreign companies came to 12.4% of total employment in the industry in Brazil, with GE-CELMA (engine maintenance) accounting for 25% of all employees of Brazilian subsidiaries of foreign companies.

2. Renault and PSA create GSCs by moving assembly lines offshore

While the Brazilian aeronautic industry has an OEM, the Brazilian automotive industry is dominated by foreign automakers and automotive suppliers who have created subsidiaries by carrying out several waves of investments. The automotive GSC in Brazil was set up by large international manufacturers and suppliers, following decisions made by corporate managers in their countries of origin. For this reason, our report discusses only the supply chain of French carmakers and parts suppliers.

Unlike their German counterparts, French automakers have chosen to move all their production offshore, rather than only particular segments. This explains why France produced only 45% of its automotive value added within its borders in 2014, compared to 55% for Germany.²⁴ This choice is detrimental to the automotive industry's trade balance. Beginning in 2007, the number of vehicles registered in France became greater than the number assembled in France, which means that domestic demand can only be

²⁴ Authors' calculations using the WIOD database.

satisfied by increasing imports. This situation results from a partial retreat of French automakers from their home base in assembly operations, more acute for Renault than for PSA. This is the corollary of PSA and Renault increasing shift of manufacturing plants to low wage countries, such as Central and Eastern European countries, Turkey and Morocco. French companies re-export the cars assembled in these countries for sale on the French market, without exporting products in return from France to these countries.

Consequently, for both companies, the share of employment abroad has risen over the last twenty years, a development that has been especially rapid and continual for Renault and more moderate for PSA (Table 7).

Renault has pursued moving offshore more boldly than PSA. Renault has improved its competitive position by selling cars designed for markets in emerging countries (Midler *et alii*, 2017; Pardi, 2017). This strategy implies moving production and R&D abroad in order to satisfy consumers in specific foreign markets, to the detriment of the home market in France, whose share of the global market is shrinking. PSA did not begin to pursue sales in emerging countries until the 2000s, then later than Renault. PSA subsequently started to manufacture in Eastern Europe (Slovakia and the Czech Republic), in South America and, more recently, China. Renault set up alliances with the Japanese manufacturer Nissan in 1999 and with Mitsubishi in 2016, while PSA chose to create short-term alliances with several manufacturers, setting up common subsidiaries in different countries in an attempt to catch up in the global market.

Table 7. Share of employees working abroad for PSA and Renault, 31 December
(in % of total employees worldwide)

	2005	2010	2011	2012	2013	2014	2015	2016
PSA (Automotive)	29.0	34.1	33.8	35.1	36.1	32.6	31.2	30.7
Renault Corporation *	44.8	55.7	57.3	58.9	60.1	60.5	62.1	63.0

* Figures for Renault Corporation include Renault financing activities (RCI).
Source: Based on corporate annual reports.

3. An increasingly central role for suppliers in automotive GSCs

French suppliers have been very active in transforming automotive GSCs (Frigant, 2011). They have expanded abroad, responding to pressures from clients to join industrial parks. Clients have even sometimes persuaded suppliers to work in clients' plants, cooperating

in producing modules that are common to different models in the final assembly phase (Frigant and Layan, 2009). Development of global automotive production platforms, where vehicles destined for different market segments are assembled using the same components and systems, requires parts suppliers to be present on the international level. Henceforth, they must be capable of producing the same parts anywhere in the world, with the same level of quality and reliability. Suppliers have also sought to expand by getting clients all over the world, not only in their home countries, while pursuing a strategy of concentration (Berger, 2016). These developments have led the three main French automotive suppliers – Valeo, Faurecia and Plastic Omnium – to expand internationally. Today, they are present in about thirty countries. Each one has more than a hundred production sites and dozens of R&D centres, working on fundamental research, advanced engineering, creation of new product standards and adaptation of standards to local markets.

More than 80% of the personnel of the top three French supplier corporations are now employed abroad. Most probably, a similar proportion of their sales is generated abroad.²⁵ Thus, suppliers have become much more globalised than automotive manufacturers (Table 8).

Tableau 8. Share of employees working abroad for the top French automotive suppliers (in % of total personnel)

	1995	2000	2005	2007	2010	2011	2012	2013	2014	2015	2016
Valeo	47.8	66.5	71.5	71.2	75.1	78.1	80.2	80.9	82.3	82.8	n.a.
Faurecia	n.a.	46.9	69	71.9	80.1	82.6	83.7	84.6	85.3	85.6	87.0
Plastic Omnium	n.a.	n.a.	60	n.a.	69	71	75	73.9	74.3	73.0	79.6

Source: Corporate annual reports.

Diversification of clientele has made offshoring easier. Suppliers have become less dependent on a single client. This has reinforced their bargaining power in their dealings with carmakers, as shown by their increasing operating margins. For example, Faurecia's number one client is the German corporation VW, while PSA, its parent company, only

²⁵ Of the three corporations, only Valeo publishes data that can be used to calculate the shares of foreign and domestic sales. In 2016, 82% of the company's sales were generated abroad.

ranks fourth. Similarly, Valeo's main clients are German. The industry is dealing with major technological challenges: making vehicles lighter, developing new engines with reduced pollutant emissions, producing connected vehicles that could make new forms of mobility possible. All of these challenges put suppliers at the forefront of change in GSCs. Their R&D capacities – focussed on new materials, energy storage, electronics and computer programmes – now surpass those of manufacturers. In 2016, Valeo replaced PSA as the company that filed the largest number of new patents in France.

4. The challenge of R&D Globalisation

The automotive industry is a global leader in R&D expenditures, after the computing and electronics industry and health. According to PWC's annual survey of the thousand automotive companies with the highest R&D expenditures,²⁶ most of these expenditures are carried out by corporations outside their home countries, and this share is growing. In 2015, nearly three quarters of automotive R&D expenditures were concentrated in five countries. The United States led with 27% of the total, followed by Germany and Japan with 15% each. China has progressed rapidly to occupy fourth position with 11%. France was in fifth place with only 5% of total expenditures. Brazil had only 2%.

R&D expenditures are concentrated in a small number of firms, mostly carmakers (VW, Toyota, GM, Ford, Daimler, Honda, etc.), but also a few large suppliers (Denso, Continental, Aisin Seiki Co., Delphi Automotive, Valeo, etc.). At the end of 2016, Valeo had 58 R&D centres, including 20 research centres, mostly located in France, Germany, Ireland and Japan. The company also had 38 development centres around the world, in charge of adapting products to demand on local markets. This is the result of a corporate policy of recruiting local engineers in order to improve the company's ability to analyse the needs of local clients and local consumers, especially in regions with high growth potential for the corporation: Central and Eastern European countries, Turkey, China, India, Southeast Asia, the United States and Mexico.

In France, carmakers have to concentrate much of their R&D efforts on engines due to recent reinforcement of pollution emission standards that leaves small fund available for other research. Consequently, they spend less on R&D than large suppliers as a proportion

²⁶ PWC, *The 2015 Global Innovation 1,000 – Automotive Industry Findings*.

of sales – around 4% to 5% – even though the sums involved are larger.²⁷ Above all, manufacturers are increasingly outsourcing R&D to engineering firms, a practice that could erode corporate research capacities and reduce the number of company employees working on R&D for the two main French car makers (Syndex, 2015). Although their R&D activities are still located in France for the most part,²⁸ they are expanding abroad, particularly in emerging countries. Nonetheless, the two French automakers have adopted contrasting approaches of globalisation of their R&D, approaches that go along with their contrasting overall strategies of globalisation: More centralized for PSA, more multidomestic and decentralised for Renault (Pardi, 2017). PSA followed a traditional centralized R&D model, based at a single centre in Vélizy-Villacoublay. Renault set up engineering centres outside France: in Rumania, South Korea, India and Brazil. However, such decentralization had little positive impact on innovation capacities in host countries. For example, Brazil has not acquired much national know-how in automotive R&D. National firms are dependent on the initiatives of the foreign automakers and automotive suppliers who are present in Brazil, and hence, they must respect the budget constraints of these foreign companies.

²⁷ Renault corporation spent 2.5 billion euros on R&D in 2015, compared to about 1 billion euros for Faurecia and Valeo.

²⁸ Renault's "Technocentre" at Guyancourt employs almost as many people (nearly 10,000) as all five of the company's assembly plants (more than 11,000).

Chapter 5

The three drivers of change in GSCs

Our report identifies three drivers behind recent changes in GSCs: interaction between the location of activities (domestic/offshore) and sourcing choices (insourcing/outsourcing); disruptive innovations; changes in the financial control of GSCs with lead corporations' focus on creation of shareholder value.

1. The interaction between location of activities and sourcing

Increasing international fragmentation of production and vertical specialization, defined as the use of imported intermediate products (IP) in exported goods (Yi, 2003), coincided with development of non-equity modes of international production (UNCTAD, 2011), alongside more traditional vectors of capital internationalization such as FDI.

Within the context of internalization, companies face a choice between maintaining activities internally or outsourcing. This question is central to understanding the GSCs of large corporations, since it determines how they are supplied. Four options are possible in terms of location and mode of supply (Figure 2).

Figure 2. Matrix of options for a corporation with a GSC

		Location	
		National	International
Sourcing	Between firms (outsourcing)	Domestic outsourcing	International outsourcing
	Within firms (insourcing)	Domestic supply	International insourcing
		Within countries	Between countries

Offshoring

Source: OECD, "Moving Up the Value Chain: Staying Competitive in the Global Economy," Paris 2007.

Offshoring of industrial production took place much earlier in the automotive industry than in aeronautics. Based on analysis and interviews in the two industries, several hypotheses can be formulated. First, internationalization, which has accelerated in recent years, can take several forms. Indeed, there are several different reasons for moving activities out of the home country: getting closer to markets, reducing the cost of production and transportation, complying with government policy including local content requirements, gaining access to government contracts, etc. The relative importance of these motivations differs from one industry to another, and sometimes from one corporation to another within the same industry. French corporations in the two industries under study have not outsourced *stricto sensu*, that is, they have not closed factories in France and transferred their production abroad. Rather they have “substituted production abroad for production in France, as a result of arbitrage by producers who have given up on France in order to produce or subcontract elsewhere” (Aubert and Sillard, 2005, p. 64). More precisely, our study shows that French corporations favour production abroad when they need to increase output in order to satisfy increased demand, a process we refer to as “exo-localization.” This term reflects current reality better than “outsourcing.” The latter term has always been ambiguous. It refers to undertaking production abroad with or without closing down plants at home. “Outsourcing” (délocalisation in French) was widely used in the 1990s when there was intense internationalization of French corporations. At that time, employment in France and employment abroad were considered antinomic. Two decades later, this contradiction is only a secondary consideration in global corporate strategies.

Modes of supply have changed radically in the two industries with increasing recourse to outsourcing. This has resulted in a transfer of added value from lead manufacturers to other agents in GSCs, especially Tier 1 suppliers, who, following a phase of concentration, have become “mega-suppliers.” However, in aeronautics, all the large OEMs – Airbus, Boeing, Embraer – have been reinternalizing activities. Tier 1 suppliers in the sector have reacted by buying “vertically.” In contrast, manufacturers and suppliers in the automobile industry have only occasionally reinternalized activities, usually in response to local situations.

Theories of firms based on transaction costs were used in the 1990s and 2000s to explain the spread of outsourcing. Firms were thought to have a choice between “make-or-buy,” or a combination of the two. However, careful analysis of the recommendations that stem from transaction cost theory shows that they are vague. Williamson (2008, p. 6) states that parties drawing up a contract can make gains “if order-preserving mechanisms are devised that enable the parties to preserve cooperation during contract execution.” No one would disagree with this recommendation, but it leaves the parties to an outsourcing contract in an unclear position. Increasing outsourcing was certainly part of a drive to reduce production costs, but changes in firms’ governance were also a factor. The push for “market control,” designed to give power back to shareholders and supported particularly by agency theory, aims at greater transparency in firms’ activities and greater control over managers. A firm is considered to be a bundle of assets that can be bought or sold on financial markets depending on need and especially depending on stock market evaluations. The strategy was widely adopted in the 1990s. It involved cutting back on activities and distributing profits to shareholders (“downsize and distribute”), unlike trends in preceding decades when corporations tried to reinvest profits in internal technological and human capacities (“retain and reinvest”) (Lazonick, 2009). To sum up, from the point of view of analysts who focus on firms’ capacities and skills, in keeping with the tradition of Chandler and evolutionary economics, OEMs’ choice for outsourcing stems from an objective of assets’ financial valorisation, rather than originated from industrial rationality based on transaction costs.

1.1 The aeronautic industry: limited and recent offshoring

Globalisation of aeronautic supply chains is relatively recent, due to several factors. Production is intensive in skilled labour, a resource that has become available in developing or emerging countries only recently. Products must be of high quality and extremely reliable, so they are subject to certification procedures and government regulations that limit opportunities to transfer activities outside of manufacturers’ home countries. Public policy has favoured national or regional networks of firms involved in aeronautics.

The three main OEMs – Airbus, Boeing, Embraer – began to offshore activities towards the end of the 2000s. This process was made possible by modularization of components

and systems, which facilitated the transfer of parts to distant zones for assembly. Nonetheless, national roots remain essential for these corporations. In discussions about the “nationality” of firms, maintenance of R&D activities in the country of origin is often cited as evidence that firms are not “stateless.” Concerning the aeronautic industry, data on employees is also revealing. Table 9 shows a striking contrast between the share of sales carried out abroad – about 70% for the three OEMs – and the much lower share of employees abroad. Aeronautic GSCs have certainly become international and lead firms have increasingly outsourced activities, but globalisation has not generated much creation of plants or jobs outside lead firms’ home countries so far.

**Table 9. Personnel and sales of OEMs
outside their home countries (in % of total)**

	Share of employees outside home country 2006	Share of employees outside home country 2016	Share of sales outside home country 2016
Airbus *	5.1	10.7	67.8
Boeing	14.4	16.7	70.0
Embraer	13.0	14.0	71.1

* Note: In this table, Europe is considered to be the home “country” for Airbus Group SE. It is a European company (SE) with headquarters in Amsterdam, listed on the stock markets of France, Germany and Spain.
Source: Authors’ calculations based on corporate annual reports.

The combinations of location and supply mode were initially different at Airbus and Boeing. The two corporations’ policies have gradually been converging, with a common trend that began a few years ago towards re-internalizing activities that were outsourced. The Brazilian corporation Embraer has also started moving offshore, but the process is accompanied by outsourcing that is less pronounced than for Airbus and Boeing. Safran has clearly opted for insourcing of offshore activities, rather than subcontracting; the company does use subcontractors to some extent but less than other OEMs. It is very well established in Mexico, for reasons of costs, personnel training, proximity to the North American market and attractive public policies.

While outsourcing of production was considered a priority by managers in recent years, with support from shareholders, it is now being questioned by the three largest OEMs (Boeing, Airbus and Embraer) and by certain Tier 1 suppliers (Latécoère in France).

Several factors can explain this change in strategy. First, outsourcing of production of complex sub-systems, generally contracted out to Tier 1 suppliers, has caused technical difficulties that are sometimes insurmountable and generate large costs. Moreover, outsourced production is generally subcontracted to powerful and competent suppliers, a move that gives these suppliers new responsibilities and thereby reinforces their bargaining power vis-à-vis the aircraft manufacturer. Insourcing of formerly outsourced activities can help an OEM to conserve power and recover critical know-how. Insourcing can also allow an OEM to avoid layoffs. This factor can explain Airbus's decision to shift some R&D activities that had been outsourced back into the company, in keeping with the "social compromise" that has long prevailed in this European corporation, in both France and Germany.

To sum up, the shares of internal and external activities a corporation chooses within its supply chain depend on the relative profitability of the two modes of production. This is linked in turn to technology and internal capacities, part of the techno-productive dimension of a GSC. This is shaped by the relationship between an OEM and its Tier 1 suppliers, a relationship that is linked to the strategic dimension of a GSC.

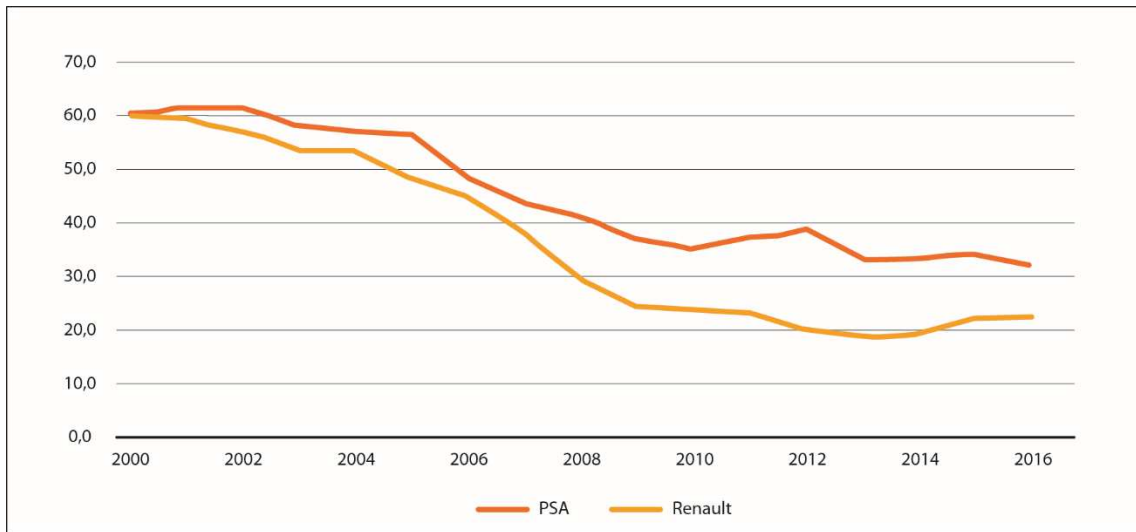
1.2 Automotive: offshoring production, not new but accelerated by outsourcing

Automakers have a long tradition of internationalisation, to the point where this process is a feature of the industry itself. During the three decades of rapid growth following the Second World War, the two main French manufacturers acquired assembly plants abroad, primarily in European countries that were members of the Common Market (Spain, Portugal, Italy) and only marginally in South America (Argentina). Beginning in the 1980s and especially in the 1990s, fragmentation of automotive production and the use of modules brought the industry's large corporations to outsource functions that had hitherto been carried out internally (Frigant and Jullien, 2014). These changes accelerated the pace of transferring production offshore. They also heralded the start of a period when lead firms were able to rationalize and optimize their choice of suppliers at each step of production, as well as their choice of locations of assembly lines and production of mechanical components (engines, gear boxes).

Renault and PSA began this type of outsourcing at the end of the 1980s. The process speeded up during the 1990s with the introduction of modular production (Frigant and Jullien, 2014) and also the dissemination of new norms for corporate governance based on financial pressures. The two companies focussed on their core activities whose contours shifted along with technological change and financial analysts' evaluations (Favereau, 2016). The stable central core activities for manufacturers are overall vehicle design, including the engine and the body; most other activities have been outsourced. This process has engendered creation of large suppliers who in turn have become worldwide. Carmaker outsourcing has led suppliers to produce more and more complete vehicle systems (brake systems, air conditioning, etc.) and to design and make sub-systems and modules (seats, etc.). The result is that today they create 80% of the added value of vehicles, a share that may become larger still with development of electric vehicles.

Outsourcing has taken place at the same time as manufacturers have increased the pace of moving production offshore, in Europe and especially Central and Eastern countries, with the goal of shifting production to countries with low costs. This strategy appears clearly in the case of Renault. The corporation bought up the manufacturer Dacia in 1999 and took over all the capital of Revoz in 2004 after a long period of partnership (starting at the beginning of the 1970s) in production of the R4 model under a licence agreement. As a consequence, Renault and PSA cut back production in France drastically. While in 2000 the two companies produced nearly 60% of their vehicles (for private and commercial use) in France, in 2016, Renault produced only 22.1% in France; PSA's, which began to offshore production later on, produced 32% (Graph 1).

Graph 1. Changes in the share of private and commercial vehicles produced in France by Renault and PSA (in %)



Source: Data from OICA.

The trend towards shifting production outside of France was particularly intense from the middle of the 2000s until the crisis. Offshoring was carried out by “exo-localization,” that is, creation of new plants abroad. These new sites produced certain models, especially smaller-engine models with relatively small profit margins. The effect was to reduce the activities of factories in France. The volumes produced directly affect different sites’ profitability (in terms of amortization costs, transportation costs, etc.).

French manufacturers have chosen to set up assembly and mechanical parts plants outside of France and to produce certain car models there. This approach differs markedly with that of German manufacturers who have set up only segments of their supply chains in countries with low costs and who continue to assemble vehicles in Germany, using imported system components and parts. Between 2005 and 2009, the share of Central and Eastern countries and Turkey in worldwide production of the two French manufacturers more than tripled, rising from 5.2% to 16.1%. These countries benefitted from “exo-localization” carried out by Renault and PSA. More recently, Morocco has benefitted similarly; this country seems to be on its way to becoming a major supplier for the two corporations’ Spanish, French and European factories, to the detriment of Central and Eastern countries. Renault’s two assembly plants in Morocco produce low cost models – Logan, Sandero, Lodgy and Dokker – most of which are reexported to France and Europe. With their lower labour costs, the Moroccan plants are competing directly with the

Rumanian plant in Pitesti. Until now, PSA has produced 80% of its engines and gear boxes in its two main French production sites, but the corporation is now planning to develop production of engines and gear boxes close to factories located outside France.

Large Tier 1 suppliers follow lead manufacturers abroad. These suppliers must be able to produce identical parts anywhere in the world for the assembly lines of lead companies, on time and at the lowest price. The acceleration in mergers and acquisitions and the emergence of mega-suppliers (Frigant and Layan, 2009; Frigant, 2011; Frigant and Miollan, 2014) has transformed the main French supplier companies (Faurecia, Valeo, Plastic Omnium) and made them more global than Renault or PSA. Suppliers have started shifting certain outsourced activities in-house. Some, such as plastic injection, have been insourced temporarily; others with high growth potential are being insourced on a long-term basis. For example, Valeo has moved electronics production from outside to inside the firm; however, production is being shifted away from France to Martos in Andalucia, Spain. Like manufacturers, suppliers have gradually transferred activities to countries with low costs, a move that has enabled them to lower prices. Valeo's production site in Poland is an example. According to interviews with trade unionists, sometimes a new product is first produced in France and, once procedures have been perfected, with rejects at an acceptable level, production is transferred abroad. Sometimes such transfers fail, but, in any case, corporations systematically make different production facilities compete with each other.

2. Disruptive innovations

Despite its name, the concept of “disruptive innovations,” popularized by C.K. Christensen (1997) is based as much on creation of a new type of business model as on technological innovation. We use the concept of “disruptive innovation” in a larger sense to refer to cyclical historical processes (Kondratiev waves) that generate the cycles of “creative destruction” analysed by Schumpeter. Obviously, disruptive innovations can bring about profound transformations of GSCs.

Digital technologies include operations and equipment as diverse as collaborative robots, additive manufacturing, Internet of Things (IoT), augmented reality, big data, etc. New forms of collaboration between men and machines herald the creation of “cyber-physical”

systems (CPS), (Brettel *et alii*, 2014) that will erase the distinction between the world of production and the world of services, a distinction that has already become obsolete (Veltz, 2017). The fact that these major innovations are occurring simultaneously makes them forerunners of a new “long wave” (Freeman and Louçã, 2001), sometimes referred to as “Industry 4.0.”

However, these innovations are only in their initial stages. Their technological feasibility, the financial resources needed for their development, corporate strategies, social resistance, and, in the aeronautic and automotive industries, the sensitive question of regulations (certification, qualification), all these factors can speed up or slow down their dissemination. In most sectors, computerization of supply chains is just beginning. This is certainly the case in aeronautics and automotive, two industries that are highly concerned by this transformation and play a pioneering role in its application.

2.1 The main challenges for the aeronautic industry

In the aeronautic industry, disruptive innovations concern mainly changes in the structure of airplanes and, more radically, computerization of GSCs. However, these two areas are not the only possibilities for disruptive innovations in this industry.

a) Changes in airplane structure

Currently, the aeronautic industry is exploring possible major innovations in wing structure (the guyed wing, the rhomboidal wing, the flying wing), innovations that cannot be applied in practice before 2030 (Courteau, 2013). Introduction of changes in processes and products often goes along with changes in human labour. Repetitive manual tasks such as treatment of holes on wings (involving hundreds of points on a single wing) are now performed by robots, with supervision from workers.

In the area of engines, integrated propulsion, that is, engines that are part of fuselage instead of being inserted under wings, is an innovation that is likely to be applied more quickly. Other disruptive innovations could be associated with development of electrical or hybrid engines.²⁹ Airbus plans to use these new engines to develop new forms of urban mobility. Uber is working on developing them through a joint research programme with

²⁹ Cf. Angela Monaghan, “EasyJet says it could be flying electric planes within a decade,” *The Guardian*, 27 September 2017.

NASA, with the first flights planned to take place in Los Angeles in 2020.³⁰ Embraer is also involved in this programme, which gives the firm an opportunity to work alongside companies with a very high level of technology and hence improve its capacity to participate in break-through innovations. Finally, supersonic airplanes, which were abandoned when Concorde ceased flying in 2003, are attracting renewed attention from low cost airlines.³¹

b) Digitalisation of supply chains

During the 2000s, the aeronautic industry was a pioneer in digitalisation. Enormous profits are expected from computerization of engineering. Innovations include adopting the same computer programmes for OEMs and suppliers and setting up virtual platforms accessible to all participants in a supply chain. These innovations will facilitate information exchange, avoid duplicate work, improve quality thanks to a common language and shorten delivery times significantly. These programs should also reduce the cost of supply chain management; some senior managers estimate that use of different computer programs by OEMs and Tier 1 suppliers increases engineering costs by 10%.³²

Airbus, Dassault Aviation, Safran and Thales created Boostaerospace in 2011, several years after Boeing set up an equivalent programme called Exostar. In Brazil, Embraer launched a drive in 2011 to digitalise its supply chain through a programme run jointly with ABDI, the Brazilian federal agency for industrial development and the Technology Park of São José dos Campos. Since 2013, the Brazilian corporation has been using 3D technology for making prototypes, and it is conducting a programme designed to apply 3D technology to production of certain complex components. Similarly, Embraer uses hybrid machine tools that combine initial 3D shaping of parts, followed by final production using traditional equipment.

Since disruptive innovations modify the techno-productive dimension of aeronautic GSCs, they also affect their strategic dimension. Concretely, aircraft manufacturers are

³⁰ Cf. Olivier James, "Uber poursuit l'offensive dans les taxis volants (avec la Nasa)", L'Usine nouvelle, 9 November 2017.

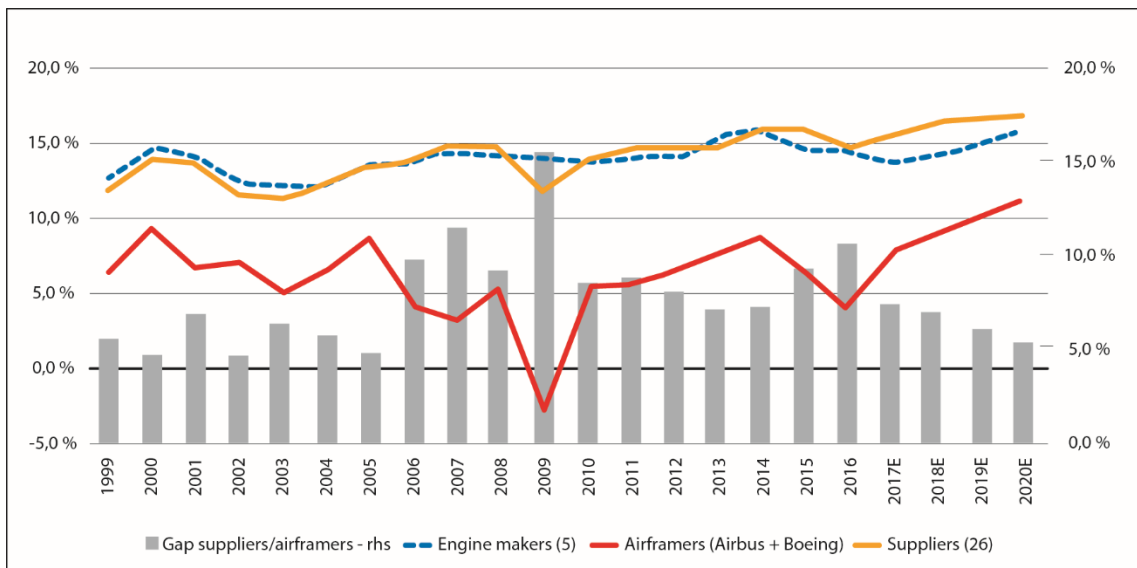
³¹ Cf. Neate Rupert, "Richard Branson reveals prototype for supersonic passenger aircraft," The Guardian, 15 November 2016.

³² Marine Protais, "BoostAerospace, le langage commun de l'aéronautique," L'Usine nouvelle, 7 July 2016.

going to face more intense competition from Tier 1 suppliers and new entrants into the industry. Three trends have appeared:

1) Tier 1 suppliers have become more powerful. OEMs themselves have contributed to empowering Tier 1 suppliers by associating them in the realization of work packages and by sharing responsibilities. Over the last twenty years, development of new generations of airplanes has been based for the most part on technological innovations that were introduced by suppliers. Series of incremental innovations to a given generation of planes have often been more significant than technological breakthroughs (Mowery, 2015, p. 5). The rise of Tier 1 suppliers, engine makers and other suppliers has brought about a rise in their operating profits, compared to those of aircraft manufacturers (Graph 2).

Graph 2. The gap between the profit rates of airplane makers and their suppliers



Source: Crédit Suisse, 2017.

2) There is a trend towards “Uberization” of GSCs, that is, emergence of a new business model based on leasing or renting. This model is already in use among low-cost airlines. It should spread and become an attractive investment for financial investors (*infra*). Leasing has advantages for those who rent out equipment: it offers a regular income stream with little tax, since firms can easily operate from tax havens.³³

³³ Nine out of the ten largest aircraft leasing companies have their headquarters in Ireland. Their activities cover all the supply chain: sales, asset management, technical services. Almost half of aircraft leasing companies are European.

3) OEMs have strengthened their position upstream in their supply chains, in the area of customer support, that is, maintenance, repairs and overhaul (MRO). These services are of great strategic importance for OEMs, including engine makers as well as electronic equipment suppliers. MRO is a highly profitable activity – Boeing estimates MRO profit margins at 20% –, making it very attractive to OEMs. According to the consulting firm Canaccord Genuity Inc., 20% of Boeing’s total sales (civilian and defence) comes from this activity and at Airbus the proportion is 15%. This percentage could rise, as it has for engine makers; MRO accounts for more than half of their sales: 52% for GE and 52% for Rolls-Royce Holdings. However, OEMs are competing with independent companies who are active in less technical segments of the industry.

MRO activities could be revolutionized by the use of “predictive maintenance” or “connected maintenance.” This technology, coupled with 3D printing, will make it possible to make parts to replace defective ones on-site (in airports), combined with systems for remote repairs made possible by digitalisation.

This promising market has attracted a good deal of interest. Airlines estimate that maintenance costs 12% to 13% of their sales, so they are well aware that computerization of maintenance could pay off. Thus, they are unwilling to give constructors complete lists of breakdowns and malfunctions.³⁴ Engine makers seem to be in a good position to take advantage of the combined use of IoT and predictive maintenance. Rolls-Royce offers contracts billed by hour of flight, a fundamental change that means the amount the client pays depends on service rendered. This business model has the advantage of generating sales revenues immediately, whereas sales of replacement parts for an engine take place only about five to seven years after the sale of the engine. Safran and GE have chosen another model based on sales of replacement parts and rapid delivery of equipment.³⁵

Digitalisation of GSCs can only be completely effective if all participants are connected. According to specialists, only 2% of the aeronautic supply chain is currently digitalised. The difficulties lie with small subcontractors, generally Tier 3 or 4. Embraer is faced with this problem, which is particularly acute in emerging countries. With the exception of a

³⁴ Airbus interview.

³⁵ Safran interview.

few engineering firms (one of the strong points of Brazilian aeronautics) and firms that manufacture machine tools (such as Globo Machining), the weakness of most subcontractors could slow down progress in digitalising the company's supply chain.

Digitalisation could increase inequalities between companies and also create obstructions to smooth operations all along the supply chain. This risk brings OEMs and Tier 1 suppliers to push for more concentration among subcontractors who are considered too small to face the new challenges.

2.2 Challenges for the automotive industry: new forms of mobility

The automotive industry is facing major technological and organizational changes that could affect the GSC.³⁶ These include new types of motorization, connectivity and gradual automatization of vehicles, people's relationship to automotive use and the approaches of traditional automakers to development of new forms of mobility (car sharing, ride sharing, chauffeur-driven cars). Additive manufacturing is not yet used much in automotive, but, in time, it should have an impact on the automotive GSC (Pipame, 2017).

a) Electric vehicles

A number of problems call for alternatives to the internal combustion engine (ICE): dependence on fossil fuels, climate warming due to concentration of green-house gasses, the recent "dieseldate" emissions scandal and concern for public health. Consequently, the use of electric vehicles should spread. Different technologies are possible: batteries that store electricity used to develop different types of hybrid vehicles; fuel cells using hydrogen. However, it is difficult to foresee how quickly the market for electric vehicles will expand; prudence is called for. History reminds us that, despite the early development of electric engines and commercialization of the first electric vehicles at the end of the 19th century, the ICE became the "dominant design" beginning in the 1930s. It was associated with the idea of the car as an instrument of freedom (Midler, 2010). In 2016, only 0.1% of light vehicles in circulation in the world were electric (OECD/IEA, 2017).

³⁶ Cf. www.mckinsey.com/industries/automotive-and-assembly/our-insights/disruptive-trends-that-will-transform-the-auto-industry

In France, battery-driven motors – hybrid or electric – account for respectively 3.2% and 0.9% of the market (CCFA, 2016).

During the present transition to battery-driven electric vehicles, suppliers of electronic components and materials are playing an increasingly important role in the supply chain, since manufacturers have not mastered production of the cell, a key component of lithium-ion batteries and a major element of their price (from 50% to 60%). Today, Korean and Japanese firms (LG Chem, Samsung and Panasonic) dominate in this technology and in the market, producing primarily in Asia and a little in Eastern Europe. Only the American manufacturer Tesla and the Chinese manufacturer BYD have begun to make batteries (Mathieu, 2017). In France, in 2009, Renault planned to produce batteries at its plant in Flins for itself and other manufacturers in the framework of a partnership with the French atomic energy commission (CEA) and a state-run investment fund (the *Fonds stratégique d'investissement*). Renault finally gave up on the plan.

In development of electric vehicles, Brazil lags behind other countries, including Korea and China, both in technological development and in the size of the fleet of electric cars in circulation. This situation does not help Brazil to attract new investment in electric engines at a time when global automotive manufacturers are concentrating their R&D efforts on electric engines. Environmental considerations do not attract much attention in Brazil. The system of tax incentives favours cars with small flex-fuel engines (up to 1,000cc). Consequently, the national market seems likely to continue to focus on this technology, which is used only in Brazil.

b) From connected to autonomous vehicles

Computer technology and artificial intelligence have begun to transform the way cars are used. The existing fleet of vehicles already has some degree of autonomy. Current obstacles to development of autonomous vehicles are less a question of technology than of other issues: insurance (responsibility in case of an accident), security (attacks by hackers), intellectual property (the capacity of agents to gather information on behaviour, consumption, etc.), government regulation and social acceptance (drivers' reticence to give up control of their vehicle).

Along with new specialized manufacturers such as Tesla or Faraday Future, most large car manufacturers are taking up positions in this area. In order to do this, they buy up specialized start-ups or collaborate in joint projects that allow them to cooperate technologically with firms specialized in information and communications. Large suppliers are also very involved in development of autonomous vehicles; they have experience in products that are already on the market, such as assisted driving systems.

Development of autonomous vehicles obviously interests certain companies who transport passengers (busses, taxis and chauffeur-driven cars) or merchandise (trucks). Such companies will certainly start using autonomous vehicles more quickly than private individuals. Operators of chauffeur-driven cars who use computer platforms, like Uber and Lyft, are trying to develop fleets of autonomous vehicles (or robot taxis); this would do away with the need for drivers and hence reduce costs. Logistics and passenger transport companies have a financial interest in using autonomous vehicles in order to reduce costs by extending the travel time during which trucks can be on the road, economizing on fuel and reducing the number of drivers, a profession whose turnover is particularly high.

c) New entrants and possible changes in the structure of the GSC

The automotive industry is confronted with major technological change in the form of embedded electronics and other technologies associated with autonomous vehicles. With the exception of Tesla, these innovations have come mostly from outside the industry itself, which has traditionally functioned as a closed self-sufficient system. Today, historical OEMs are threatened by new entrants. They face a non-negligible risk of changes in their competitive environment and possible transformations of their GSC.

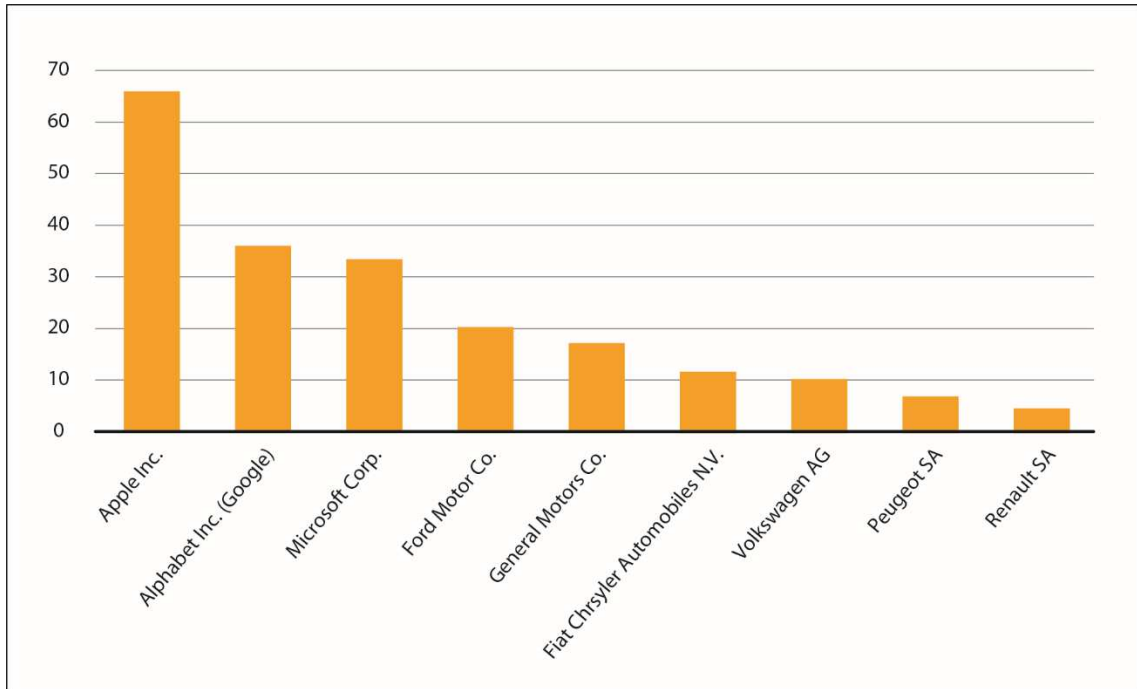
Nonetheless, automakers have strong points that could enable them to deal with competition from digital giants: The contacts they have always maintained with their customers, through captive finance companies and sales networks, constitute solid barriers to entry. It is essential that manufacturers keep in touch with customers and foster brand loyalty by offering new services (access and financing for mobility). However, the corporations of the digital economy have the know-how in computer programming and (big) data processing needed for customer relations. This know-how is crucial to

development of assisted driving systems (connected or autonomous vehicles), to enhancement of security and connectivity and to development of mobility services. The threat that digital companies pose to automakers is reinforced by the fact that these newcomers are very powerful financially compared to automakers; in addition, they are attractive to investors, unlike the automotive industry (Graph 3).

In the context of these new forms of competition, French car manufacturers seem to lag somewhat behind foreign competitors, particularly those of Germany, in development of autonomous vehicles or new mobility services. The French companies lack sufficiently strong financial capacities, and they have chosen other priorities (Pipame, 2016).

In conclusion, as has been the case in the past, technology is a powerful stimulant to competition and a strong factor of destabilization of companies, even in the most established industries, such as aeronautics and automotive. However, this observation calls for qualification. First, history shows that disruptive innovations, despite their name, take years, and even decades, to develop. Next, the pace and orientation of technological development are largely determined by the socio-economic context, as has been shown by research in the economics of innovation. In “mature” industries, such as aeronautics and automotive, large manufacturing corporations have the capacity to influence how technological innovations are introduced and to use their relational networks to influence regulations (certification and qualification). Finally, widespread dissemination of disruptive innovations requires investment in new infrastructures, which depends to a great extent on public policy.

Graph 3. Net operating cash flow of traditional automakers and newcomers to the industry in 2016 (in \$ billions)



Source: Based on data from Marketwatch.com (net operating cash flow).

3. The preponderance of finance

A third vector of transformation of GSCs – one that is neglected in the academic literature – is the financial approach to management that has become preponderant in large manufacturing corporations, an approach that interferes with production. We do not consider finance to be external to the strategies adopted by large manufacturing corporations; rather, we consider finance to be an intrinsic characteristic. An approach based on finance has repercussions on GSCs as spaces for creating added value.

3.1 R&D and dissemination of financial norms in the aeronautic GSC

Airplane production is attractive to investors. The aerospace and defence industry has largely outperformed other sectors on American and European stock markets.³⁷ This success has resulted in investment funds holding an increasing share of the capital of the main companies in the industry. For example, the French state has gradually decreased its share in the capital of Airbus, while institutional investors have become more

³⁷ The increases in military spending that go along with geopolitical tensions have been favourable to aeronautical corporations; almost all of them engage in both civilian and military production.

predominant. The European corporation has now clearly stated that shareholder value has become a priority.³⁸

Financial preoccupations and constraints have pushed Airbus Group to set up an in-house bank. Its objective is to reinforce centralization of the corporation's financial assets, particularly the large cash flow that results from customer advances, as well as to improve coverage of exchange risks, including risks on markets for financial derivatives such as contracts on interest rates or currencies.³⁹ Approximately 70% of Airbus sales are in dollars, 60% of which is compensated for by procurement of dollars; the rest must be hedged.

Embraer has gradually moved away from state control. Today the corporation is dominated by U. S. investment funds. The goal of satisfying shareholders is mentioned in corporate reports in terms that resemble those used by the directors of Airbus. The weight of financial considerations has led Embraer to reinforce the power of management, a fact that confirms the idea that the agency relationship model does not suffice to control antagonism between shareholders and managers. Bonuses for managers and even top-level engineers have outstripped dividends for shareholders.

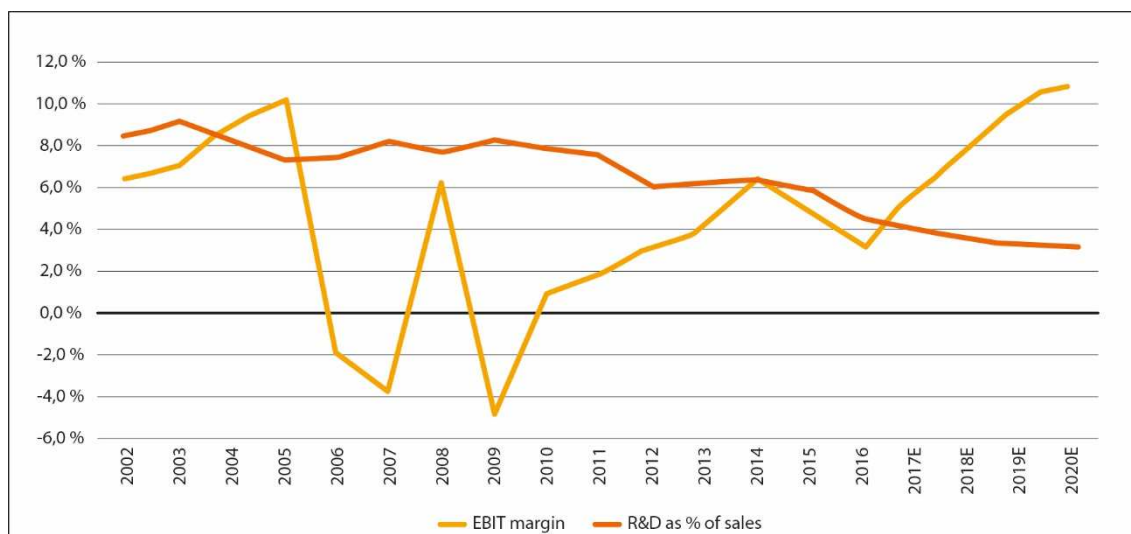
The influence of financial considerations is even more apparent at Boeing. For decades, the strategy of the U. S. manufacturer was based on an engineering culture. This has gradually given way to a quest for financial performance and a priority on cost reduction. Thus, the competitive decline of Boeing in relation to Airbus and the decline in Boeing's R&D efforts appear to be caused by the influence of shareholders on corporate decision-making (Beaugency *et alii*, 2015). Even at Airbus, there has been a slowdown in R&D spending in recent years (Graph 4). This is due above all to an absence of development programmes for new airplanes, but also to the sense of security that the duopolistic structure of the market provides to the company.⁴⁰

³⁸ Cf. T. Enders, Airbus Group Annual Report 2015, p. 19.

³⁹ Cf. Airbus Finance B.V., "Notes to the Unaudited Interim Financial Statements for the Six-Month Period Ended June 30, 2017."

⁴⁰ Cf. "Airbus et Boeing font une trêve pour reconstituer leur trésorerie," L'Usine Nouvelle, 21 May 2014.

Graph 4. Trends in Airbus earnings and R&D expenditures (in % of sales)



Source: Crédit suisse (2017).

Note: EBIT stands for earnings before interest and taxes. EBIT and R&D are presented here as a percentage of sales.

The long-term decline in R&D expenditures is a major cause of the decline in employment at the research departments of suppliers in the Greater Southwest region of France. It directly affected R&D employment at Airbus itself for the first time in 2017. These cutbacks in employment were part of a radical reformulation of corporate strategy, based on outsourcing of R&D.

In contrast, R&D expenditures at Embraer have been increasingly continuously since 2010, with an acceleration since 2014 because programmes for new airplane models have reached the development stage. This increase in the absolute level of R&D expenditures masks their decrease in proportion to added value. Furthermore, Embraer's R&D programmes are increasingly being financed on credit.

Hence, new financial strategies have brought about partial convergence between Embraer and Airbus in their decisions concerning distribution of dividends and the share of added value devoted to R&D and capital expenditure. However, there are persistent differences between the two corporations' strategies. R&D expenditures have continued to increase in volume at Embraer, whereas Airbus has enacted a significant reduction. Embraer's financial debt has increased, a development that could make the corporation vulnerable if it were faced with a takeover attempt.

The large corporations that control GSCs have the power to exercise financial control over smaller companies and companies that do not have access to final markets. Dissemination of financial norms in the aeronautic GSC can be illustrated with three examples. First, development of the practice of Risk Sharing Partner (RSP) has enabled OEMs to transfer financial risks linked to development of new programmes to Tier 1 suppliers. RSP contracts increase financial pressure on Tier 1 suppliers, especially in terms of the need for working capital, since they must store the modules they produce on behalf of the OEM. Second, large corporations can sometimes use subcontractors as a convenient source of financing by delaying payment. One of our interviewees stated with regret that, as an important client, it was possible to negotiate a reduction of 10% in a bill with a subcontractor, while it takes several months to realize equivalent gains in productivity by improving work organization. Subcontractors in France, who are all smaller than lead corporations, seem to be handicapped in general by payment delays that are longer than in other countries, and especially long in this industry.⁴¹ Finally, OEMs and Tier 1 subcontractors have obliged suppliers to accept contracts in dollars – a peculiarity of aeronautics – although most of them are not active in the dollar zone. This augments smaller subcontractors' exchange rate coverage costs.

3.2 Finance as a driving force in automotive GSC restructuring

Finance affects automotive corporation management in several ways. In addition to the tradition which dates back to the beginning of the industry of running captive finance companies, finance has led these corporations to become organized as holding companies. They can be considered “financial corporations with dominant manufacturing activities” (Morin, 1974) that are active in financial market operations both inside and outside the corporation, alongside their manufacturing activities.

Four examples can illustrate the influence of finance on the manufacturing activities of large corporations. One is the traditional role played by manufacturers' captive banks, a condition of development of the automotive market (financing of distributors and clients, both private individuals and companies). Another is centralized management of subsidiaries' cash surpluses. Manufacturers also sell insurance through highly profitable

⁴¹ Euler Hermes, “New DSO Data: A High Stakes Game,” 27 July 2017. DSO stands for Days Sales Outstanding.

captive insurance companies. This explains the disproportionate importance of Switzerland in automotive sector FDI. Switzerland handles 20% of total automotive industry FDI, a share that has almost doubled since 2000. This is due to the presence in that country of the financial subsidiaries – active in banking, insurance, management of exchange risk and cash management – of the two French automakers. Over the 2000s, the financial activities of the two manufacturers have sometimes compensated for the poor performance of their automotive production activities.

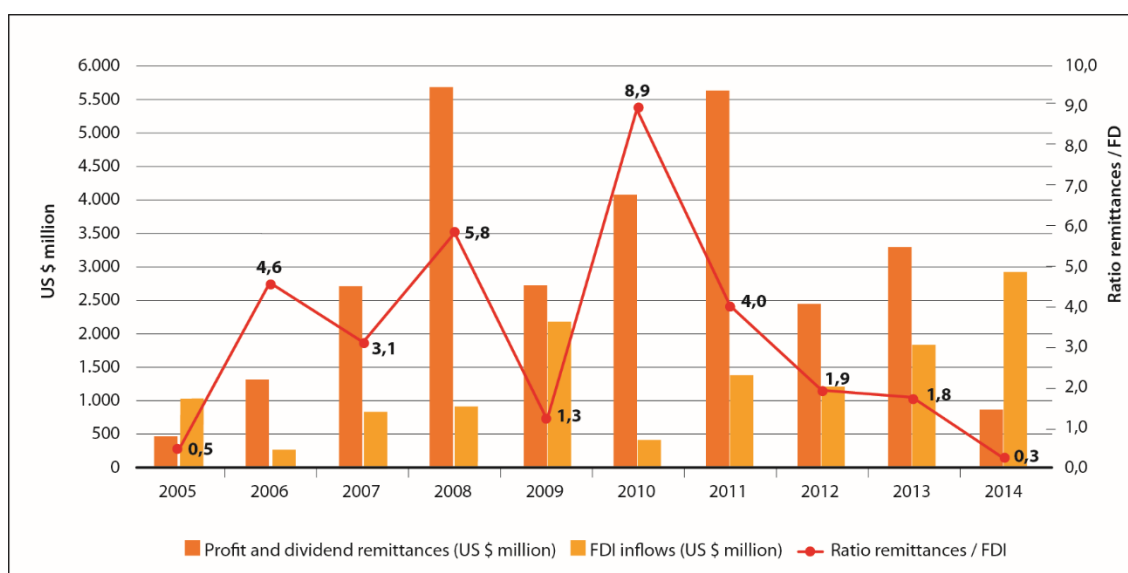
Another vector of the influence of finance is the penetration of new norms of governance into French corporations during the 1990s, after they went public and were evaluated by financial markets.⁴² After the end of the 1990s, certain indicators of financial profitability were introduced and then became the main criteria for management and investment decisions in both corporations. At Renault, this new financial culture developed just when relations with shareholders were thrown into question and foreign investment funds became major stockholders. Around the same time, in 1996, C. Ghosn became Deputy General Director of the corporation. The French government supported maximization of shareholder value, and also the buyout of Nissan, which the French government voted for as shareholder (Tiberghien, 2007). Today, most of the dividends distributed by the company stem from its share in the capital of Nissan. As for PSA, between 2000 until the crisis of 2008, an increasing share of its resources were devoted to buying back stock and distribution of dividends. This policy undoubtedly deprived the corporation of the financial resources it needed to grow and expand abroad (Sartorius, 2012).

Suppliers also have been influenced by finance. The extent of this influence depend to a great extent on the evolution of their shareholder structure. After U.S. investment funds became shareholders of Valeo, the corporation divested itself in the 1990s of many activities that were not considered essential (brake linings, ignition, warning lights). According to our interviews, the American supplier Delphi imposes operating margin objectives on its French subsidiaries above 10%. This expectation led to drastic reduction of the company's activities in France, with closing down of many sites that could not reach such a goal.

⁴² Cf. Frigant and Lung (2001) concerning this development in automotive corporations.

The increasing importance of finance in automotive corporations has also resulted in a redefinition of the purchase department role, a function that is more and more crucial, and a change in the culture of buyers, who act more and more as managers rather than technicians (Sebti and Nasr, 2015).⁴³ Large manufacturers reconfigured their relations with suppliers beginning in the 1990s. They cut back on the number of Tier 1 suppliers and required that they have solid finances and the capacity to produce on a worldwide scale, with a presence in several continents. Tier 1 suppliers' development of capacities in conception and development of modules resulted in a transfer of risks that was desired by lead corporations, who bring constant pressure to bear on supply networks to cut prices. This situation is similar to the rationale behind the Risk Sharing Partner (RSP) concept in the automotive industry. Dominant corporations are more and more aggressive in their purchasing; they systematically foster competition between suppliers and constantly threaten to renegotiate contracts. Tier 1 suppliers adopt similarly aggressive practices towards their subcontractors. Buyers are given incentives in the form of bonuses indexed to the amount of price reductions they have obtained over the year.

Graph 5. Repatriated profits and dividends and FDI inflows in the automotive industry in Brazil, 2005-2014 (in millions of dollars)



Source: Data from the Bank of Brazil.

⁴³ Renault has devised elaborate and costly management tools for analysing and comparing suppliers' prices. The corporation's purchasing department is completely centralized. After its alliance with Nissan, purchasing was the first department to "converge," the expression used in the company jargon.

The behaviour of Brazilian subsidiaries of large foreign automakers and automotive suppliers during the crisis that struck the world economy in 2008 is a further illustration of how financial considerations have won out over industrial considerations and of the negative impact of finance on investment. Parent companies of large foreign corporations demanded that their subsidiaries repatriate the profits and dividends they had earned thanks to the resilience of the Brazilian market, in order to compensate for losses incurred following the drastic drop in sales in Europe and the United States. Graph 5 clearly shows the effect of this development: The amount of money from profits and dividends that went back to corporate home countries, money that could have been reinvested in Brazil, was much larger than flows of FDI.

Up to 2013, a continually high level of demand and high rate of utilization of production capacities in Brazil should have warranted new investment in automotive production, investment that would have enabled Brazil to avoid an increase in imports.

Chapter 6

The impact on employment and labour

In order to analyse quantitative and qualitative developments in employment in the aeronautic and automotive industries in France and Brazil, we have used several databases: national accounts, information from industry associations, information from the corporations studied.

Due to its good performance, the French aeronautic industry was able to create jobs in France, mainly in subcontracting firms of large corporations, and to increase France's share of skilled European employment (in R&D). However, these trends may not hold. Forecasts concerning skilled employment in the Greater Southwest region of France predict a decrease in numbers of jobs, a reason for concern given the region's central role in the GSC of large corporations.

Total employment in the French automotive industry has decreased. Although there has been a sharp drop in automotive manufacturing, automotive suppliers have created new jobs in France. However, these new jobs were created at a time when large French automakers were participating more and more in the supply chains of German automakers. This development speeded up creation of new production sites in Eastern Europe and also creation of new R&D centres closer to customers, mainly in Germany, a move that greatly reduced French groups' domestic employment share .

The arrival of large global automakers and automotive suppliers in Brazil, where the market is attractive because of its size, had a great impact on automotive employment. The way in which the industry has adjusted to changes in demand, especially during the economic crisis, has been different from other industries. Automakers used partial unemployment insurance in order to hold onto their workforces while waiting for demand to pick up again. Suppliers, who are specialized in high added value activities, chose to reduce employment at the very moment when the industry skill level was increasing rapidly. Manufacturers and suppliers working in Brazil gradually began to procure supplies from other countries. The negative impact on employment in Brazil was manifest when there was a downturn in demand for cars at the beginning of the 2000s. In both

aeronautic and automotive industries, an increase in workers' skill levels has coincided with strong pressure to cut wages.

In Brazil, Embraer's status as a major aeronautical manufacturer has attracted a few large foreign suppliers, but a large share of the systems outsourced to Tier 1 suppliers is imported. Embraer's success has therefore had a limited impact on employment. Furthermore, while the workforce has become more skilled, their real wages have decreased, a fact that reflects a certain loss of status.

1. The impact on employment in France of large corporations' strategies and of changes in their GSCs

Since the two industries' market environments have been very different, automobile and aeronautic employment have evolved in opposite directions. On the whole, there has been a geographic shift in automobile production from Western Europe (except for Germany) to Eastern Europe, while aeronautic production has moved towards France, to the detriment notably of the United Kingdom. Beyond these differences, production has become increasingly international in both industries. However, employment growth in France has not kept pace with the strong growth in worldwide demand for the products of the two industries.

1.1 Automotive and aeronautic industries: opposite growth patterns but similar trends towards moving employment abroad

France has succeeded in maintaining its competitiveness in aeronautics. Employment rose strongly between 2000 and 2015 (39%). France has more aeronautic jobs than any other country in Europe, ahead of the United Kingdom, where the number of workers in the industry has dropped drastically, despite strong growth in aeronautic production.

Table 10. Employment in the aeronautic industry in Europe

	2000	2007	2011	2015	Change 2000-2015
France	79,711	94,123	87,700	110,896	+39%
Germany	70,913	79,942	69,429	75,109	+6%
Italy	28,639	35,222	31,786	31,804	+11%
Spain	11,704	16,327	18,489	22,204	+90%
United Kingdom	119,439	106,434	n.a.	92,242	-23%
European Union	342,753	397,900	341,600	400,000	+17%

Source: Eurostat.

The shift of European aeronautics employment to France is partly due to the positive effects of strong cohesion within the industry and concentration of production sites (Chapter 3). A comparison between national accounts data and information published by the large corporations shows that most of the strong growth in aeronautic employment has taken place in medium-sized companies (250 to 5,000 employees). In the automotive industry, the drop in employment in France resembles the situation in Italy or Spain; in contrast, Germany has managed on the whole to avoid cutbacks in automotive employment (Table 11).

Table 11. the Employment in automotive in industry Europe

	2000	2007	2011	2015	Change 2000-2015
France	276,867	254,631	223,839	230,085	-17%
Germany	855,155	846,584	782,555	849,075	-1%
Italy	175,629	166,428	166,437	157,960	-10%
Spain	164,549	154,123	139,121	142,425	-13%
CEE countries ⁽¹⁾	293,956	410,390	558,881	509,516	+73%
European Union	2,078,073	2,235,300	2,222,400	2,355,000	+13%

Source: Eurostat.

Central and Eastern European countries defined here as Bulgaria, Czech Republic, Hungary, Poland, Rumania, Slovakia.

Between 1996 and 2015, the French automotive industry lost nearly 60,000 jobs (-21%). This decrease was solely due to automakers, who cut back employment by 34%, while employment grew by 6% among suppliers over the period (Table 12).

Table 12. Employment in the automotive industry in France

	1996	2000	2007	2011	2015
Automotive	290,711	276,867	254,631	223,839	230,085
Manufacturers	185,160	151,409	163,700	139,411	122,585
Suppliers	79,335	96,607	66,159	59,579	84,271
Bodies	26,216	28,851	27,511	24,850	23,229

Source: Eurostat

Suppliers did in fact reduce their workforces but only over a limited time period, from 2000 to 2011. This reduction does not appear to be very large from a longer-term perspective, even without going very far back. If the reference point is the year 2000, employment among suppliers dropped drastically before the crisis (-31%). If the reference point is the year 1996, the drop was much less pronounced (-17%). (Table 12). The drop registered from 2000 to 2007 followed a strong increase in employment from 1996 to 2000 (+22%), because manufacturers outsourced some of their activities to suppliers. The drop observed between 2007 and 2011, due mostly to conditions in the general economy, did not herald a general downturn since employment grew quickly after that, surpassing the 1996 level. The remarkable increase in employment among suppliers since 2011 (+41%) did not allow them to reach the peak level of 2011 (99,813 employees). Early restructuration of the suppliers' sector in France (2000-2007) enabled the industry to weather the 2008 crisis without reducing employment much, especially in comparison with Germany.

On the European level, the automotive industry is currently marked by competition between French and Italian suppliers for the clientele of German manufacturers. Like companies that were once suppliers to Fiat and became suppliers to German manufacturers, Valeo and Faurecia now sell more to German automakers – Volkswagen in particular – than to French automakers (Chapter 3).

In France and Germany, automakers employ more workers than suppliers (Table 13). In Italy and throughout Eastern Europe, suppliers account for more than half of employment in the automotive industry.

Table 13. Suppliers' share of total automotive employment in Europe

	1996	2000	2007	2011	2015
France	27.3%	34.9%	25.9%	26.6%	36.6%
Italy	37.5%	43.6%	49.2%	54.6%	52.4%
Spain	39.3%	40.5%	43.3%	47.6%	46.0%
Germany	n.a.	33.3%	37.1%	33.5%	36.6%
CEE ¹	n.a.	41.8%	78.5%	57.1%	70.6%
E.U.	n.a.	36.8%	42.9%	47.3%	48.6%

Source: Eurostat.

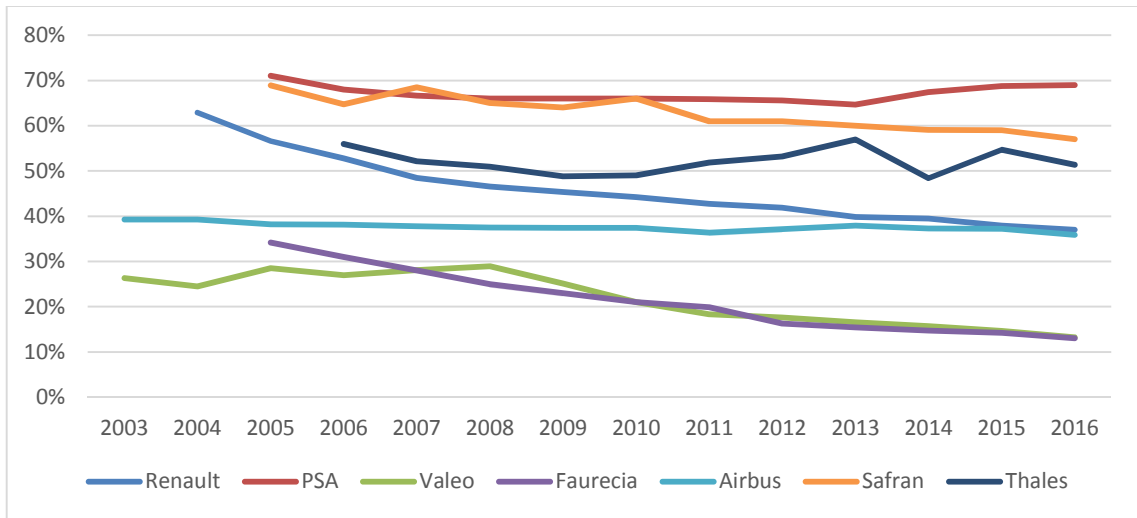
1. Central and Eastern European countries are defined here as the main countries of Eastern Europe: Bulgaria, Czech Republic, Hungary, Poland, Rumania, Slovakia.

2001-2008 for CEE countries. Data is missing for the Czech Republic in 2000 and for Bulgaria in 2007.

The remarkably strong growth in automotive employment in Eastern Europe indicates that the French domestic base has lost out in the automotive market in Europe and the rest of the world. Employment among French automakers has dropped in absolute terms; in the case of suppliers, employment has progressed in France but at a much slower pace than in Eastern Europe.

Increasing globalisation of the automotive and aeronautic production, analysed in Chapter 2 of our report, has led to globalisation of employment. However, in 2016, employment of large corporations is much more global in the automotive than in the aeronautic industries.

Graph 6. France's share of employment for the seven largest automotive and aeronautical corporations



Source: Data from corporate annual reports.

Note: PSA figures apply only to the “automotive” division. Renault figures apply to the whole corporation, including financial activities.

The automotive industry is characterized by a very high proportion of employment outside France for the two largest suppliers. Only a small share of their employees remains in France: 13% for Faurecia in 2016 and 17.2% for Valeo in 2015. Suppliers became international at a remarkably rapid pace from 2003 to 2016, much faster than manufacturers. While the share of manufacturers’ employment in France dropped by a third, it dropped by two thirds in the case of Valeo. Automotive suppliers did not cut back much on employment in France during the crisis, but they expanded their activities abroad. As for manufacturers, employment trends at Renault and PSA were very different. Renault expanded abroad more and earlier than PSA, where employment (automotive production, except for its subsidiary Faurecia) remains very much concentrated in France, with more than two thirds of total employment.

Like the French automotive industry, the French aeronautic industry has tended to expand employment abroad, even though France still has a large share of global employment. Airbus is an exception: The French share of corporate employment has remained stable at 37%, a share decided on by participating governments. The share of employment in France for the other two aeronautical corporations has been dropping, even though it is still more than 50%. Currently, the effects of deployment of activities abroad have been

less marked and their results less “painful” in aeronautics because employment, especially highly qualified employment, has continued to rise.

Analysis of employment trends in the automotive and aeronautic industries in France compared to trends elsewhere in Europe suggest that employment in the automotive GSC has become more concentrated in Germany while employment in the aeronautic GSC is more concentrated in France.

1.2 R&D employment: French strength in aeronautics versus decline in automobile

French corporations in both industries have made great efforts to develop overall R&D. The French aeronautic industry has benefitted from these efforts, but the French automotive industry – including subcontractors – has not. There has been a trend towards concentration of R&D employment in France and in Germany, similar to trends in overall employment in the two industries. Initially, France had more employment in aeronautic R&D than other European countries. The number increased rapidly and France specialized in the most complex activities, a trend confirmed by the rapid increase among aeronautical personnel in the share of engineers and PhDs. Trends in German automotive R&D employment are quite similar to trends in French aeronautic R&D employment. By contrast French automotive R&D employment has been decreasing and declining in quality, even though the share of skilled jobs is higher than in automotive R&D employment in Italy or the United Kingdom.

R&D is an activity that tends to remain in the home country (Thévenot, 2007), despite a trend towards offshoring that began in the 1970s (CREST, 2008). The automotive and aeronautic industries have internationalized their R&D less than other industries (Pavlinek, 2012). The automotive industry has nonetheless witnessed rapid outsourcing of R&D for some time; offshoring of R&D has been more recent. This trend is particularly marked in France for two reasons. First, Renault has created a large R&D centre in Rumania, a centre that is involved in many research topics (Rodet-Kroickvili *et alii*, 2014). Second, as mentioned above, French suppliers have become integrated into the supply chains of German manufacturers. The location of suppliers’ R&D seems to depend on the location of manufacturers’ assembly lines for moderately complex components. However, for highly complex components (modules and systems), which absorb most of

suppliers' R&D efforts, location seems to depend on the location of manufacturers' R&D (Frigant and Layan, 2009). Increasing integration of French suppliers into German supply chains explains why part of their R&D for highly complex components has been moved to Germany.

Aeronautic R&D seems to be little affected by offshoring; most of French corporations' R&D is domestic. R&D is almost all internal to companies (88%), and it takes place in the home country (INSEE, 2017). Hence, two parallel processes can be observed. In the automotive industry, integration of French suppliers into German supply chains has increased concentration of R&D in Germany. In the aeronautic industry, concentration of European activities in France has increased concentration of R&D in France.

Since the beginning of the 2000s, a certain concentration of aeronautic R&D has taken place, similar to the concentration observed for employment in general in the industry. In the 2000s, employment in France registered very strong growth (doubling between 2000 and 2011), while employment increased little in Germany and the U.K., the two other European countries with large aeronautical firms (Table 14).

Table 14. Number of jobs in aeronautic R&D in France, Germany and the United Kingdom (1996-2015)

Pays	1996	2000	2007	2011	2015
France	14,755	11,125	17,683	21,508	n.a.
Germany	n.a.	8,912	12,219	9,854	9,979
United Kingdom	n.a.	10,542	13,540	10,722	13,664

Source: Eurostat.

In France, the increase in aeronautic R&D employment was even stronger than the increase in total aeronautic employment. Hence, aeronautic employment in France is R&D-intensive and aeronautic R&D is concentrated in France to a great extent. In 2011, France had as many jobs in aeronautic R&D as Germany and the United Kingdom put together. Furthermore, French aeronautical firms employ a large proportion of "researchers." R&D jobs are located in the research centres of large corporations, and also in the design offices of the engineering and computer firms that participate in the subcontracting networks of large corporations.

Nonetheless, the predominance of finance may have a negative impact on this type of employment (Chapter 4), along with the fact that ambitious airplane development programmes have been brought to a halt since the beginning of the 2010s. According to OPIIEC (a French observatory of employment in computers and engineering, jointly run by employers and labour unions), upcoming cutbacks in the numbers of engineers and consultants employed by the aerospace and defence industry in the Greater Southwest region of France should be around 5,000 by 2020, a drop of almost 20% in jobs compared to 2013.

Employment in the French automotive industry is decreasing. Until 2000, the share of R&D employees in the industry was about the same in France and in Germany.

**Table 15. Share of R&D in total automotive employment
in France, Germany, United Kingdom, Italy and Spain (1996-2011)**

Industry	Country	1996	2000	2007	2011	2015
Automotive	France	6.8 %	9.1 %	6.6 %	6.2 %	n.a.
	Germany	n.a.	8.7 %	10.6 %	11.9 %	13.2 %
	United Kingdom	3.2 %	3.5 %	1.9 %	8.5 %	10.5 %
	Italy	5.1 %	4.7 %	6.8 %	7.7 %	9.2 %
	Spain	n.a.	1.2 %	2.7 %	4.1 %	4.1 %
Manufacturing	France	3.2 %	3.2 %	3.7 %	5.3 %	n.a.
	Germany	n.a.	3.7 %	4.4 %	4.8 %	5.0 %
	United Kingdom	2.0 %	2.1 %	2.2 %	3.2 %	4.2 %
	Italy	1.3 %	1.4 %	2.7 %	3.4 %	4.1 %
	Spain	n.a.	1.2 %	2.3 %	3.2 %	3.2 %

Source: Eurostat.

Total automotive employment has declined. The decrease in the share of R&D in automotive employment is all the more worrisome because it indicates an absolute drop in the total number of R&D employees that is more pronounced than the drop in the industry's total employment.

Two factors explain this trend. One, a statistical factor, is linked to increased outsourcing of R&D in the automotive industry. Outsourced jobs are classified in national statistics as part of the services and engineering sector. The other factor is linked to the fact that outsourcing of R&D coincided with a shift of R&D to locations outside France. A similar decline has taken place for the most skilled jobs in automotive R&D. France is the only large automotive-producing country in western Europe where the absolute number of “researchers” has been dropping, while large French automakers have increased their total R&D expenditures (Table 16).

Table 16. Number of “researchers” employed in automotive R&D in France, Germany, Italy, Spain and the United Kingdom (2007-2015)

Country	2007	2011	2013	2015
France	8,121	8,427	7,955	n.a.
Germany	53,440	58,763	61,097	70,939
United Kingdom	n.a.	5,521	6,380	7,536
Italy	2,506	3,511	3,900	4,327
Spain	1,400	1,523	1,719	1,841

Source: Eurostat.

France is not in a favourable situation compared to Germany. In 2013, only 7,955 researchers were employed in automotive R&D in France, compared to 61,097 in Germany. However, France has many more automotive workers than the United Kingdom or Italy. The existence of national automakers with significant R&D capacities places France in an intermediate position, between Germany, on the one hand, and the United Kingdom and Italy, on the other.

Data confirm the shift by French automotive groups of their R&D towards Germany, especially among suppliers. Valeo now has more R&D employees in Germany than in France. Our correspondents in the company provide two reasons for this shift. First, there is a lack of engineers in France, where the qualified workforce is employed by the aeronautic industry in a higher proportion than in the automotive industry, (since Thales

and Safran employ many more highly qualified workers than the four main automotive corporations).⁴⁴ Second, Valeo needs to be close to the assembly lines of German automakers, who are now the company's biggest clients and who require their suppliers to be present in Germany (Frigant, Layan, 2009). Renault and PSA have kept their essential R&D capacities in France. However, PSA has announced that its merger with Opel will result in locating future R&D projects in Opel's R&D centre, instead of outsourcing to firms involved in *engineering activities and related technical consultancy* that PSA usually contracts with (Altran, Akka or Alten).⁴⁵ In comparison with other multinational companies, Renault and Valeo's R&D efforts clearly reflect an increased intensity of skilled work. However, the increase of R&D personnel has not benefitted France, where the number of workers in automotive R&D has been declining, as it has risen greatly in aeronautic R&D. Thus, the strong increase of employment in R&D declared by automotive firms, especially suppliers, with Valeo in the lead, has not taken place in France.

1.3 Temporary employment: the "new normal" for production workers in the French automotive industry ?

The French national statistical institute, INSEE, conducts an annual survey on employment. Findings from 2007 to 2015 are available on INSEE's website. Manual workers still account for more than half of automotive industry employees – manufacturers and suppliers – despite the marked long-term decline in manual work and the rise in proportions of technicians, engineers and managers (Méot, 2009). The share of manual workers has stabilized at around 57% after a drop during the 2009 crisis followed by a rise in 2015 (Table 17). Temporary agency contracts were used as an adjustment factor during the crisis; the proportion of temporary workers fell to 3.25% in 2009, but it rose later, with a share of 11.8% in 2015 versus 11.8% in 2007. Temporary contracts are most common among unskilled manual workers.

⁴⁴ Airbus does not publish statistics on numbers of employees working in R&D.

⁴⁵ Cf. L'Opinion, "PSA transfère ses projets R&D en Allemagne chez Opel," 16 Novembre 2017, <https://www.lopinion.fr/edition/economie/psa-transfere-projets-rd-en-allemande-chez-opel-137954>

Table 17. Automotive industry employment by type of contract and category of employee

Type of contract (%)	2007	2009	2015
Permanent contract	87.55	92.50	83.77
Short-term contract	3.31	2.88	2.50
Seasonal contract	0.00	0.03	0.05
Temporary contract	7.88	3.25	11.80
Apprenticeship	1.25	1.33	1.88
Category of employee (%)			
Managers and engineers	13.63	18.63	14.34
Supervisors and other intermediate categories	25.55	24.14	24.49
Office employees	3.99	3.97	4.12
Manual workers	56.83	52.26	57.05
including skilled manual workers	39.40	38.83	38.18
including unskilled manual workers	17.43	14.43	18.88

Source: Data from INSEE employment surveys.

Increased use of temporary contracts is confirmed by interviews with manufacturers. Our correspondents say that rates of temporary contracts are about 25% to 30% on average and can be as high as 50%, and even higher in certain factories for certain product lines. Recourse to temporary agencies is partly a result of the way production is organized. The head of French Human Resources department at Renault explains that it corresponds to a night shift in a product line that functions with three eight-hour shifts per day. Fluctuations in demand for vehicles made in Western Europe are so wide that factories do not function constantly at that pace. During slowdowns, night shifts may be cut back and night shift crews may be disbanded. This puts a halt to temporary contracts. Permanent workers who normally do night shifts are switched to other time slots. According to the Renault's head of French Human resources department, such external

flexibility measures are needed because internal flexibility measures, which were used extensively in the 1990s and 2000s, have now reached their limits in terms of social acceptance.

Temporary workers often do the most difficult jobs. They must deal with a fast work pace, and their turnover is particularly high. This creates quality problems in final products, but it also does not give employers incentives to train these workers.

2. The impact of Brazil's integration into aeronautic and automotive GSCs on employment and skills

The automotive industry generates many manufacturing jobs in Brazil, but the aeronautic industry creates few jobs. Although the growth rate of employment in aeronautics has been high, the number of workers involved is small. In both industries, these trends in employment have been accompanied by a strong increase in skill levels.

2.1 Contrasting employment trends in the aeronautic and automotive industries

In Brazil, both the aeronautic and automotive industries experienced strong growth in added value between 2000 and 2016, a trend that led to employment growth. Nonetheless, there is a difference between the two industries. The weak impact of added value growth on employment in the aeronautic industry is the result of the predominance of Embraer and the company's dependence on imports, in the absence of a national network of suppliers. Embraer's status as OEM and world leader in the market segment of regional airplanes has certainly stimulated growth of aeronautic production and employment. However, this development is counterbalanced by the firm's strategy of offshoring production and supply sources, which has a negative effect on employment in Brazil. Moreover, production sites of the large foreign suppliers who work for Embraer have little effect on employment. Overall, aeronautics created few jobs compared to other manufacturing industries: Between 2007 and 2014, it accounted for only 0.3% to 0.4% of manufacturing jobs (Table 18).

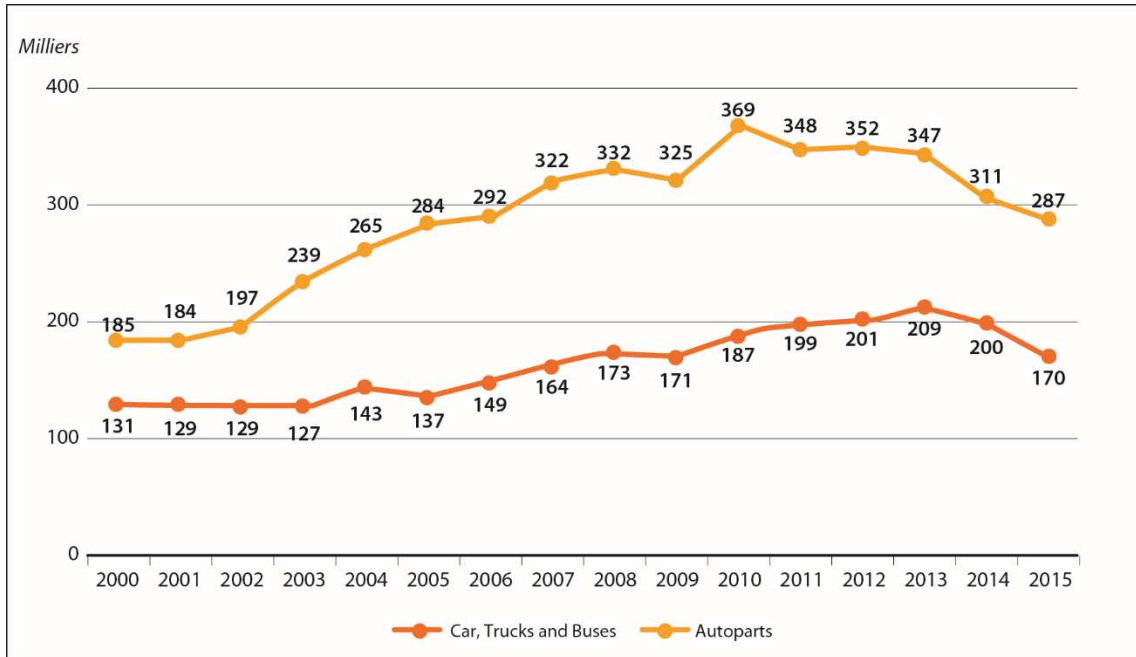
Table 18. Aeronautic industry in Brazil: Number of companies, number of employees and average size of companies

	Companies			Employees			Average size (employees / company)	
	Aeronautics	Manufacturing	Share of aeronautics (%)	Aeronautics	Manufacturing	Share of aeronautics (%)	Aeronautics	Manufacturing
2007	18	32.,188	0.06	22,165	5,534,452	0.40	1,231	172
2008	21	34,554	0.06	23,651	5,764,319	0.41	1,126	167
2009	26	35,421	0.07	19,186	5,801,561	0.33	738	164
2010	27	35,768	0.08	20,428	6,208,722	0.33	757	174
2011	26	38,278	0.07	20,405	6,445,905	0.32	785	168
2012	28	38,633	0.07	19,979	6,616,200	0.30	713	171
2013	27	37,655	0.07	21,124	6,701,085	0.32	782	178
2014	30	38,118	0.08	21,278	6,566,525	0.32	709	172
Δ (%)	66.6	18.4		-4.0	18.6		-42.4	0.2

Source: Data from RAIS.

In contrast, in the automotive industry, the very strong increase in added value – +91% for carmakers and +318% for automotive suppliers between 2000 and 2015 – resulted in many new jobs: +30% for manufacturers and +55% for suppliers. During the period preceding the 2011 downturn, growth was particularly strong for suppliers (+99%), as shown in Graph 7.

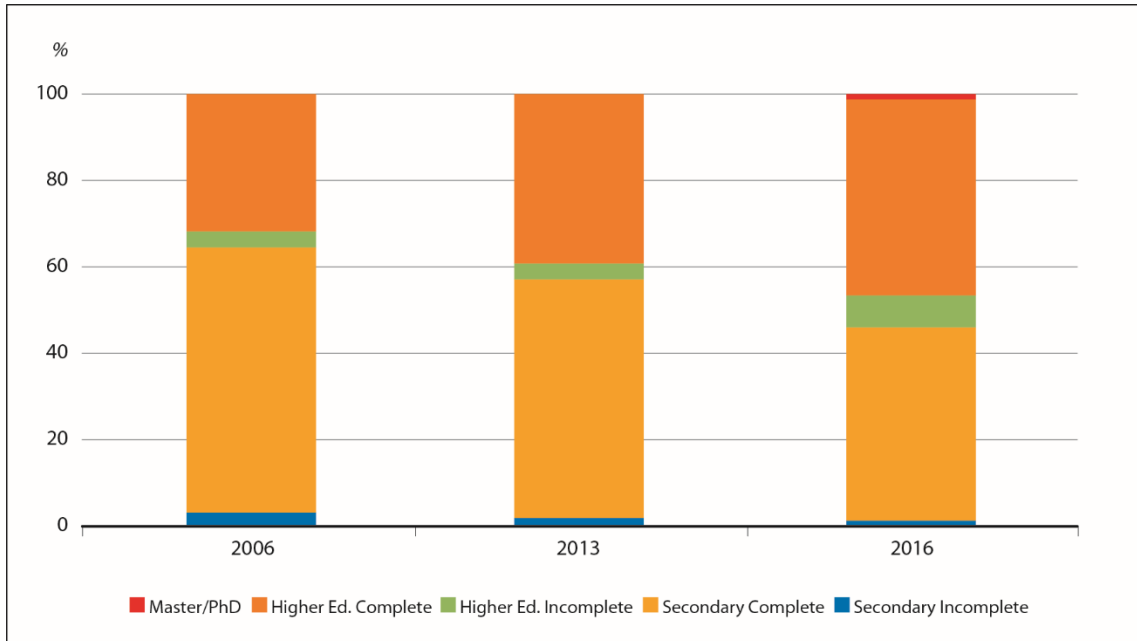
Graph 7. Number of jobs in the Brazilian automotive industry (in thousands)



Source: Data from the Brazilian national accounts office, IBGE.

As early as 2011, employment among suppliers began to drop; for manufacturers, it did not begin to drop until 2014, and especially 2015. The slower reaction among manufacturers is probably due to their strong labour unions, but above all to the way the companies used the programme for employment protection (PPE) launched by the government in July 2015. In exchange for a pledge to maintain jobs, the programme gave companies experiencing financial difficulties authorization to reduce employees' work schedules and to cut employee compensation for hours not worked down to 30% of the regular wage. The government paid out 50% of the regular wage for hours not worked. According to labour unionists we interviewed, manufacturers – notably Volkswagen, Ford and Mercedes-Benz – took advantage of this programme extensively.

Graph 8. Education levels of Brazilian aeronautic employees, 2006-2016



Source: Data from RAIS.

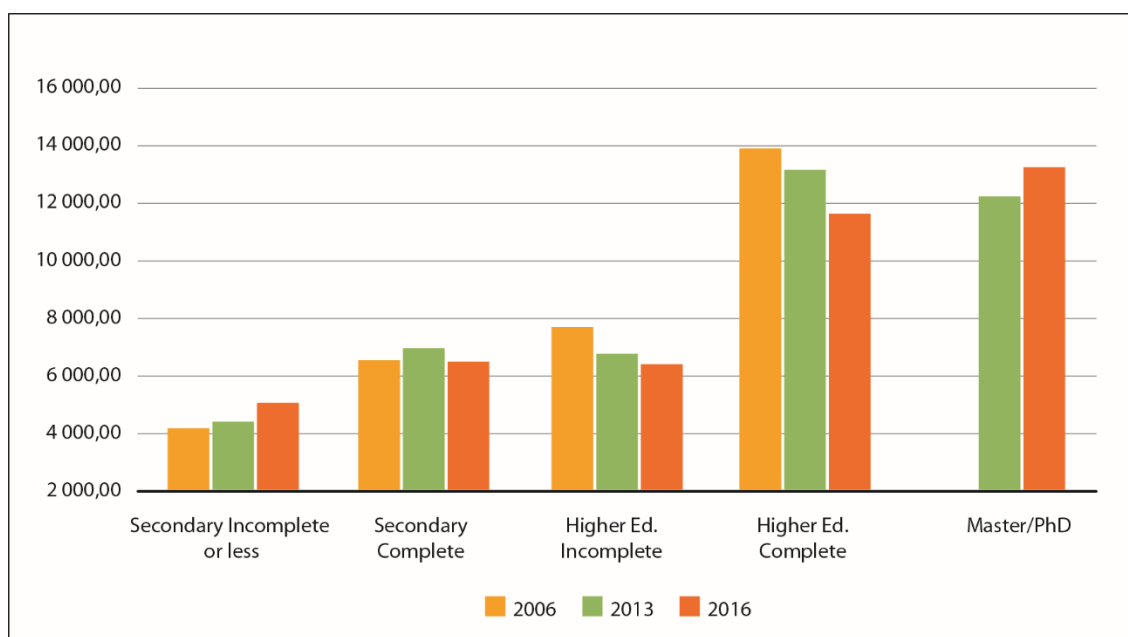
2.2 A strong rise in employee education levels in both industries

In both industries, there has been a strong rise in employee education levels, but because of the large influx of graduates from higher education, Brazilian employers have been able to lower wages.

The Brazilian aeronautics industry has been marked by a very rapid rise in workforce education levels. Between 2006 and 2016, the share of employees with a higher education diploma rose from 31.9% to 46.3%. Over the same period, the share of those with a secondary school education or lower dropped from about two thirds of employees to less than half (45.7%) (Graph 8).

The rapid rise in the general level of education in Brazil enabled companies to replace workers with a secondary school education with workers with a higher education, while maintaining downwards pressure on wages since there are many highly educated workers on the labour market (Graph 9).

**Graph 9. Average wage in the Brazilian aeronautic industry
by employees' level of education, 2006-2016 (in constant 2016 R\$)**



Source: Data from RAIS.

Embraer runs two in-house training programmes, one for engineers and one for technicians.⁴⁶ However, both programmes are for new recruits, and the company does not have a formal programme for furthering the education of older workers, even though there are some relatively informal efforts. Thus, there is a risk that the general improvement in the Brazilian education system will make it more profitable for aeronautical companies who need to raise personnel skill levels to lay off workers with little formal education and replace them with young university graduates at declining real wage levels, rather than training the existing workforce.

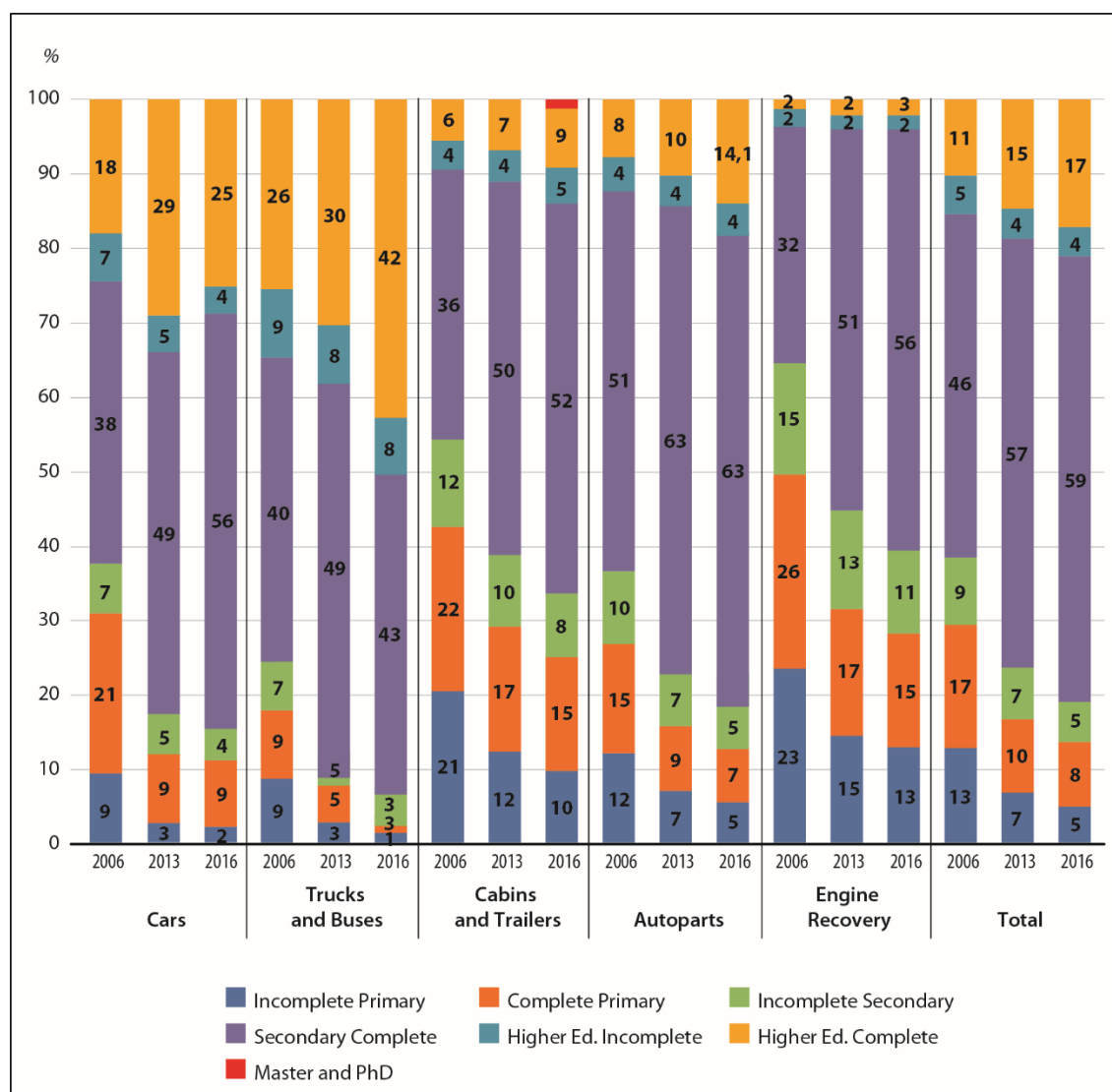
The Brazilian automotive workforce is well-educated. The great majority of employees – 80% in 2016 – have completed secondary school or have attained a higher education diploma. This share has grown rapidly over a ten-year period (Graph 10).

There are two reasons for these trends. First, most of the workers hired during the 2000s had a higher level of education. Second, most of them were spared during the layoffs that began in 2013. Those layoffs were concentrated on less educated workers, who accounted

⁴⁶ The aeronautical engineering programme (PEE) gives a master's degree. The other programme is called the "projector" programme (PPE).

for 34% of the 145,000 jobs destroyed between 2013 and 2015. Over the same period, only 12.2% of the workers who had studied in university, whether or not they had obtained a diploma, were laid off. A large number of workers – 17,651 – lost their jobs, but the proportion of highly educated workers was smaller than their 19% share of employment.

Graph 10. Education levels of Brazilian automotive employees, 2006-2016 (in %)



Source: Data from RAIS.

Despite the general rise in the level of education of automotive workers, and especially the rise in the share of those with higher education, the average wage has not risen and has even dropped for workers employed by automakers (Table 19).

Table 19. Breakdown of average wage by educational level in the automotive industry
(in constant 2016 Rs)

		Incomplete Primary	Complete Primary	Secondary Incomplete	Secondary Complete	Higher Ed. Incomplete	Higher Ed. Complete	Master/ PHD
Cars	2006	3,364	4,845	4,089	4,623	7,142	11,401	14,991
	2013	2,841	6,043	4,032	4,640	7,537	9,446	14,530
	2016	2,217	5,190	3,849	4,068	6,582	9,633	11,491
Trucks and Buses	2006	1,964	5,461	4,966	5,455	6,650	12,827	15,718
	2013	1,739	5,776	5,631	5,598	6,461	12,450	16,951
	2016	875	4,863	5,395	5,052	5,959	10,784	15,254
Cabins and Trailers	2006	771	2,106	1,864	2,276	3,220	6,726	12,023
	2013	769	2,467	2,138	2,518	3,527	6,234	13,283
	2016	737	2,316	2,030	2,398	3,221	5,733	12,340
Auto Parts	2006	1,110	2,525	2,362	2,616	4,444	9,666	14,210
	2013	1,033	2,610	2,502	2,738	4,398	9,125	13,095
	2016	1,022	2,493	2,450	2,658	3,967	8,262	12,498
Engine Recovery	2006	570	1,474	1,367	1,456	1,477	2,542	0
	2013	732	1,924	1,765	1,852	2,139	2,567	2,070
	2016	689	1,927	1,843	1,868	2,039	2,543	2,325
Total	2006	1,386	3,085	2,607	3,015	5,220	10,446	14,479
	2013	1,130	3,248	2,740	3,143	5,162	9,430	13,813
	2016	1,068	3,107	2,679	3,002	4,556	8,871	12,416

Source: Data from RAIS.

Paradoxically, the drop in real wages has affected the most highly educated workers, whose average real wage fell over the whole period, during the phase of growth and during the slowdown of 2011. In contrast, the average wage of employees with a medium level of education followed trends in the economy, rising until 2013 before dropping. Thus, the rise in the average wage paid by suppliers is the result of a change in workforce structure rather than a policy of wage hikes.

3. The impact of disruptive innovations on employment

All significant disruptive innovations have been accompanied by major change in labour relations. If the concept of “Industry 4.0” is taken seriously, there could be sweeping

transformations in labour relations. After all, the first industrial revolution went along with the preponderance of wage labour; the second, and the third even more so, went along with the new model of mass consumption and a radical change in employer-labour relations with the Fordist model of mass production. Most macroeconomic forecasts drawn up by think tanks or economists predict that many jobs are at risk with the 4th industrial revolution, which is linked to information technology. The current wave of creative destructive might result in job destruction on a hitherto unknown scale as the ILO has put it (ILO, n.d.). It also might affect other dimensions of employment (quality of work, job polarization, new skills, etc.) in positive or negative ways, as shown by our examples from the aeronautic and automotive industries.

Employees' ability to be digitally connected to work stations located at different points in a GSC and their consequent ability to intervene remotely in production processes are emblematic of the changes taking place. Large aeronautical corporations are pioneers in the technology of connected objects that makes possible the introduction of robots in certain assembly operations and predictive maintenance. In contrast, the French automotive industry lags behind in production automation. In automotive, "Industry 4.0" is not well advanced and the use of such techniques is not widespread. The factory of the future is just at its beginnings.

Information technologies will determine the work conditions of the "agile worker" and could throw into question wage earner status, which is still the dominant mode of labour mobilization. It does not seem feasible to extend independent status to most workers in the aeronautic or automotive industries, but new technologies – especially digitalisation of GSCs – could create a new deal for some employees. Could digitalisation lead to reversing the shift of activities to developing or emerging countries? Could it stop the trend towards offshoring activities, one of the driving forces behind changes in GSCs? Clear answers to these questions have not yet emerged. Although some effects of disruptive innovations are already visible, others are just the subject of forecasts. The scope and trajectories of these effects will depend on how the social partners and governments deal with transitions. Recent collective bargaining agreements at Renault and PSA point to integration of new issues into social dialogue. Keeping production and jobs in France is a priority for French labour unions, but they are not willing to accept

deterioration of work conditions. This question is not so acute in the aeronautic industry, given the dynamics of employment in the industry in France.

In Brazil, unions' priority in the automotive industry is workers' purchasing power, and wages were more of an issue than jobs in recent collective bargaining. In the Brazilian automotive industry, work conditions are better than in other manufacturing industries, and wages are usually higher. This is due to the predominance of multinational firms, who generally pay higher wages than national firms. However, jobs could easily become a major preoccupation for unions and a central issue in collective bargaining because of two significant reforms that passed in 2017. First, subcontracting has been liberalized. Second, labour law has been amended with the introduction of measures promoting flexible employment and work hours, measures that could endanger job security.

Conclusion

Our concluding remarks do not sum up the main lessons of our report. Instead, we suggest some possible interpretations. Four points are thus developed.

Re-interpreting the GSC concept

Our study confirms that the concept of GSC has become inseparable from analysis of the strategies of large corporations. Consequently, it would seem that the concept of the GSC of an industry (the aeronautic industry, for example) has become too general. Likewise, it makes little sense to refer to a French “automotive GSC” that would encompass the two competing corporations, PSA and Renault. Although their records are similar and the techno-productive aspects of their GSCs are similar, the two corporations have adopted different international strategies in the 2000s, with contrasting results for the national system of production.

Our comparison of Airbus and Embraer also confirms that there is not really an aeronautic industry GSC. The Brazilian corporation is a world leader on a market niche (regional transport) which is threatened by developments on the global market for air travel. Furthermore, Embraer set up its GSC with Tier 1 suppliers who are all non-Brazilian. This makes the GSC vulnerable since the Brazilian aeronautic industry suffers from the absence of a dense network of entrepreneurial know-how, like the one that exists in France. Such a network facilitates the kind of interactions that are essential to innovation, as in the Greater Southwest region of France.

GSCs and upgrading

Our comparison of the automotive and aeronautic industries in Brazil sheds light on the questions raised by Baldwin concerning the choice between “building or joining” a GSC (Chapter 1). Indeed, Embraer built its own GSC, while Brazilian automakers joined GSCs that had been set up by foreign OEMs. What impact do these two different approaches have on upgrading?

In order to clarify this question, we use the classification formulated by Gereffi *et alii* (2001). They distinguish four possible types of upgrading. Table 20 applies the classification to the two industries in Brazil.

Table 20. The four types of upgrading in the Brazilian aeronautic and automotive industries

Type of upgrading	Aeronautic industry	Automotive industry
1. Process upgrading	Yes	No
2. Product upgrading	Yes (but limited to regional airplanes)	Yes (flex-fuel motors)
3. Functional upgrading (moving into activities with higher added value)	No	No
4. Inter-sectoral upgrading	No	No

Source: Elaborated by authors.

Brazilian aeronautical firms joined a GSC by creating an OEM without domestic suppliers. Brazilian automotive firms joined a GSCs in a subordinate position, as Tier 2 or 3 suppliers, under the aegis of the foreign OEMs present in Brazil. These ways of entering GSCs stopped the upgrading process, without reaching types 3 or 4 (see Table 20). Indeed, none of Embraer's Brazilian suppliers has acceded to Tier 1 status within Embraer's GSC. The corporation remains highly dependent on foreign suppliers for the components it needs to assemble final products. In the automotive industry, no national OEM has emerged, nor have any Brazilian suppliers moved upstream. They are stuck in the lower subordinate positions (Tiers 2 and 3). In both industries, functional upgrading, that is, a move into activities with higher added value (type 3,) has not taken place, and inter-sectoral upgrading, that is, dissemination of know-how into other industries (type 4), has not occurred either.

The typology formulated by Gereffi and his colleagues gives the impression that there is a continuum between different forms of upgrading, when in fact they are qualitatively different. Thus, type 1 and type 2 upgrading can take place in two ways. One is that firms that are already present in an industry learn new processes or how to make new products. The other is entrance of new firms into the industry. Type 3 upgrading requires government support, starting with training of a workforce capable of carrying out more skilled activities. Type 4 upgrading is qualitatively different. Inter-sectoral transfers – sometimes referred by economists as spin-offs or spillovers – should not be viewed as windfall effects, nor should they be considered to take place automatically, as if an entrepreneur's decision sufficed to make them happen. A national economy is more than

the sum of the industries that coexist in a country, as was shown by research in the 1980s and 1990s working on the concept of “national innovation system,” and also by research on the foundations of national structural competitiveness, which cannot be reduced to the microeconomic competitiveness of a country’s firms. Dense backward and forward linkages between sectors and dissemination of innovations as a process based on constant interaction between private and public sector agents (universities, research centres), require conditions that reach far beyond the strategic horizon of firms, even the largest ones. Such conditions have been singularly lacking in Brazil.

Inter-sectoral upgrading requires far more than certain characteristics of GSCs. As several authors have pointed out (Fortwengel, 2011; Milberg and Winkler, 2013; Rodrik, 2013), inter-sectoral upgrading requires, at the very least, integration of domestic firms into a GSC and an industrial policy that gives high priority to dissemination of technologies between sectors. Hence, focussing on integration into a GSC while ignoring the conditions cited above risks limiting developing countries to activities with low added value (UNCTAD, 2013, p. XI).

GSCs and corporations’ home countries

Our report highlights the extent to which French aeronautical corporations are tied to their home country, particularly in terms of domestic employment. The GSCs of Airbus and the large supply corporations (Safran and Thales) are worldwide, but their key activities – R&D, intellectual property, final assembly of high-tech products – remain in France (and also in Germany for Airbus). These corporations can keep solid upstream ties with public institutions (the French aerospace lab Onera, public universities, etc.) and downstream ties with government-regulated agencies, notably the French civil aviation authority, DGAC, which distributes a large share of government aeronautic subsidies, as explained above.

PSA and Renault are in a different situation. They have moved their activities abroad to a much greater extent than French aeronautical corporations. Our data on employment confirm that PSA and Renault have shifted activities offshore, first production and later downstream R&D activities (development activities). Hence, they have broken with the traditions of previous decades, when the French automotive industry was often described

as a “national network” (close to the concept of *filière*), because of government policies and manufacturers’ choices of factory locations and suppliers. It is risky for corporations to limit “exchange of experiences, which is essential to technical mastery and optimization of products and processes” (Veltz, 2017). French automotive suppliers have been even quicker to leave France than automakers. They have set up permanent partnerships with most of the world’s large automakers, a move that has further weakened their ties with the two French OEMs.

Nonetheless, large French automotive corporations are not indifferent to their presence in France. Although they have shifted more and more of their R&D abroad, their core R&D (advanced engineering) is centred in France, a choice that is encouraged by CIR, the government research support programme. Moreover, Renault still employs about 40% of its personnel in France and PSA employs nearly 70% in France (without counting Faurecia and activities other than automotive). These percentages are much higher than the share of the French automotive market in their total sales. Employment is a social relationship that places an individual’s work in a collective and protective framework, the framework of wage earners (Fouquet, 2011). Organized labour fiercely resists current changes in GSCs. Large corporations have turned their attention abroad more and more, but they cannot break completely with compromises that have been negotiated with workers’ representatives, who consider employment within France a priority (Chapter 5).

The question of the national roots of multinational firms and their GSCs is different in Brazil. Embraer is definitely tied to its home country, but the aeronautic industry has a narrow industrial base in Brazil. The situation of the automotive GSC differs in several ways from that of the aeronautic GSC: The automotive industry is a major manufacturer, and it has contributed to creation of a dense network of companies. However, the companies that make up this network occupy subordinate positions in supply chains created in Brazil by foreign corporations.

Employment and labour issues

The aeronautic and automotive industries have different employment dynamics in France and in Brazil. Increases in production in the aeronautic sector and in the automotive supply sector have resulted in job creation in France, but a large share of new production is carried out outside of France, in factories that existed before or were created to satisfy the increase in demand. This is the process we refer to as “exo-localization.” It is the result of decisions made by corporate directors in order to reinforce their worldwide added-value by putting sites in different countries in competition with each other.

In Brazil, wages in the aeronautic and automotive industries are higher than wages in other manufacturing. In both industries, skill levels have risen, especially in aeronautics. At the same time, wages have declined in the automotive industry. In aeronautics, well-educated new hires are put in job slots that normally require a lower level of education. Hence, social upgrading is far from systematic. The social upgrading process could come to a halt in future, given the limited extent of economic upgrading.

In the French automotive industry, even though the great majority of workers employed by large corporations – both automakers and suppliers – have permanent contracts, corporations have hired more and more temporary workers since the crisis, workers who generally have less training than longer-term personnel. This form of internal flexibility has become so widespread that factories are now faced with quality problems that can block vehicles from coming off the assembly lines. This issue was put on the table at the last round of corporate-level collective bargaining at Renault (Chapter 5). It is conceivable that temporary contracts, which are much more widespread than before the crisis, could completely erode what little is left of Fordist standards in automotive production. Since employment trends depend heavily on how current disruptive innovations play out, perhaps profound changes in workers’ status are to come, as profound as those caused by the industrial revolutions of the past. Nonetheless, trends in employment, workers’ status and labour relations also depend, as in the past, on the social arrangements that shape relations between workers, employers and the state, arrangements that are greatly affected by public policy.

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