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Frigant, Vincent and Zumpe, Martin

GREThA, CNRS, UMR 5115, University of Bordeaux

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The persistent heterogeneity of trade patterns: A comparison of four European Automotive Global Production Networks

Vincent FRIGANT [1, 2]

&

Martin ZUMPE [1]

[1] GREThA, CNRS, UMR 5113; University of Bordeaux, Bordeaux, France
[2] GERPISA-International Networks, ENS-Cachan, Cachan, France

Abstract:

In this paper, we examine the structure and the evolution of international exchanges of auto parts over the 2000-2012 period for four European countries. The first part of our study reviews the literature and points out four stylized facts about the geography of automotive supply networks. In section 2 we propose an analysis of the organisation of automotive supply chains based on the *global production networks* framework. We give details about this approach by stating the nature of trade flows that occur in these networks, and by highlighting the importance of intra-firms flows. In the third part, we compare the structure of external GPNs of German, Spanish, British and French automotive firms located in these countries. On the basis of *Chelem* data about auto parts exchanges, we examine in a comparative way the evolution of intra-continental and intercontinental flows. Our results highlight the heterogeneity of situations and of trajectories in the different countries.

Keywords: Global Production Networks; Automotive industry; International Comparison; Auto-parts industry; Regional integration; Globalisation.

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Corresponding author:

Vincent FRIGANT
GREThA UMR CNRS 51113
University of Bordeaux
France
vincent.frigant@u-bordeaux.fr

Introduction[1]

Since the 1990s, intermediate goods exchanges represent an increasing proportion of international goods trade (Feenstra, 1998). This evolution is nowadays widely recognized as being a result of the impressive development of the international fragmentation of production processes (Berger, 2006; Milberg, Winkler, 2013; UNCTAD, 2013; OECD, 2013). This fragmentation finds its roots in four phenomenona: the movement towards vertical disintegration of large industrial firms (and the related outsourcing trend); international labour division set up by these large industrial (and commercial) firms; the transformations of institutional environment (liberalization of trade and finance, etc.); the insertion of new spaces into world trade, starting with China.

However, this vision of global trend towards an increasingly fragmented production may imply some misunderstanding. Indeed, the opportunities of fragmenting production are not similar in all industries and for all technological processes; institutional environments create opportunities/constraints that are more or less incentive; the economic determinants also differ from sector to sector (production costs are only one determinant of the equation). Finally, managers can also have different interpretations of the desirability (or the undesirability) of fragmenting production and/or of choosing one place to locate over another. In brief, despite a lot of studies about fragmentation, several issues remain unanswered; in particular questions related to the quantification of the fragmentation process.

Our paper aims at contributing to a critical literature that puts into question the advent of a general and uniform trend towards fragmentation, underlying the idea of a massive delocalisation movement. Indeed, in the European context, fragmentation is closely related to offshoring and deindustrialisation. Taking the example of the automotive industry, we wish to show that significant structural differences remain (and reproduce through time) when we study the origins of auto parts importations of major European automotive countries.

To demonstrate this, we will compare four similar (in terms of weight – at least at the beginning of our studied period) European countries: Germany, France, United Kingdom and Spain. We will show that the intensity and the origins of their auto parts imports are quite distinct, and that major differences seem to persist over time.

From a theoretical point of view, this study contributes to the Global Production Networks literature (Coe, Dicken, Hess, 2008; Henderson et al., 2002). Indeed, a key lesson drawn from the GPN approach is the diversity of spatial supply networks between firms and *a fortiori* between industries. GPN studies are usually based on monographic empirical methods; interestingly, we find convergent results by means of comparative analysis of macroeconomic data. Our methodology may be less precise than monographic studies, but it contributes to GPNs results in a rather original way.

In this paper, we postulate that the geographical transformation of production networks has been technologically and organisationally caused by changes in the way of manufacturing automobiles. Such changes are driven by technological and organisational innovations that have

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appeared or developed as a result of the strategic actions taken by actors (carmakers and increasingly suppliers) and because of the influence exercised by certain institutions[2]. Against this background, the geography of the automotive industry is in a perpetual state of change. This is challenging for researchers who should formulate convenient theoretical models capable of apprehending the spatial dynamics underlying all of these movements. From this perspective, the paper will be organized as follow. Section 1 reviews the literature about the geography of the automotive value chain, thereby establishing our analytical framework, based on the Global Production Networks theory (Section 2). Section 3 proposes measures of the structure and the 2000-2012 evolution of German, French, British and Spanish auto parts procurement networks based on Chelem data. The last section synthesizes our main propositions and offers suggestions for empirical improvements.

1. Four robust stylised facts from the literature review[3]

In this paper we focus on productive activities and the way linkages between input/output flows enable vehicle assembly operations. Recent applied literature in this area highlights four key points.

1.1. Stylised fact number 1: Resistance of forms of proximity

A first notable fact about the geography of the automotive industry is that ever since the sector's birth, suppliers and manufacturers have clustered together. Despite a number of recurring shocks (Rutherford, Holmes, 2008) and major changes (Klier, McMillen, 2008), the formation/re-formation of clusters has long been a stylised fact. Indeed, the conditions under which automobiles are produced justify the search for a greater or lesser degree of geographic proximity between carmakers and suppliers for three main reasons: delivery conditions; organisational learning; and access to information.

One significant moment in the identification of the need for proximity was the introduction of just-in-time (JIT). The first studies in this area (Estall, 1985) portrayed this as an organisational model based on a singular spatial geography. For instance, Fujita and Hill (1995) have shown that Toyota had a network of suppliers localised around its plants in a radiocentric formation, with Tier 1 suppliers being situated nearby, Tier 2 a little further away and Tier 3 at an even greater distance. Authors have largely described this type of organisation as reflecting the intensity of delivery flows, although they do recognise that Japan's particular geography (lack of room to build and ongoing congestion problems) offers another explanation. Similarly, Linge (1991) used the example of Australia to demonstrate that proximity constraints can be overcome if logistics are organised efficiently. The transfer of JIT to the USA when the Japanese transplants first moved there seems to corroborate this idea of a search for proximity, albeit on a larger scale. In turn, this suggests that the distance between firms - even if this is not a fully deterministic variable - constitutes a parameter that suppliers consider when making their location choices (Hill, 1989; Mair, Florida, Kenney, 1988).

Analysis of JIT's transfer to Europe should enable the identification of another important factor. This is due to the relative dearth of companies moving into this region. One explanation highlights transportation, given the smaller distances between European carmaker plants, and due to logistics providers' growing capabilities, which allows them to manage flows over longer distances (a development reinforced by future generations of 4PL [four-party logistics] firms, c.f Fulconis, Saglietto, Paché, 2007). Lung and Mair (1993) offer a second explanation, namely organisational

[2] The simplest example is the introduction of new safety or environmental legislation causing product modifications. But there have also been changes in labour market rules or, closer to the present article's focus, international trade regulations (local contents requirements, customs tariffs, standardisation of norms, etc.).

[3] This section was initially published in Frigant and Zumpe (2014).

learning. Their idea is that when European manufacturers and suppliers establish a JIT system, they are familiar with its functioning and therefore have a lesser need for proximity. This might explain why the arrival of modular production occurred in the late 1990s, alongside a new wave of co-locations (Lung et al, 1999) that dissipated as learning spread, except for certain kinds of production run out of suppliers parks (Larsson, 2002; Sako, 2005). Of course, suppliers parks were not only meant to resolve transport problems but also had an organisational justification insofar as they enhanced knowledge exchanges between organisations and helped to reduce the risk of opportunism stemming from certain site specificity factors (in Williamson's sense of the term) that the suppliers parks themselves brought into play – if only because the bilateral hostage-taking that they engendered helped to reduce the chance of opportunistic behaviour (Frigant, Lung, 2002).

Another noteworthy element is that clustering makes it possible to benefit from knowledge externalities even as it accelerates and facilitates the capture of information about carmakers' new needs. Thus, despite advances in large global suppliers' means and volumes of communication (which seem to have offered them a certain freedom to move as they saw fit), they continue to try to locate in carmakers' vicinity to better understand their expectations and establish closer relationships with decision-makers (Cabigiosu, Zirpoli Camuffo, 2013). This kind of advantage could also be found with SMEs – indeed, it is what ultimately allowed them to survive by maintaining their productive flexibility and rearranging their collaborative networks in such a way as to adapt to any changes in value chains and/or competition from mega-suppliers (Castelli, Florio, Giunta, 2011; Rutherford, Holmes, 2008; Herrigel, 2004).

All of these studies converge around the idea that geographic proximity is a necessity or an advantage ensuring the coordination of productive actions. The (complex) conditions of automobile production, especially where this is done on a mass basis and following the precepts of lean management, requires certain forms of proximity. At the same time, *the studies continue to assert that not all kinds of production are subject to this proximity imperative*. In this view, technological and/or organisational variability preclude any sense of determinism. They claim there are powerful but *not entirely* determinant centripetal forces.

One empirical objection might be that the observed clusters reflected suppliers' geographic inertia. But for two reasons, this would only be partially true. Firstly, because analysis of the new plants that carmakers build in relatively virgin territories demonstrate that they were still attractive. Carmakers' investments in Eastern Europe led to the development of powerful automotive clusters in countries like the Czech Republic (Pavlinek, Janak, 2007) or Poland (Domanski, Gwosdz, 2009) – even if the older clusters tended to survive (Holl, Pardo, Rama, 2010) despite relocation pressures (Kim, 2005; Lampon, Lago-Penas, 2013; Lampon, Lago-Penas, Gonzalez-Benito, 2014). Secondly, observed changes over time in the different suppliers' factories show that they tended to track carmaker plants' changing geography (Klier, Rubenstein, 2011; Klier, McMillen, 2013).

1.2. Stylised fact number 2: Suppliers' move to low-cost countries

The desire to follow carmakers was not the only factor influencing suppliers' relocation strategies. The auto parts industry also moved *en masse* to low-cost countries situated in zones on the periphery of the traditional big automotive countries.

Mexico was the first major destination to hit the headlines, back in the late 1970s (Carrillo, Contreras, 2007). This process accelerated as the prospect of NAFTA became a reality, coinciding as well with an acceleration in carmakers' outsourcing tendencies. In turn, this justified suppliers' search for new locations, if only because their markets were expanding, forcing them to set up new production units. From the 1970 onwards, a number of German companies were signing cooperation agreements with Eastern European companies, although it was not until the Iron Curtain came down and the prospect of European integration took shape that the process accelerated. By the 2000s, however, Eastern European countries had become major auto parts production centres. Analysis of

output and employment in this sector, and of European countries' sectorial specialisation indexes, reveals the magnitude of the industry's growth in the East and decline in the West (Frigant, Miollan, 2014). Where the rise of the auto parts industry in Mexico was basically driven by greenfield investments, Eastern Europe saw numerous acquisitions of local companies at the beginning of the period in question, creating in turn a certain impression of neo-colonialism (Havas, 2000)[4]. Some of the facilities built in these low-cost countries were meant to supply the new plants that manufacturers had built locally. Having said that, analysis of national trade balances shows that much of their output was meant to be exported back to Western Europe (Frigant, Miollan, 2014) or North America (US Department of Commerce, 2011).

These import/export flows suggest the possibility that what was involved here was the reorganisation of the division of labour on a continental scale. More monographic studies have confirmed this finding, whether for North America (Klier, Rubenstein, 2008 and 2011; Carrillo, 2004); Europe, where Central and Eastern European countries played this role (Pavlinek, Domanski, Guzik, 2009; Jürgens, Krzywdzinski, 2009); the Maghreb and North African countries (Layan, Lung, 2007); and Turkey (Ozatagan, 2011). All of these studies converge in one respect, namely that mega-suppliers became the key drivers of this international production fragmentation process. Certainly, they were moving some of their production segments to low-cost countries.

1.3. Stylised fact number 3: A division of labour driven first and foremost by mega-suppliers – modularisation's winners

Since the 1980s, Western carmakers have engaged in a vertical disintegration process (Lamming, 1993) similar to what their Japanese counterparts had done previously (Cusumano, 1989). There was an acceleration from the late 1990s, however with the advent of modular production (MacDuffie, 2013; Sako, 2003; Veloso, Kumar, 2002). Coupled with carmakers' increasing interest in outsourcing, automobiles' increasingly modular design caused major changes in carmakers' procurement, with a sharp decline in subcontracting accompanied by the growing purchase of more complex modules/subassemblies - themselves resulting from the aggregation of components, the so-called macro-components (Volpato, 2004) - designed, developed and produced by suppliers who were being asked to deliver all of these parts to their carmaker customers' plants. This led in turn to a major consolidation of suppliers, with fewer working with manufacturers directly on a Tier 1 basis – even if several chosen companies did become global oligopolies and began working with most of the world's main carmakers (Frigant, 2011; Frigant, 2009; Klier, Rubenstein, 2008; Sturgeon, Florida, 2001), becoming trailblazers in an era subsequently referred to as "the dawn of the mega-supplier" (Donovan, 1999).

These mega-suppliers were the key drivers behind the new international division of labour, organised on a continental scale. There were three reasons for this.

- ✓ Firstly, they had to develop their productive apparatus and technological competencies in a severely competitive context, causing them in turn to opt for mergers and acquisitions. Each acquisition led to their integrating a number of units that would then have to be rationalised both in terms of their productive function within the business's general organisation and also as regards their location. This translated into many plants being closed, opened and re-qualified. As an example, between 2001 and 2006, the French mega-supplier Valeo closed 59 plants, opened 29, sold 26 sites and acquired 13 others.
- ✓ Secondly, even in the absence of any major acquisitions, mega-suppliers had to restructure their own value chains. For a long time, being a supplier meant delivering simple components to a few

[4] A process found in several countries like India or Brazil (Humphrey, 2000; Humphrey, Salerno, 2000) where Western suppliers who had been forced to follow their carmaker customers ended up partially destroying the local suppliers.

special carmakers running operations in just a few countries. Henceforth they would have to organise long value chains making complex parts based on their mobilisation of many external suppliers but also in-house units. This production was aimed at a growing number of carmaker customers worldwide, who were themselves running a growing number of assembly plants. The carmakers would then organise the different models' production along continental lines (Freyssenet, Lung, 2000; Carrillo et al., 2004), the end result being that the mega-suppliers would generally organise their productive geography on a basis similar to the carmakers, i.e. continentally.

- ✓ Thirdly, the market was not sufficiently concentrated for mega-suppliers to be particularly strong in market power terms. Temporarily at least, and for most of their models, the carmakers were able to maintain their domination using avoidance strategies (exclusivity contracts when there is introduction of new technology, rotating suppliers from one model to another, maintaining in-house supply subsidiaries, etc.). They try to escape to an Intel Inside syndrome, and they succeed in because mega-suppliers' profitability remains fairly weak due to strong downwards pressure on prices (Jacobides, MacDuffie, Tae, 2012; Frigant, 2009). To restore their margins, one of the strategies they adopted was to move to low-cost countries.

From the late 1990s onwards, Sadler (1998; 1999) started writing about the connection between all of these different movements. In this view, the rise of outsourcing, which mainly benefited a particular category of suppliers (so-called mega-suppliers) and happened in a context defined by European integration, culminated in a hollowing out process characterised by massive relocations from Western to Eastern Europe. Things more or less took place as expected, although the spatial reality seems somewhat more complex insofar as proximity needs actually did help to maintain a number of large clusters in the West (the same scenario appeared in the USA and Canada) - if only because certain processes that began to emerge in local institutional contexts revived some spaces' dynamism (Rutherford, Holmes, 2008; Herrigel, 2010). This latter movement was often led by SMEs.

1.4. Stylised fact number 4: SMEs still active up and down the supply chains

The dawn of mega-suppliers does not capture the entirety of the story. SMEs continued to play a major role in the value chains, sometimes even operating at the top of the supply pyramid. Herrigel (2004) was sceptical about the extent to which the rise of modular production would transform cars into a game of Lego where "big" suppliers would be the only parties producing "big components" assembled in manufacturers' assembly plants. Although mega-suppliers dominate the top of the supply pyramids, many SMEs are still working as Tier 1 suppliers. In a study covering a sample of 696 French SMEs, Frigant (2011) demonstrated that although 30.4% operated exclusively in Tier 2 and 14% in Tier 3, 12.9% said that they were working in Tier 1. Furthermore, 12.5% were operating in tiers 1 and 2 simultaneously, and 4.3% in tiers 1, 2 and 3. The supply pyramid was less static than is often described (strict separation between tiers). Nor was the summit as closed to SMEs as some observers inferred.

This is because the automobile is not a perfectly modular product (Sako, 2003; MacDuffie, 2013). Carmakers still need to purchase simple parts, call upon subcontractors, organise maintenance operations, turn to engineering SMEs, etc. In addition, mega-suppliers sometimes refuse to follow carmakers overseas when they feel that the profit opportunities are insufficient and/or when the cars need local adaptations to satisfy consumers' national preferences. The end result is that some auto parts have had to be redesigned and built for a single factory. In both of these cases, carmakers have had to find local suppliers replacing the mega-suppliers. This has not necessarily involved "exotic" factories built in very distant countries, one example being Dacia's Romanian factory, whose supply networks ranged from local businesses (Romanian SMEs) to the whole of Europe and other international mega-suppliers (Jullien, Lung, Midler, 2013).

Outside of Tier 1, SMEs obviously maintained a major presence up and down the supply chain. Mega-suppliers relied on a large number of SMEs to carry out their activities. What is worth emphasizing at this level is the discovery revealed in several studies, namely SMEs' internationalisation, which tended to go down two routes. On one hand, some SMEs started creating their own productive units in low-cost countries and/or in automotive clusters because they wanted to get closer to their customers (carmakers or big or small suppliers). A study carried out in France showed, for instance, the 14% of French SMEs working in the automotive sector had overseas subsidiaries for the following purposes: 1) low production costs, 2) access to the local market, 3) customer demand (OSEO, 2011). In addition, SMEs would also export some of their output. In the same study, 40.9% of SME respondents stated that they were involved in export activities, with 24.3% saying that exports accounted for more than 10% of their revenues (OSEO, 2011). Although there is probably a European specificity at this level (compared to North America and Asia) in the sense that the European automotive industry is more geographically and economically integrated (if only because of the single currency), these figures demonstrate that the internationalisation of SMEs working in the automotive sector is a factor to be reckoned with (for an Italian example, see Castelli, Florio, Giunta, 2011; Bacchiocchi, Florio, Giunta, 2014).

These studies have the merit of showing that SMEs' local automotive productive systems have not disappeared. They also suggest that, methodologically speaking, analysis of the international trade in auto parts can help to enhance understanding of production networks' changing geography.

2. An interpretive framework rooted in Global Production Networks theory

The four aforementioned stylised facts are areas where authors converged. The question then becomes how they are interlinked and what kinds of logic they respond to. To answer these questions, an analytical representation of buyers/suppliers' relationships in space is necessary.

2.1. Why stylised facts support a GPN framework

In recent years, conceptualisation of interfirm relationships in space (and in relation to space) have been profoundly renewed through so-called Global Commodity Chains/Global Value Chains approaches (Gereffi, Korzeniewicz, 1994; Gereffi, Sturgeon, Humphrey, 2005) and Global Production Networks approaches (Coe and al, 2004; Coe et al, 2008; Henderson et al, 2002) that tried to break with the centre/periphery vision. The general idea is to reconstruct firms' supply networks via two methodological principles:

1) A reticular conception of interfirm relationships. Firms are apprehended here as functional nodes that are interconnected for economic reasons (exchange relationships). Hence the need to study the spatial structure of these interconnections, which are simultaneously local and international.
2) The firms' network must be studied in light of a particular product/service. This is something of a reverse approach where one starts with the final product and reconstitutes the supply network to determine its functional logic and historic trajectory (the latter point being the crux of GPN analyses).

However, significant analytical differences remain between GVC and GPN (Bair, 2008; Coe et al 2008). Given the aforementioned stylised facts and other elements developed below, there are three kinds of reasons to model the automotive industry's geography using a GPN framework.

GVC studies try to categorise typical governance forms implemented by anchor firms whose spatial embeddedness needs to be characterised. In terms of the aforementioned stylised facts, however, this approach raises two problems. In their desire to develop a useful typology demonstrating the coexistence of several kinds of value chains, the corpus adopts a static approach neglecting the depth and variety of chains *within one and the same sector*. In relation to this latter

point, empirical work carried out by Sturgeon et al (2008) has recognised that automobiles can lend themselves to several forms of governance (including relational and captive). Having said that, detailed empirical studies have shown that the whole five types of governance can be observed in the auto sector, and even for one and the same carmaker. Carmakers can purchase several types of service from distinct actors (electronic components bought off-the-shelf; modules co-designed and co-produced with mega-suppliers; SME subcontracting arrangements, etc.). This variety problem comes with a depth problem in the sense that Tier 1 might feature one form of governance with other forms being present in other tiers. One example might be a relational form of governance applied for the purchase of a cockpit made by mega-suppliers calling upon subcontractor SMEs working under captive governance conditions. This dual problem is further complicated when we analyse networks not in terms of the final producer (carmaker) but at some intermediary point: a supplier can adopt one form of governance when relating to one carmaker but another form for another one.

These problems are easier to apprehend using the GPN approach that, more pragmatically, considers the need to specify bilateral relationships according to the activities actually being conducted. This particularly applies (especially further down pyramids that are necessarily unstable and changing, see stylised fact number 4) to firms working with several customers in several sectors (e.g. automobile but also aircraft). Spatially, this is an important point since it also assumes the need to build networks compatible with different customers' requirements. Another crucial point is if the goods being delivered are subject to significant economies of scale and delivery time constraints (stylised fact number 1). Clearly, carmakers exercise a certain attraction but cannot be considered flagship firms given that suppliers belong to several value chains – a diversity of membership better apprehended using GPN's more holistic approach (Ernst, Kim, 2002).

Another key aspect of GPN is the institutional dimension of inter-firm relationships, especially the importance of multi-dimensional embeddedness processes (Henderson et al, 2002[5]). In the automotive business, these issues affect two levels: macro-economic; and local.

In terms of the former, studies of the transfer of productive automotive models (Boyer, Freyssenet, 2002) have shown that from one institutional space to another, firms have had to adapt to national regulations, norms and practices (Boyer et al, 1998), i.e. it is a myth to say that there is some kind of transnational or stateless organisational model that is dominant in all institutional contexts (Freyssenet et al 1998). Clearly, there is a question here whether regional integration processes, specifically in Europe where they are very advanced, might have glossed over some of these national specificities. Recent studies show that European automotive sector public policy is basically incomplete because firms remain embedded in their national settings and because nation-states still try to define supranational regulatory frameworks reflecting domestic manufacturers' interests (Jullien, Pardi, Ramirez, 2014). As noted by Lagendijk (1997: 14) "On the socio-political front, the attachment of carmakers to their home country is still a pervasive factor that seems to fetter the transition to a European production system". National sites are closed less frequently than sites located in other European countries. It is also harder for carmaker to abandon a failing domestic supplier (especially when the case has been widely publicised) and easier to abandon a foreign supplier.

From another point of view, the European Union has also helped to transform automotive GPN by subsidising carmakers' new investments in Eastern Europe (and co-funding mass redundancy programmes in the West). By doing so, it helps to encourage an exploitation of institutional differences between EU member-states, despite the fact that the European customs union (and

[5] We know this is a terrible simplification but there is no room here for real discussion. To deepen understanding of the relationship between GPN, institutional concepts and forms of embeddedness, see Bair (2008) and Hess (2004).

monetary union for nowadays 18 member-states) has created a unified commercial space. National differences in production coincide here with a single market. The two ingredients are exactly what is needed to create an international division of labour on a continental scale. The effects are not equally distributed throughout Europe, however, since a modicum of local embeddedness still exists.

The GPN approach clearly argues in favour of including findings from regional science studies (Coe et al, 2004). The approach's relational perspective highlights the effects of territorialisation (Dicken, Malmberg, 2001). Reflecting the degree of political decentralisation, the interactions of local actors (firms or institutional bodies) or their territorial embeddedness (Hess, 2004), productive resources are being developed and reproduced in many ways. Where stylised fact number 4 evokes SMEs' strategic responses, it is worth noting that these are based on a mobilisation of interfirm networks (territorialised or not) and on the mobilisation of local institutional infrastructures, whose density explains local strategies' effectiveness (Amin Thrift, 1993; Bailey et al, 2010). Automotive cluster case studies have all found similar phenomena to varying degrees (Herrigel, 2004; Rutherford, Holmes, 2008; Whitford, Enrietti, 2005). Even multinationals mobilise (and transform) local resources (Dicken, Forsberg, Malmberg, 1994), as demonstrated by the mega-supplier Delphi in Mexico (Carillo, 2004) or complexes built by (or organised) around carmaker plants in other places.

Another aspect is the power games that parties play when developing such networks. One consequence of the automobile's modularisation is the complication of market power. Succinctly, during the pre-modular era, relations between carmakers and suppliers corresponded to a Fordian model of descending domination, in both functional and decisional terms, i.e. it was a schema where carmakers dominated suppliers and subcontractors both technologically and economically (Chanaron, 1995). Although national models could be distinguished (Sako, Helper, 1995), power remained asymmetrically distributed, benefiting carmakers who became the real focal points for product definition, and around whom there was a convergence of products coming from suppliers who remained largely dependent on historic carmaker customers. With the rise of modularisation, mega-suppliers partially freed themselves from this dual dependency, since they now had the key technologies that carmakers no longer controlled, or at least not sufficiently (Morris, Donnelly, 2006). Monopolistic competition tightened around several module series (Sutherland, 2005). The ensuing internationalisation broadened their customer portfolios. The end result was that depending on a carmaker's size and growth or decline trajectory (i.e., Hyundai vs. Fiat); depending on the potential market for a particular vehicle model (i.e. niche versus mass); and depending on the size and location of factories requiring supplies (i.e. a plant making 400,000 vehicles annually located at the heart of Europe versus another calibrated for 100,000 vehicles located in a country where the carmaker was the only operator) - the ability of a given carmaker to negotiate with mega-suppliers could be quite variable. This relativity in the balance of power between carmakers and mega-suppliers determined how value creation, and enhancement broke down between firms (Henderson et al, 2002). It also influenced the spatial organisation of interfirm networks.

2.2. A heuristic mapping of the European automotive production networks industry

The GPN framework is useful because it helps to apprehend the many different dimensions of interfirm networks (material but also immaterial, like power and information). It does this by reasoning on several levels, ranging from the local to the global (cf. Figure 1, in Coe et al, 2008). Although we feel that this duality (multi-level and material/immaterial) is essential and should be used to hypothesize and explain changes in international trade, the organisation of supply networks is so complex that we have come up with a simplified framework that only incorporates material input/output flows. The aim is to have a heuristic framework in order to understand which kind a flows we measure with imports data. As such, it neglects immaterial flows as well as dimensions that do not directly relate to trade (mainly institutional) but also, amongst material flows, suppliers of

capital goods or services companies specialising in areas such as engineering, maintenance or logistics.

This choice can be justified by the need to increase the complexity of the representations habitually found in literature in both of these areas. Authors studying the automotive industry from a GPN/GVC perspective focus rarely on the differences between intra- and interfirms flows (for a counterexample see Coe et al, 2008, p.7-8). They also tend to neglect the depth of the supply pyramid. Thus, in a first paragraph, we wish to explain how the auto supply chains should be described nowadays, in this period of modular paradigm. Two following paragraphs will translate this organizational description in space.

2.2.1. The organization of supply chains in the modular era

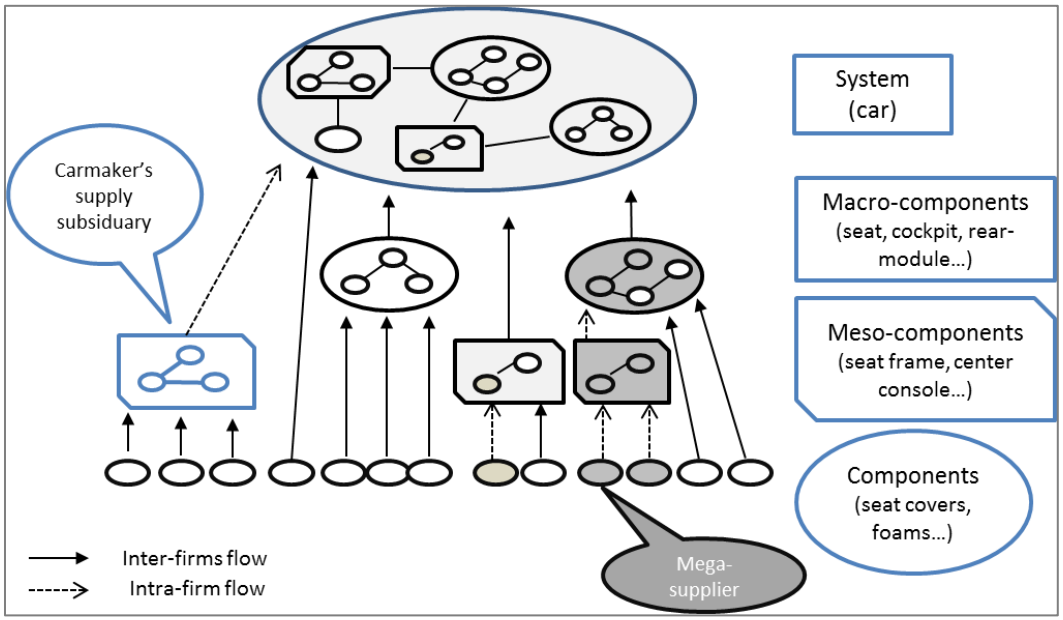
The modularity issue is one of the key subjects in the auto industry since the end of the nineties (Lewis, Wright, 1999; McAlinden, Smith, Swiecki, 1999). Analytically, the best way to examine this issue is to mobilise the notion of product architecture, where the final product (the system) is viewed as an interconnected hierarchy of different sub-systems (Murman, Frenken, 2006). Despite certain characteristics, automobiles are imperfectly modular (MacDuffie, 2013; Sako, 2003) yet automotive engineers still try to modularise them (Cabigiosu and al, 2013) with the help of mega-suppliers. A linear and sequential view would describe the automotive value chain schematically as a pyramid interlinking three levels of parts, with the assembly plant located at the top of this pyramid. Carmakers make use of 1) macro-components, which accounts for most of their procurement; 2) meso-components[6] when, for strategic reasons (like engines) or because they have no choice (i.e. local contents requirement) they maintain a high degree of vertical integration; and 3) components. The different levels then purchase meso-components and components from another, as illustrated in Graph 1.

After this technical breakdown of the production process, the next question relates to its organisational materialisation (Colfer, Baldwin, 2010; Campagnolo, Camuffo, 2010). Modularisation has forced mega-suppliers to increase their vertical integration (Klier, Rubenstein, 2008; Frigant, 2009). If their goal is to design, produce and sell macro-components, this means that they are already making many of their macro-components' constituent parts. In addition, in their bid to generate economies of scale, they tend to build units specialising in the production of meso-composants. Elementary parts, which we call components here, are either manufactured in-house or purchased from subcontractors. This generates two types of flows (respectively, intra-firm and inter-firm). Lastly, despite the vertical disintegration trend, carmakers are still responsible for making some of their key meso-components, like engines, gearboxes, etc. Graph 1 expresses this as intra-firm flows. One particularity of these kinds of production is that they are often at a distance from assembly plants. Hence the need to transpose this model along spatial lines.

Graph 2 offers a representation of automotive production networks in space. In line with lessons drawn from GPN research, it highlights supply networks' multi-level spatial interconnectedness, starting with the local and going towards the global. The next paragraph focuses on the left-hand side of the graph. The right-hand side is dealt with in the paragraph below.

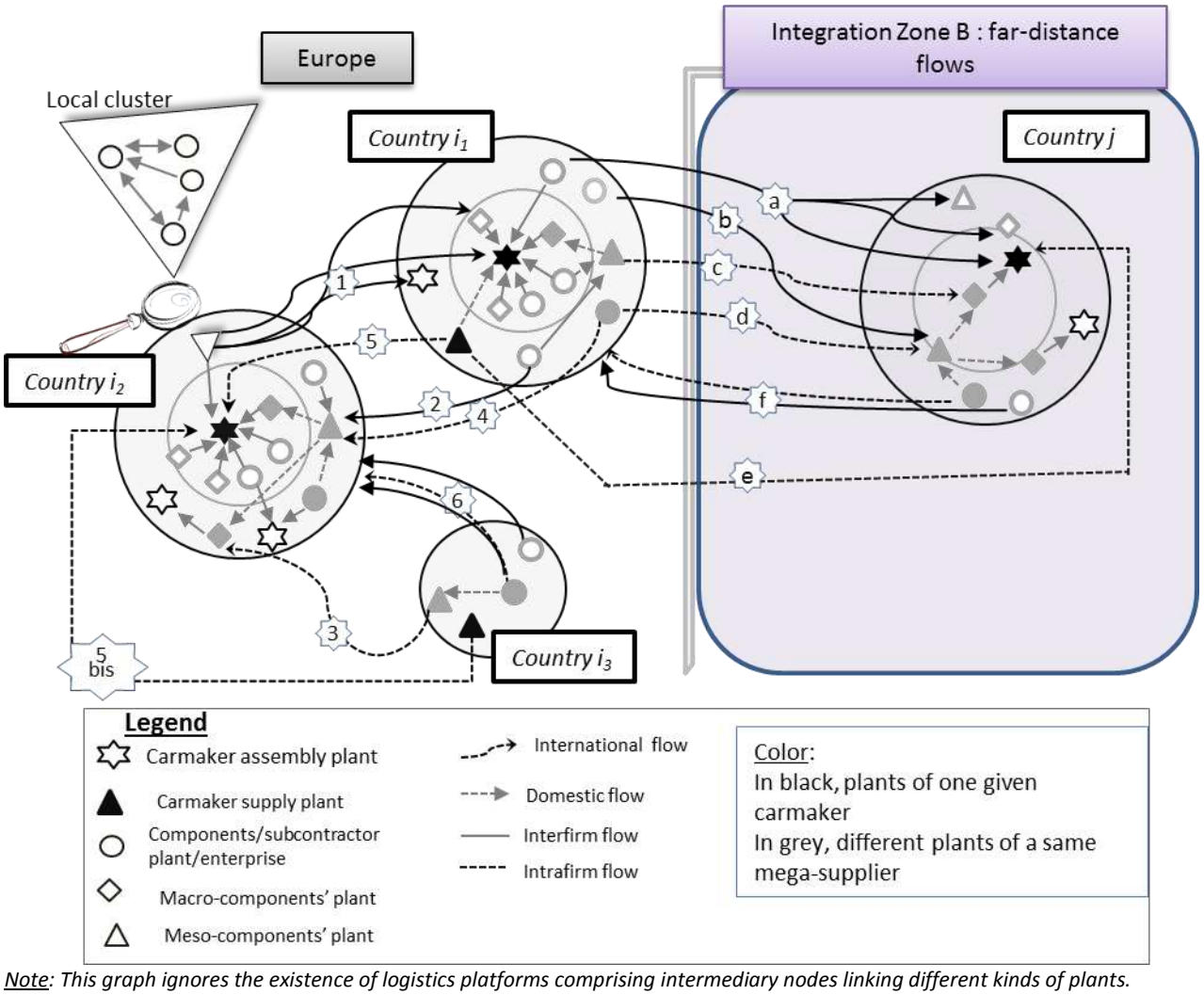
[6] Meso-components are kinds of platforms on which macro-components can be built. The goal is to create economies of scale since each macro-component is specific to particular carmaker and usually a specific model. Another kind of meso-component is huge mechanical equipment like engines or transmissions which can be delivered to different car models (See Frigant, Layan, 2009 for more details).

Graph 1. Translating the concept of modularity to the automotive industry



Source: authors

Graph 2. Schematic representation of the European automotive production networks



Note: This graph ignores the existence of logistics platforms comprising intermediary nodes linking different kinds of plants.
Source: authors

2.2.2. Intra-European flows of auto parts

On the left side of the Graph 2 (Europe), we consider two types of countries. Country i_1 and i_2 are typically historical core countries of the European Automotive system (let's say Germany and France) with high-wages. Country i_3 is a low cost country (we suppose here without car assembly plant in order to simplify the schema).

Starting with **interfirm flows** (bold font in Graph 2), a first major interconnection node can be found amongst those clusters that last over time and are regenerated in time and space, as indicated in the first stylised fact and confirmed by automotive studies formulated in GVC (Sturgeon et al, 2008) and GPN (Coe et al, 2004) terms. Supplier clusters tend to found on a narrow perimeter surrounding automakers' plants, whether units belonging to mega-suppliers or SMEs.

The second level is national, characterised by very dense connections with one particular point, namely the fact that the spaces in question can feature a dense fabric of suppliers without being located in a carmaker's immediate vicinity (see the 'local cluster' box in Graph 2). This can be witnessed, for instance, in Southeast France where automotive suppliers constitute a territorialised productive system from where they supply plants that can be quite far away. In these clusters (and similar to the clusters found around carmakers' factories), supplier relationships are dense and not necessarily linear. Depending on which customers a company wants to deliver, it can either act as an order-giver or as a subcontractor, even collaborating on specific projects while competing on others (Chanarron, 2013). Such companies are not even necessarily working only in the automotive sector, and certainly not just for one manufacturer. Some of them - potentially SMEs (stylised fact number 4) – are export-oriented and deliver their output either to mega-suppliers (when they operate in tiers 2 or 3) or directly to carmakers (when they operate in Tier 1). These exports are the flows between countries i_1 and i_2 seen in Graph 2 (arrows 1 & 2), which is relatively sparse to show that local and national trade densities are greater. Indeed, it is more through this kind intrafirm trade and large companies' organisation of an internal international division of labour that import/export flows can be forged.

Two kinds of intrafirm flows featured on this graph.

The first are internal to carmakers (arrow 5). This is because assembly plants are not the only productive units they possess. Most still have plants they use to produce mechanical assemblies (transmission, clutch, etc.) and/or driving systems (mainly engines). They will, however, run relatively few of these units, if only because they are trying to achieve economies of scale. Historically, these meso-component factories were located in carmakers' countries of origin and used to supply some of their other plants (Bordenave, Lung, 1996). The regional integration process means, however, that some carmakers built new meso-component plants in low-cost countries (arrow 5.bis). Examples include Volkswagen and Opel, both of whom built major engine factories in Hungary, or else Daimler in Romania. Output from these factories was distributed macro-regionally to carmakers' different assembly plants.

The second are related to mega-suppliers. Stylised fact number 2 showed that they were at the heart of the international production fragmentation process. According to Frigant and Layan (2009), suppliers' dominance strategy has mainly consisted of fragmenting their production into three main kinds of plants corresponding to the breakdown shown in Graph 1.

i. Plants or workshops dedicated to the final assembly of macro-components. Such units labour under lean management constraints. Their output is also hard to transport, meaning that they are very much influenced by proximity constraints. Typically, they are found in supplier parks (Larsson, 2002; Sako, 2005) or in the immediate vicinity thereof.

ii. The second category of units produce meso-components. The strategic goal here is to isolate this kind of production in dedicated units in order to maximise economies of scale. Such plants tend to be few and far between and are ideally located at the centre of the different macro-component

plants that they are supposed to be supplying - even if mega-suppliers' historic locations turn this optimisation model into something of a theoretical ideal.

iii. The third type of units involves plants manufacturing components that can be used either to make meso- or macro-components, or else components to be delivered directly to a carmaker. In spatial terms, these units are the most footless. They are less subject to proximity constraints since they operate at a more upstream part of the value chain. They are also less subject to JIT constraints, their output is easier to transport and their flows can therefore be regulated via logistics platforms (something not illustrated on Graph 2). The need for interactions between users/producers is less intense here, meaning that they have no great need of working in proximity to suppliers or carmakers' R&D centres (Frigant, Layan, 2009).

Under these hypotheses, we can identify their typical locations and flows. We represent the flows discussed under items *i.* and *ii.* by arrows 4 and 6 in order to introduce a distinction between two similar countries (i_1 and i_2) on the one hand, and countries with significant different production costs (i_3 vs. i_1 and i_2) on the other hand. Indeed, arrow 4 illustrates the case of a mega-supplier who keeps a component plant in its domestic country (we suppose here with high production costs) and who supplies its meso-components plants from this unit (because of high sunk costs, efficient productivity levels, specific employee skills, etc.). Arrow 6 illustrates a delocalization strategy: the mega-supplier creates a greenfield plant in the low cost country i_3, in order to supply its own units, or carmaker plants or spare parts markets. Another way of implementing such an international division of labour is to create a meso-component plant in country i_3, even if, for reasons of scale economies, this solution is less frequent (arrow 3). Arrow 6 captures also international subcontracting strategies designed to reduce costs: carmakers, mega-suppliers, other smallest suppliers and spare parts distributors purchase components from indigenous producers of components.

GPN approaches also intimate a need to look at connectivity. Because of their degree of centrality (characterised by the number of connections they have and by the number of different actors with whom they are connected), some firms play key role in building up an overall network structure and in developing its specific projections. Two kinds of firms can be isolated here.

Clearly, carmakers are central to the equation since, quantitatively, the greatest number of flows converges around them. They also have connections to the largest number of suppliers. But the point we want to make here is actually a different one, highlighting carmakers' power to replicate supply networks in different countries. The reason is because their purchasing practices tend to promote follow sourcing. They encourage mega-suppliers (mainly) to duplicate their productive apparatus in countries where they have established operations. On our scheme, this can be seen in the formal duplication of networks centring around the carmaker's two plants (portrayed in bold font) in countries i_1 and i_2. This was perfectly true when similar models were manufactured in several plants on a continental scale. It is a kind of strategy that has tended to disappear to be replaced by the idea of having a single production site for each model. But, on the contrary, the advent of modular platforms, with the same types of modules or parts being used for several models, implies that these modules/parts need to be delivered to several plants. This particularity is one of the key points explaining the rise of intercontinental flows of automotive parts.

Mega-suppliers have also been characterised by a strong degree of centrality, something first witnessed at the intra-firm level since they tended to own a very large number of units (cf. Frigant, 2009). This comes from the fragmentation strategies that they pursued; their merger/acquisition-based development trajectory, meaning that they inherited numerous sites; and their response to follow sourcing. They managed a major volume of intra-firm flows that were largely organised on a continental basis, replicating carmakers' regional integration logic (stylised fact number 3). In addition, these mega-suppliers called upon external suppliers themselves and, like carmakers, tried to continue working with their customary suppliers on all of their different sites. Sometimes Tier 2 or 3 suppliers would accompany them overseas but more often, the connection would be maintained

via exports. This was especially the case when the goal was to conquer exotic and very distant markets situated on other continents.

2.2.3. Extra-European flows of auto parts

In the automotive industry, intercontinental exchanges take a rather special form. With respect to strategy issues, firms consider themselves as global players, but from a commercial and productive point of view, they are stilled organized according to the so-called multi-multiregional scheme (Bélis-Bergouignan, Bordenave, Lung, 2000). The commercial space is most relevantly defined at the level of regional integration areas: inside an area, sold cars are relatively homogeneous, but cars sold in different continents are quite heterogeneous. There are of course similar products sold over all continents, but this is only the case of products belonging to small market segments (for each continent). There are also lots of seemingly similar car models that are in reality closely tailored to local preferences, standards and use constraints.[7] This state of affairs largely explains why carmakers have sharpened their production facilities according to the continental scheme just mentioned. Another explanation is that car exportations over long distances are expensive because of the risk of materiel damage. For these raisons, macro-regional integration is dominant in the automotive industry (Carrillo, Lung, van Tulder, 2004; Freyssenet, Lung, 2000). With this in mind, we consider that auto parts exchanges « spontaneously » tend towards some macro-regional organization scheme. The existence of intercontinental trade flows is thus the result of a real effort in terms of strategy, based on 1) the exploitation of competitive advantages; 2) adaptation to institutional opportunities and constraints; 3) the nature of inter-firm relations.

The right-hand side of graph 2 illustrates the main flows that we have to explain. For better understanding, please note that the arrows *a* to *f* are more or less similar to arrows *1* to *6 ,* but we need to specify the originality of their origin in an intercontinental context.

Arrow *a* represents inter-firm flows which result from the specific nature of the production of the component manufactured by the supplier: of-the-shelf purchasing, production by suppliers which are not directly affiliated to the automotive value chain. This is e.g. the case for some electronic components: they are manufactured in factories characterized by high fixed costs and huge economies of scale, and they are not very exposed to logistical constraints[8]. The double disaster of Fukushima and major floods in Thailand have highlighted in a dramatic way that carmakers and suppliers make use of such kinds of components delivered to destinations all over the world.

A second scenario is that of far-distance exchanges that result from anchoring in specific areas: either productions rely on particular know-how and/or on important knowledge externalities, indicating some kind of territorial effect; or they are anchored by resource scarcity. Anchorages may be artificially created by means of exportation restrictions applied in the host country. China for example set up measures in order to restrict rare-earth exports, so that companies that make use of this resource have to establish themselves in China, and then export the processed products (Canis, Morrisson, 2013).

Arrow *b* reflects a mega-supplier driven strategy of international following without setting up of production facilities in the host country. This strategy namely applies to simple elements that are weakly affected by transportation constraints (i.e. they are easy to transport and characterized by low exposure to flow tensions). There are several reasons that may push carmakers to maintain their traditional rank 2 supplier: reduction of transaction costs (search for alternative suppliers); financial advantages linked to supplier-based economies of scale; reliability and high quality production of the

[7] Due to the frequent recourse to drivers, cars sold in China are lengthened in order to provide added legroom to the back seats, dashboard needs to be very smooth, etc. ; heating systems are removed in India ; cars sold in Brazil are characterized by reinforced suspensions and high ground clearances (because of the bad state of the roads).

[8] OTM (2012) created the term « Tier 8 supplier» for those invisible, but crucial, suppliers.

traditional suppliers. These suppliers are typically much smaller and thus incapable of setting-up abroad production facilities; as long as there are no restrictions to exports, intercontinental exports are the most convenient solution, at least at the beginning, i.e. when the market size has not yet reached the point where local production facilities become profitable.

Flows c and d correspond to a rationale very close to that of intra-firms flows of mega-suppliers. Depending on eventual trade barriers and on the degree of implication of the mega-supplier in zone B, there are two distinct configurations. In both of them, the mega-supplier follows his customer (i.e. the carmaker) and sets up a factory where takes place final assembly of macro-components. However, this production facility may be provided with meso-components in two different ways. The first scenario is that of a customer-carmaker's assembly plant with a low production level, and which is isolated in country j: in this case, the mega-supplier provides its macro-components factory with meso-components produced in country i_1 (arrow c). In the second scenario, the factory of the customer-carmaker is of large size and/or there is another customer-client localized in country j; this is precisely the moment where a process of duplication of the production facilities begins: the factories producing macro-components are now supplied by a meso-components' factory localized in country j, and only some other components are imported from country i_1 (arrow d). In case of sufficient market size and favourable local conditions (skilled work force, respect of intellectual property rights), the mega-supplier may set up a factory in country j that produces almost all necessary components (grey circle starting from arrow f).

Carmakers choose a similar strategy of production facilities duplication. Initially, the factory localized in country j is provided with meso-components which are typically produced in the carmaker's origin country (**arrow e**[9]). In some cases, namely when the targeted market is too small, the assembly plant is only in charge of Complete Knock Down (henceforth: CKD) or Semi-Knock Down (SMD), inducing thus high-valued trade flows (*cf.* the case studies of BMW in Coe et al., 2004, and Dacia in Jullien et al., 2013). This type of flows may last over time when the market remains on low levels; in case of growth of the targeted market (as in China), the best established carmakers join meso-components factories to their assembly plants, implying the decrease of the intercontinental flows in question.

The last kind of trade flows (**arrows f**) reflects a rationale clearly different from the preceding ones, which all rely on the idea of an international extension of the production networks established in the zone of origin of the carmaker/supplier. We now have to illustrate offshoring for reasons of costs compression (consider now that country j is like country i_3 in Europe, but far-away; let's say, China and Romania for instance). In order to highlight the distinctive nature of these flows, we reversed the direction of the arrows (arrow directions are of course unimportant in this schematic representation). We can identify two configurations.

- ✓ The first one concerns inter-firms relationships and corresponds to a situation where components are produced by a supplier localized in country j (subcontracting relationship).
- ✓ The second configuration concerns intra-firm relationships and reflects a rationale of international production fragmentation organized by a mega-supplier. The represented example is the following: a mega-supplier has set up a factory destined to provide a local production facility with meso-components, and it reimports towards country i_1 a part of the production of this factory[10].

[9] Just one example: more than 70% of the Peugeot Citroen's automatic transmissions (model AL4) produced in France (Valenciennes) are exported to Peugeot's Chinese plants.

[10] It is not by accident that we pay attention to this scenario: in the last few years, several mega-suppliers have increased their production capacities in China in order to supply their local plants. However, when the 2008/2009 crisis seriously affected North America and Europe, some of their factories localized in these latter areas moved beyond the plant-closing threshold and were shut down; the mega-suppliers in question rely nowadays on their local factories (typically localized in China) in order to supply the production in their countries of origin (OTM, 2012).

In our scheme, these flows are not associated to a specific arrival point in country i_1 (like country i_3). They are indeed likely to provide either component suppliers, or mega-supplier production facilities for components or meso-components, or carmaker's factories. They also may provide spare parts for the aftermarket. We have indeed to account for the fact that cars are durable goods; estimations of the proportion of auto parts destined to the aftermarket range from one quarter to one third. The associated trade flows go to auto parts stores and independent service outlets.

Graph 2 provides a description of the main flows characterizing the automotive European Global Production Networks, be they intrafirm or interfirms flows, domestic or international ones. But how important are these flows? As Sturgeon and Gereffi (2009) wrote, the GVC/GPN approaches are powerful to characterize value chains thanks to monographic studies, but it is difficult to propose a general measure of flows (at an industry level). In this perspective, our aim is to propose a quantitative evaluation of certain of those flows. Using data about auto parts imports, we can propose an evaluation of the structure of the international procurement behaviour of automotive firms located in a given country. Obviously, these data can tell only a part of the story about the formation of the GPN[11] , but an interesting one: the pattern of international procurement strategy of domestic firms. We can take a snapshot of the (double) six arrows discussed in the above typology thanks to these data. Here is the first objective of our empirical study with an underlying issue: can we observe similar procurement strategies from automotive firms located in Germany, France, Spain and the United-Kingdom?

A related issue is about the evolution of this network. Without any doubt, the (double) six arrows have experienced profound transformations in the first decade of the 21th century, a decade marked by increased outsourcing in a context of growing modularization, by the emergence of mega-suppliers, by trade liberalization and a trend towards standards' harmonization, and by the integration of emergent countries into international trade, namely the emergence of a continent-country like China; at the same time, variability in exchange rates, as well as differentials in production costs and in national and territorial institutional specificities remained wide, inducing a consolidation of the differentiation of places. On the other side, since 2000, the integration process in Europe has known acceleration with the fall of the Iron Curtain, the economic integration of eastern countries to the UE, the Euro creation, the building of modern transport infrastructures, etc. Does this integration process boost an Europeanisation of the GPN? Or, on the contrary, are the previous centrifugal forces more powerful? Here is the second objective of the paper: how have intercontinental (vs intracontinental) auto parts flows evolved?

3. European auto parts importations patterns: an empirical investigation

A modern car comprises more or less 10,000 elementary parts, so it is quasi impossible to map all the global production networks. But a frequently neglected source of information is exports/imports parts. If these data do not enable us to describe precisely the network(s), they allow to catch the general trend and to answer to our research questions:

i. Which are the auto parts importation patterns of the leading European car-producing countries? To which degree are they relying on "far-distance" auto parts importations?

ii. Is there one general European importation pattern, or can we identify country-specific patterns?

[11] Clearly, the domestic flows cannot be identify with this methodology. Moreover, as we explain in conclusion, we will consider only some auto-parts in this paper.

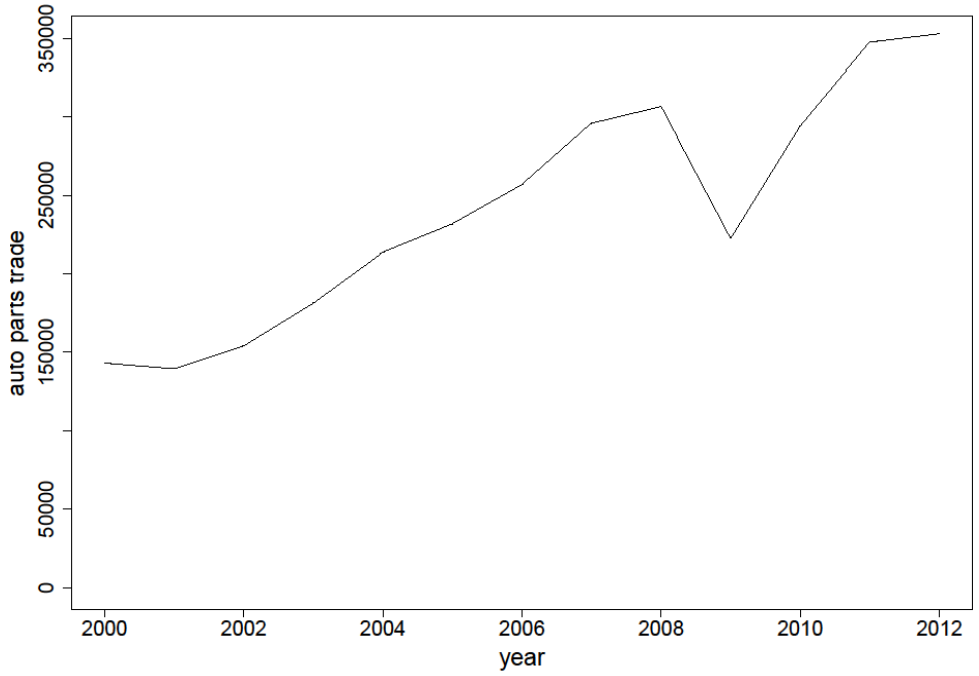
iii. Are the auto parts importation patterns of the leading European car-producing countries stables over time, or have there been changes over the 2000 – 2012 period?

Note that when we use in questions *i.* to *iii.* the term « importation patterns », we are especially interested in the respective proportions of « far-distance » and « near-distance importations ».

3.1. The worldwide context

Figure 1 shows that during the 2000s, importations of auto parts grew sharply. At the same time, the 2008/2009 crisis is clearly visible since the worldwide exchanges dropped dramatically in 2009. Since this year, the auto parts importations knew a new growth and joined the previous trend.

Figure 1. Evolution of worldwide international auto parts importations (in million US Dollars) from 2000 to 2012.



Source: authors from Chelem database

3.1.1. "Far-distance" and "near-distance" importations

In a companion paper (Frigant, Zumpe, 2014), we decomposed the international trade figures represented in figure 1 into *far-distance* and *near-distance* importations. We indeed broke down the world economy into nine economic macro-regions:

1. **Europe and its economic backyard** (henceforth noted ***EUR*** in equations, tables and graphics): *Europe (with exception of Russia, Ukraine, Belarus, Moldavia and former Soviet Caucasian states), Turkey, and North Africa (Algeria, Egypt, Libya, Morocco and Tunisia)*.
2. **The Commonwealth of Independent States** (henceforth noted ***CIS***) with exception of the Baltic States.
3. **Sub-Saharan Africa**: *all African States with exception of Algeria, Egypt, Libya, Morocco and Tunisia.*
4. **Near and Middle East**: *Bahrain, Kuwait, Lebanon, Iran, Iraq, Israel, Jordan, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, and Yemen.*
5. **East Asia** (henceforth noted **EAS**): *China, Cambodia, Hong Kong, Indonesia, Japan, Laos, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand, and Vietnam.*

6. **South Asia and Pacific**: *Bangladesh, India, Pakistan, Sri Lanka and some small economies in Asia and Oceania.*
7. **Australia and New Zealand**.
8. **North America** (henceforth noted ***NAM***): *Canada, Mexico, and the United States of America.*
9. **South and Central America**: *all American States, with the exception of Canada, Mexico, and the USA.*

Trade flows between two states belonging to the same macro-region were considered as "near-distance" exchanges; flows between states located in different macro-regions were regarded as "far-distance" exchanges, even in case of geographical neighbourhood of the states concerned, e.g. Poland (*EUR*-zone) and Ukraine (*CIS*-zone). Thanks to this binary distinction, we were able to attribute to each observed trade flow either a near-distance or a far-distance status.

3.1.2. Importation patterns and their 2000-2012 evolution

The most interesting results highlighted by our companion paper are the following:

i. At a worldwide level, far-distance auto parts importations are growing faster over the 2000-2012 period than near-distance importations. This global movement towards an increasing globalisation of the automotive supply chain is mainly driven by two macro-regions: North America and the CIS.

ii. The European automobile industry is characterized by its self-sufficiency in terms of auto parts procurement. In 2000, only 10.9 % of the European auto parts importations came from far-distant countries.

iii. The European importations pattern is highly stable over the 2000-2012 period (the share of far-distance importations increases very slightly from 10.9 % to 11.4 %).

This last result can be somewhat surprising when we consider the stylized facts of the first section. At a general level, i.e. when we consider the whole macro-region, Europe seemed to have experienced only few transformations. But is this still the case when we go into details? Are there compensation effects, ensuring that the (stable) average is built on a set of contradictory individual evolutions? To answer these questions, we will focus on four major European countries.

3.2. Data and definitions

In this empirical investigation, we concentrate on the four leading European car-producing countries (in terms of automobile production levels): Germany, France, United-Kingdom and Spain.

3.2.1. Data

Data used in this paper comes from *OICA* (Organisation Internationale des Constructeurs d'Automobiles) and from the *Chelem CIN Database*. More precisely, we make use of OICA data about the automobile production of Germany, France, United-Kingdom and Spain, and of international trade figures from 2000 to 2012 concerning the product category "auto parts" (designed by the acronym *FS* in the Chelem categorization). Note that Chelem international trade figures are given in millions of current US Dollars, i.e. in nominal terms.

3.2.2. “Far-distance” and “near-distance” importations to Europe

As in the case of our companion paper, the distinction between “far-distance” and “near-distance” importations is at the heart of this empirical investigation. In this context, we use the macro-regional delimitation of Frigant & Zumpe (2014) presented in subsection 3.1.1. Consequently, importations from Europe (with exception of Russia, Ukraine, Belarus, Moldavia and former Soviet Caucasian states) and from Europe’s economic backyard (Turkey and North Africa) are considered as near-distance importations. Far-distance importations to Germany, France, United-Kingdom and Spain consequently come from Russia, Ukraine, Belarus, Moldavia and former Soviet Caucasian states as well as from non-European countries (with exception of Turkey and North Africa)

3.3. Static comparative analysis

As a first step, we touch upon the issue of the importation patterns of the four leading European car producing countries by means of a static comparative approach. In concrete terms: we compare the respective shares of "far-distance" and "near-distance" importations at two points of time – in 2000 and 2012 (i.e. at the beginning and at the end of the time period chosen in this study).

3.3.1. *Far-distance* and *near-distance* importations: some nominal measures

First of all, we report descriptive statistics and graphics of importation flows to Germany, France, United-Kingdom, and Spain. Table 1 shows that nominal auto parts importations to Germany, France, United-Kingdom and Spain have substantially grown over the 2000-2012 period. In Germany, United-Kingdom and Spain, importations from Europe and its backyard grew faster than importations from far-distant countries. The reverse is true for France.

Table 1. 2000-2012 growth of nominal importations from Europe and its backyard (near-distance) and from other countries (far-distance)

	Germany	France	United-Kingdom	Spain
import growth	205.17 %	84.93 %	64.45 %	51.59 %
near-distance import growth	206.69 %	82.23 %	64.70 %	51.72 %
far-distance import growth	190.66 %	127.41 %	63.26 %	48.95 %

Sources: Chelem, authors treatment

Table 2. Share of importations from Europe and its backyard (near-distance) and from other countries (far-distance) in 2000 and 2012

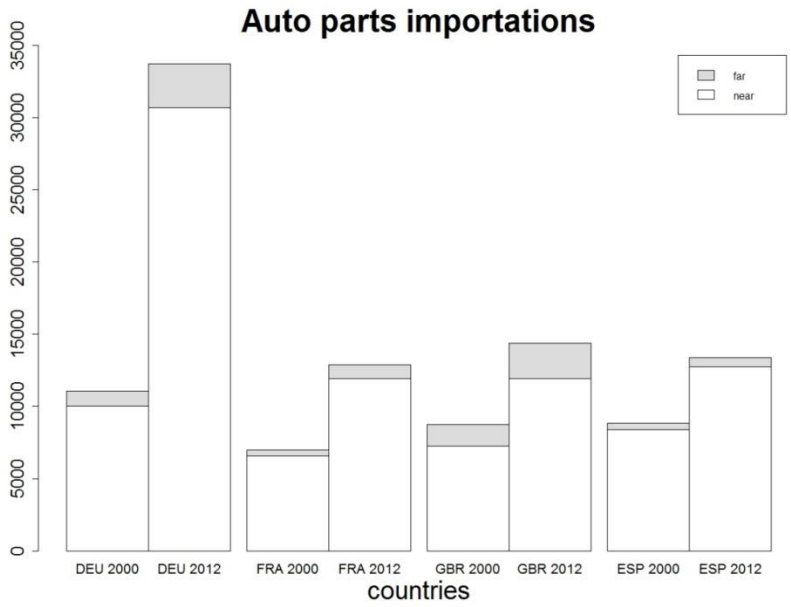
	Germany	France	United-Kingdom	Spain
near-distance share in 2000	90.52 %	94.03 %	82.74 %	95.01 %
far-distance share in 2000	9.48 %	5.97 %	17.26 %	4.99 %
near-distance share in 2012	90.97 %	92.66 %	82.87 %	95.09 %
far-distance share in 2012	9.03 %	7.34 %	17.13 %	4.91 %

Sources: Chelem, authors treatment

Table 2 may suggest that the specific evolution of France's import pattern is due to the French backlog in the field of far-distance importations: the 2000 share of French far-distance importations is indeed much lower (5.97 %) than the German and the British shares (9.48 % and 17.26 %). The growth differential in favour of France thus might interpret as something like a "catch-up" process (with respect to far-distance importation shares). However, this interpretation is rather fragile: indeed, according to this argument, Spanish far-distance importations should have risen even faster than French ones, but this was clearly not the case; in addition, there are data imperfections which suggest other interpretations of the trajectories of the importation schemes (see infra subsection 3.3.3).

Tables 1 and 2 only inform about shares and growth of the two types of auto parts importations; they do not take into account of the importations levels. This gap is filled by figure 2, which provides evidence of the outstanding rapidity of Germany's importations growth. It also underlines the fact that European auto parts importations are essentially near-distance importations, they come mainly from the European macro-region; trade relations with far-distant macro-regions are significantly less intensive.

Figure 2. Nominal importations from near-distance and far-distance countries to Germany, France, United-Kingdom and Spain in 2000 and 2012 (in millions of current USD) [12]



Sources: Chelem, authors treatment

Figures 3 and 4 give supplementary information about importations' origins.

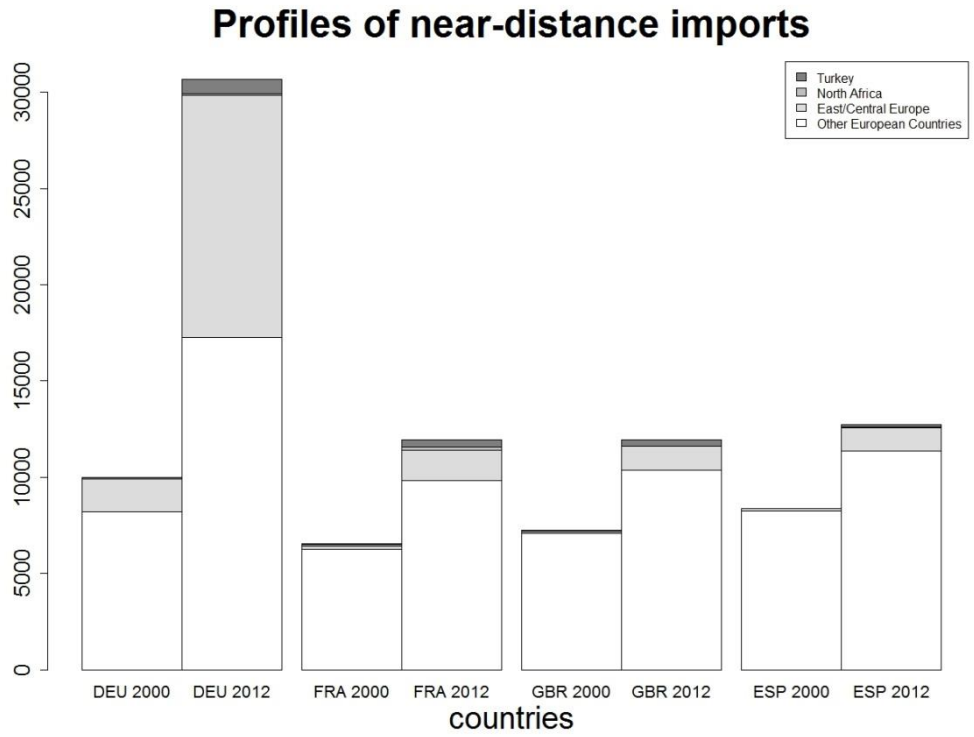
Figure 3 highlights an interesting specificity of the German importation pattern[13]. Imports from the leading Eastern and Central European economies (Poland, Czech Republic, Slovakia, Hungary and Romania) are far more important for the German automotive industry than for the French, British and Spanish ones. This is already true in 2000, and this pattern is even reinforcing over the observation period: in 2012, German imports from East and Central Europe have become nearly as important as those from the traditional core of the (Western) European automotive industry: France, United-Kingdom, Italy, Spain, Benelux etc. (grouped together in figure 2 under the term "Other European countries").

Figure 4 shows some kind of "switch" in the relative importance of auto parts importations from North America and from East Asia. North America's weight shrinks from 2000 to 2012; on the contrary, we observe an intensification of importations from East Asia.

[12] In what follows, we use *ISO-3166-1 alpha 3* acronyms: CHN = China, CZE = Czech Republic, DEU = Germany, FRA = France, GBR = United Kingdom, HUN = Hungary, JPN = Japan, POL = Poland, RUS = Russia, SVK = Slovakia, ESP = Spain, TUR = Turkey, WLD = World.

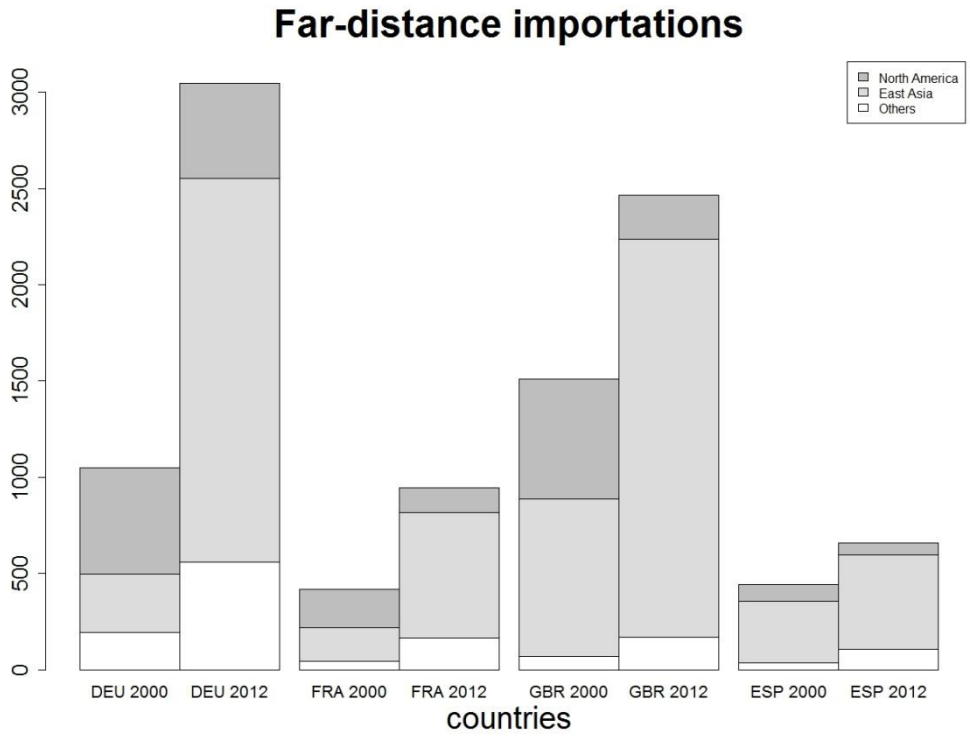
[13] We can note that the major part of passenger car production in Germany is due to domestic carmakers. In 2012, Ford had two assembly plants (Saarlouis and Cologne, + five plants producing meso-components (engine, transmission) and other elements (die, cast, forge and tool)). Opel, owned by GM, possessed three assembly plants in Germany in 2012.

Figure 3. Decomposition of figure 2 near-distance importation levels: shares of importations from Turkey, North Africa, East/Central Europe and other European countries (in millions of current USD).



Sources: Chelem, authors treatment

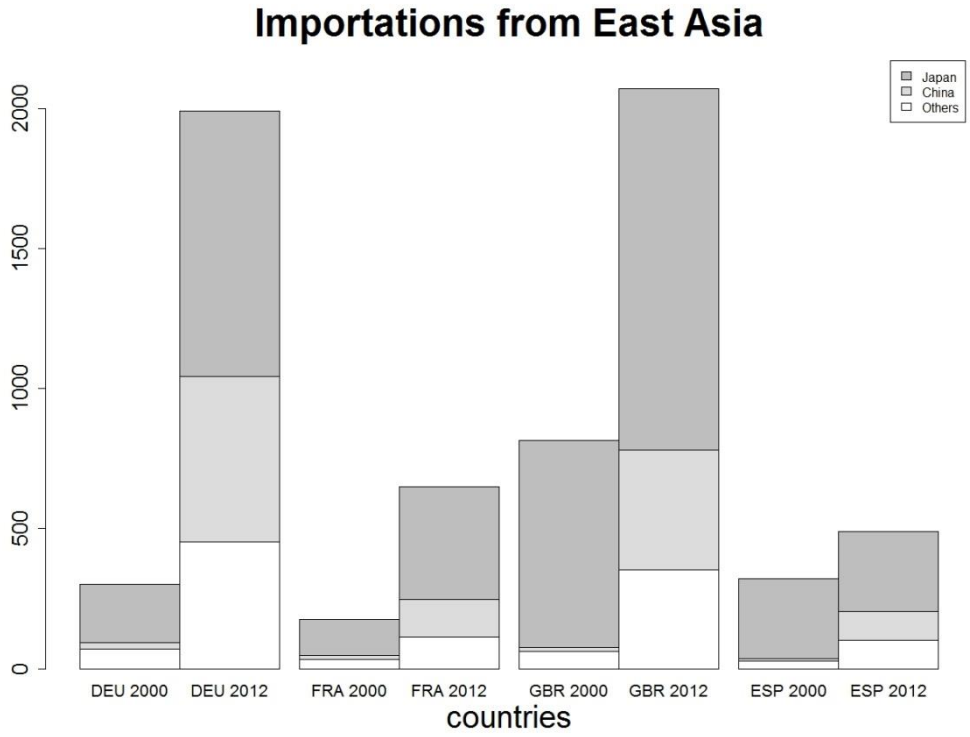
Figure 4. Decomposition of figure 2 far-distance importation levels: shares of importations from North America, East Asia and other far-distant macro-regions (in millions of current USD).



Sources: Chelem, authors treatment

Figures 3 and 4 give interesting indications about the "British exception", i.e. the striking importance of the share of far-distance importations (see table 2). Indeed, figure 3 shows that these importations essentially come from East Asia (and – in 2000 – from North America), and namely from Japan (*see* figure 5). This may be explained by the presence on the British territory of assembly plants belonging to Japanese and American automakers which are directly supplied with auto parts made in Japan and North America[14]. We probably catch here two types of flows of Graph 2: intrafirm flows of macro-components coming from carmakers' subsidiaries (arrow e) and intra firm flows of meso-components/components coming from mega-suppliers (arrows c and/or d), but also an internationalization of supply networks built with domestic suppliers still located in US or Japan (arrows a and f). Comforting this interpretation, the decline of imports from the US can be explained by the collapse of the car production of UK-located American car makers between 2000 and 2012 (see note 14).

Figure 5. Decomposition of East Asian importations drawn in figure 4: shares of importations from Japan, China and other East Asian countries (in millions of current USD).



Sources: Chelem, authors treatment

Spanish auto parts importations seem to follow the same logic. Indeed, figures 4 and 5 show that far-distance importations essentially come from East Asia, and namely from Japan. Near-distant importations to Spain are clearly dominated by Western European countries (*Other European countries* in figure 3). It is highly plausible that this structure points to the primacy of importations flows from the domestic countries of the carmakers located in Spain, i.e. from Japan, France and

[14] In 2012, the top five UK carmakers were Nissan (510,572 cars produced), Land Rover (acquired by Indian Tata Group in 2008, 305,467), MINI (BMW Group, 207,530), Honda (165,630), Toyota (109,429). These three Japanese carmakers assembled 53.6% of the passenger cars produced in the UK.
We need to note that the weight of the US carmakers sharply decreased during the period. GM closed Vauxhall's Luton car assembly plant in March 2003. Ford ceased the production of passenger cars in its historical plant of Dagenham in 2002 (the plant was transformed in an engine factory). Moreover, in 2000, Ford (via Premier Automotive Group) owned Land Rover, Jaguar and Aston Martin who were sold during the period.

Germany. The weak flows of imports from the US suggest that the American carmakers located in Spain have built their production networks at a European scale[15].

East Asia is clearly the most dynamic zone over the 2000-2012 period. Exportations to the four European countries in question have been multiplied by a factor of 3.2 (more than 6.6 in the case of Germany). China's exportations are growing most rapidly, but Japanese exportations shares resist not too badly, especially in the three countries where Japanese assembly plants are located (United-Kingdom, France and Spain).

We now turn back to more general considerations linked to the importation patterns of the four leading European automobile producing countries. Figure 2 suggests a rather distinctive nature of the German importations scheme: at the beginning of our observation period, Germany's total importations of auto parts are already considerably higher than French, British and Spanish ones (11052 million USD against 8831.6 million USD of Spain taking the second place). In addition to this initial lead, Germany enjoys the fastest 2000-2012 growth of auto parts importations. As a result, Germany clearly dominates European auto parts importations: in 2012, Germany imports more auto parts than its two main competitors (Spain and France) taken together! Finally, note that both types of importations (near-distance and far-distance importations) are benefiting from the rapid growth of German auto parts importations.

At first sight, figure 2 could give the impression that German automakers rely more heavily on international outsourcing strategies than their European competitors, and that this German specificity is reinforcing over the 2000-2012 period. It might therefore be thought that the recent German "automobile miracle" is to a large amount due to these outsourcing practices. We could suppose that Eastern countries could be the country i_3 of the Graph. 2: German firms should have delocalized massively and the growth of imports from Eastern Countries should represent the growth of flows number 5bis, 6 and 3. The "automobile miracle" could be explained by an offshoring strategy allowing to restore cost competitiveness.

However, before drawing hasty conclusions, we would like to emphasize the limits and imperfections of Chelem data. Interpretations are indeed likely to be misguided by two aspects of Chelem data:

i. Trade figures are given in nominal terms; changes over time of these trade figures thus may simply reflect variations in auto parts prices.

ii. Trade figures do not take into account the evolution of the automobile production; changes over time of auto parts imports of a given zone thus may simply reflect the fact that the zone's production level has changed.

We deal with these two issues in the remainder of this section.

3.3.2. Overcoming data imperfections

With respect to the two potential sources of data misinterpretation mentioned in the previous subsection, we propose the following decomposition of Chelem trade figures, henceforth noted $X_t^{i\to j}$:

$$X_t^{i\to j} \equiv P_t^{i\to j} \times x_t^{i\to j} \qquad (1)$$

where $X_t^{i\to j}$ stands for country i's auto parts export earnings from country (or zone j) in year t (in millions of USD); $x_t^{i\to j}$ is a quantity index that describes the volume of auto parts exported from i to j

[15] In 2012, we identified (PC+LC assembly factory) the following carmakers (number of produced vehicles): French: Renault (286,200) and PSA (374,000); American: Ford (138,000) and Opel (265,000); Japanese Nissan (137,867); German Mercedes (76,500), VW (287,000) and its subsidiary SEAT (377,343).

in t, and $P_t^{i\to j}$ is the associated auto parts price index. Auto parts price changes mentioned under i) are now captured by $P_t^{i\to j}$-changes.

To the best of our knowledge, there is unfortunately no price index proposed by statistical offices corresponding closely or remotely to the auto parts index $P_t^{i\to j}$. There are of course national importation price inquiries, but only in a minority of countries (those endowed with the most efficient statistics institutes). What is more, these inquiries usually do not break down prices over the different origins of imports. These inquiries can thus be considered as reliable proxies for $P_t^{WLD\to j}$, but they do not enable us to decompose further in order to get proxies for $P_t^{EUR\to j}$, $P_t^{East\ Asia\to j}$, …, $P_t^{North\ America\to j}$, which are essential for our research approach.

The absence of a reliable proxy for $P_t^{i\to j}$ induces major difficulties to handle with this auto parts price index, especially when it comes to take into account for index evolutions over time (e.g. comparisons between $P_t^{i\to j}$ and $P_{t-k}^{i\to j}$ with $k > 0$). In this context, it is worth noting the following two points:

- $P_t^{i\to j}$ may or may not be affected by exchange rate variations. In fact, trade contracts denominated in dollars are not influenced by fluctuations of exchange rates (because Chelem trade data itself is dollar-denominated). On the contrary, trade contracts denominated in other currencies induce dependence of $P_t^{i\to j}$ with respect to variations between the dollar and the currencies in question. There is every raison to believe that both situations apply in one and the same price index, but in *a priori* unknown proportions.
- $P_t^{i\to j}$ depends heavily on composition effects: the structure of internationally traded auto parts evolves indeed rather quickly.

Under these circumstances, even the most prudent and reasonable assumptions about $P_t^{i\to j}$ are likely to be excessively hazardous. *A priori*, one could be tempted to assume that the index is characterized by a long-term downwards trend (thanks to productivity gains and cost-compressing international labour division). Now take for example a euro-denominated trade contract between some German carmaker and its Slovakian supplier. Even if the exchanged quantities of auto parts and the contracted exchange prices remain perfectly stable, this exchange relation would give rise to an increase of the price index $P_t^{SVK\to DEU}$ in case of an appreciation of the euro against the dollar, *ceteris paribus*.

Composition effects are probably even more disturbing. Imagine that the price of each individual auto part exported from Slovakia to Germany has decreased, but that at the same time, the proportion of expensive auto parts (e.g. driveline, gear boxes, etc.) has drastically increased. In this case, one may observe a $P_t^{SVK\to DEU}$-increase despite the overall auto parts deflation.

In spite of these difficulties, we will have to formulate working assumptions about the behaviour and the evolution of $P_t^{i\to j}$ in order to make practical use of decomposition (1).

We now account for the impact of automobile production levels in order to deal with data aspect ii).

Recall in this context that one central point of our paper is the comparison of *far-distance* and *near-distance* auto parts importations, and of their respective growth. So one might be tempted to evaluate whether there is $x_t^{far\to j}$-growth. Now remark that pure observations of $x_t^{far\to j}$-growth are not necessarily very helpful when it comes to answer our research question: for example, $x_t^{far\to DEU}$-growth may simply reflect an increase in the German automobile production, leaving unchanged the average quantity of far-distance imported auto parts used to build each individual automobile. But a scenario where German carmakers continue to import the same quantity of far-distance auto parts

per produced automobile can hardly be regarded as a manifestation of an increasing importance of far-distance imports.

In order to control for the evolution of the automobile production, we propose to introduce a *per automobile* version of the auto parts quantity index, noted $G_t^{i\to j}$:

$$G_t^{i\to j} \equiv \frac{x_t^{i\to j}}{y_t^j} \quad (2)$$

where y_t^j is zone j's automobile production in t (i.e. the number of produced automobiles) and where $G_t^{i\to j}$ measures the *per automobile volume* of auto parts exported from i to j (i.e the number of auto parts from i incorporated in the "average" automobile produced in zone j).

With this index per automobile, we get for equation (1) :

$$X_t^{i\to j} = P_t^{i\to j} \times y_t^j \times G_t^{i\to j} \quad (3)$$

3.3.3. *Per automobile* importations measures

In order to deal with the absence of reliable data concerning the auto parts price index $P_t^{i\to j}$, we make the working assumption that auto parts importations prices do not differ too much between the four countries selected for this study. Consequently, we have

$$P_t^{i\to j} \approx P_t^{i\to k} \quad (4)$$

for both $i = near$ and $i = far$ and for j and $k = DEU, FRA, GBR, ESP$. We then normalize these price indexes to 1, which implies that equation (2) becomes

$$G_t^{i\to j} \approx \frac{X_t^{i\to j}}{y_t^j}. \quad (5)$$

With assumption (4), we can get round the impact of auto parts prices and interpret equation (5) in real terms, which means that we can now directly compare the *per automobile* auto parts importations levels of the four countries. Note however the rather restrictive character of assumption (4). The following results should thus be taken with precaution.

Table 3. Auto parts importations *per automobile* in 2000 (in current USD/automobile)

	Germany	France	United-Kingdom	Spain
$G_{2000}^{WLD\to j}$	1999,78	2421,93	5336,37	3732,15
$G_{2000}^{near\to j}$	1810,19	2277,37	4415,54	3545,83
$G_{2000}^{far\to j}$	189,59	144,56	920,83	186,3

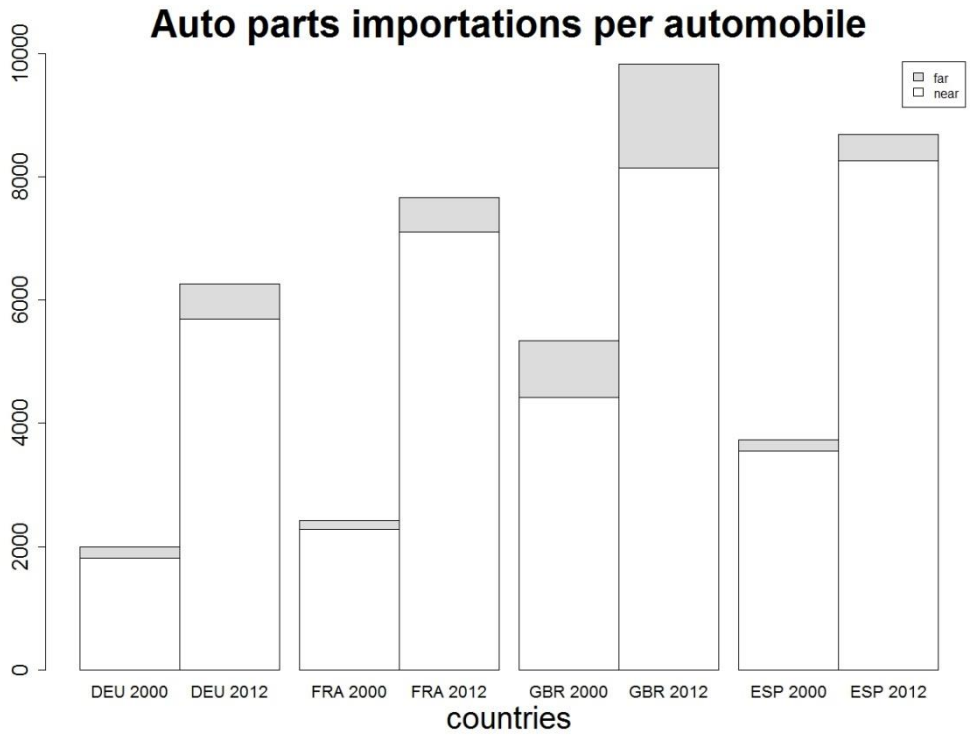
Sources: data from OICA and Chelem, authors treatment

Table 4. Auto parts importations *per automobile* in 2012 (in current USD/automobile)

	Germany	France	United-Kingdom	Spain
$G_{2012}^{WLD\to j}$	6259,14	7664,60	9833,53	8694,92
$G_{2012}^{near\to j}$	5693,95	7102,03	8149,06	8268,41
$G_{2012}^{far\to j}$	565,19	562,57	1684,48	426,52

Sources: data from OICA and Chelem, authors treatment

Figure 6. Far-distance and near-distance importations *per automobile* to Germany, France, United-Kingdom and Spain in 2000 and 2012 (in current USD/automobile). **(based on tables 3 and 4)**



Sources: data from OICA and Chelem, authors treatment

First of all, we would like to mention that one should refrain from interpreting the 2000-2012 progressions of per automobile importations in figure 6. In fact, this would require the assumption $P_{2000}^{i\to j} \approx P_{2012}^{i\to j}$, i.e. the decennial stability of auto parts prices. Assumptions like that are clearly at odds with facts.

Tables 3 and 4 and figure 6 highlight the heterogeneity of the importations patterns of the four leading European car-producing countries. With respect to total and near-distance *per automobile* importations, we observe in 2000 the following rankings:

$$G_{2000}^{WLD\to GBR} > G_{2000}^{WLD\to ESP} > G_{2000}^{WLD\to FRA} > G_{2000}^{WLD\to DEU} \quad (6)$$

and

$$G_{2000}^{EUR\to GBR} > G_{2000}^{EUR\to ESP} > G_{2000}^{EUR\to FRA} > G_{2000}^{EUR\to DEU} \quad (7)$$

In the 2000 ranking of far-distance *per automobile* importations, the positions of Germany, France and Spain are somehow inverted:

$$G_{2000}^{far\to GBR} > G_{2000}^{far\to DEU} > G_{2000}^{far\to ESP} > G_{2000}^{far\to FRA} \quad (8)$$

These results shed new light on the growth differentials in favour of importations to Germany and France highlighted in subsection 3.3.1. (cf. table 1). The initial weakness of German and French *per automobile* importation levels (more precisely: total and near-distance per automobile importation levels) suggests that these growth differentials interpret as a "catch-up process", but not the one discussed above (cf. subsection 3.3.1.). We think that the fast German and French growth is due to their initial “backlog” in the field of auto parts importations levels (and not of importations shares!): in 2000, both countries clearly import less auto parts *per automobile* than United-Kingdom and Spain.

From a structural point of view, these data suggest an opening of the French and German supply chains: the (double) six arrows of Graph 2 have sharply grown in France and Germany but, at the same time, both countries still enjoy significant trade surpluses (in auto parts and accessories, Frigant, Miollan, 2014). So, we cannot accept the hypothesis of a simple substitution effect; this state of affairs is better explained by an increasing interconnection between domestic and foreign supply industries. At the beginning of the period, French and German networks were less open than the Spanish and British ones (the supply industry of these two countries was less powerful, and thus imports were necessary in order to satisfy the demand[16]) but now, the data suggest an interconnection of French and German networks, both on the European and the worldwide scale.

In the wake of this process of increasing connectedness, France's per automobile importations level from far-distance countries has exceeded the Spanish one. In 2012, we consequently obtain the new ranking:

$$G_{2012}^{far\rightarrow GBR} > G_{2012}^{far\rightarrow DEU} > G_{2012}^{far\rightarrow FRA} > G_{2012}^{far\rightarrow ESP} \quad (9)$$

Despite the growth differentials in favour of German and French total and near-distance importations, France and Germany still find themselves at the bottom of the corresponding rankings:

$$G_{2012}^{WLD\rightarrow GBR} > G_{2012}^{WLD\rightarrow ESP} > G_{2012}^{WLD\rightarrow FRA} > G_{2012}^{WLD\rightarrow DEU} \quad (10)$$

and

$$G_{2012}^{EUR\rightarrow ESP} > G_{2012}^{EUR\rightarrow GBR} > G_{2012}^{EUR\rightarrow FRA} > G_{2012}^{EUR\rightarrow DEU} \quad (11)$$

3.4. Dynamic analysis

In the previous section, we described and compared the importations patterns of Germany, France, United-Kingdom and Spain at two points in time, 2000 and 2012. This section is dedicated to the analysis of the evolution of these importation patterns, i.e. to the process that transformed the initial patterns to those observed in 2012. In this context, we focus on country-to-country comparisons of patterns' evolutions. By proceeding this way, we also tackle the question of the stability of German, French, British and Spanish importations patterns.

3.4.1. Dynamic comparison indexes

In order to compare the evolution of far-distance *per automobile* importations to two countries j and k, we propose the *evolution comparison ratio*, noted $\delta_{t,t+l}^{far\rightarrow j/k}$:

$$\delta_{t,t+l}^{far\rightarrow j/k} \equiv \frac{\frac{G_{t+l}^{far\rightarrow j}}{G_{t}^{far\rightarrow j}}}{\frac{G_{t+l}^{far\rightarrow k}}{G_{t}^{far\rightarrow k}}} = \frac{\frac{x_{t+l}^{far\rightarrow j}}{x_{t}^{far\rightarrow j}}}{\frac{x_{t+l}^{far\rightarrow k}}{x_{t}^{far\rightarrow k}}} \times \frac{\frac{P_{t}^{far\rightarrow j}}{P_{t+l}^{far\rightarrow j}}}{\frac{P_{t}^{far\rightarrow k}}{P_{t+l}^{far\rightarrow k}}} \times \frac{\frac{y_{t}^{j}}{y_{t+l}^{j}}}{\frac{y_{t}^{k}}{y_{t+l}^{k}}} \quad (12)$$

where t is the initial observation date and l the number of periods covered by the observation sample. A ratio higher than 1 highlights that the number of auto parts (per produced automobile) imported from far-distant countries has risen faster in country j than in country k between periods t and $t+l$.

Unfortunately, we do not dispose of reliable data concerning the auto parts price $P_t^{far\rightarrow j}$. In order to cope with this difficulty, we assume that:

[16] Spain and the United Kingdom were characterized by large deficits in Auto Parts and accessories all along the 2000s. As they remained important automakers, they relied greatly on imports in order to build cars (Frigant, Miollan, 2014).

$$\frac{\frac{P_t^{far\to j}}{P_{t+l}^{far\to j}}}{\frac{P_t^{far\to k}}{P_{t+l}^{far\to k}}} \approx 1. \qquad (13)$$

In this case, the evolution comparison index (12) can be written as follows:

$$\delta_{t,t+l}^{far\to j/k} \equiv \frac{\frac{G_{t+l}^{far\to j}}{G_t^{far\to j}}}{\frac{G_{t+l}^{far\to k}}{G_t^{far\to k}}} = \frac{\frac{x_{t+l}^{far\to j}}{x_t^{far\to j}}}{\frac{x_{t+l}^{far\to k}}{x_t^{far\to k}}} \times \frac{\frac{y_t^j}{y_{t+l}^j}}{\frac{y_t^k}{y_{t+l}^k}} \qquad (14)$$

It can be shown that assumption (13) is equivalent to

$$\pi_{t,t+l}^{far\to j} = \pi_{t,t+l}^{far\to k} \qquad (15)$$

where $\pi_{t,t+l}^{far\to j}$ is the inflation rate (or deflation rate) of auto parts importations from far-distant countries to country j from periods t to $t+l$. In the case of German, French and Spanish data, this assumption does not seem too restrictive: the three countries are exposed to the same exchange rate movements (because they belong to the Euro Zone), and they are characterized by similar levels of industrial development. In the British case, assumption (15) should be handled with care: United-Kingdom may face different exchange rate variations because of its monetary independence from the Euro Zone. Note that assumption (15) is clearly less restrictive than assumption (4) used in subsection 3.3.3.

Two complete the picture, we propose similar comparison indexes associated to near-distance importations and total importations:

$$\delta_{t,t+l}^{near\to j/k} \equiv \frac{\frac{G_{t+l}^{near\to j}}{G_t^{near\to j}}}{\frac{G_{t+l}^{near\to k}}{G_t^{near\to k}}} = \frac{\frac{x_{t+l}^{near\to j}}{x_t^{near\to j}}}{\frac{x_{t+l}^{near\to k}}{x_t^{near\to k}}} \times \frac{\frac{y_t^j}{y_{t+l}^j}}{\frac{y_t^k}{y_{t+l}^k}} \qquad (16)$$

and

$$\delta_{t,t+l}^{WLD\to j/k} \equiv \frac{\frac{G_{t+l}^{WLD\to j}}{G_t^{WLD\to j}}}{\frac{G_{t+l}^{WLD\to k}}{G_t^{WLD\to k}}} = \frac{\frac{x_{t+l}^{WLD\to j}}{x_t^{WLD\to j}}}{\frac{x_{t+l}^{WLD\to k}}{x_t^{WLD\to k}}} \times \frac{\frac{y_t^j}{y_{t+l}^j}}{\frac{y_t^k}{y_{t+l}^k}}. \qquad (17)$$

3.4.2. The 2000-2012 evolution of European importations patterns

Concerning the evolution comparison indexes of far-distance importations, we get the following results:

Table 5. *Evolution comparison ratios* of far-distance importations *per produced automobile* to Germany, France, United-Kingdom and Spain.

$\delta_{2000,2012}^{far\to DEU/F\,RA}$	$\delta_{2000,2012}^{far\to DEU/GBR}$	$\delta_{2000,2012}^{far\to DEU/ESP}$	$\delta_{2000,2012}^{far\to FRA/GBR}$	$\delta_{2000,2012}^{far\to FRA/ESP}$	$\delta_{2000,2012}^{far\to GBR/ESP}$
0,766	1,630	1,302	2,127	1,700	0,799

These ratio values imply the following ranking of the progression of auto parts importations *per automobile* from far-distant countries over the 2000-2012 period:

Far-distance imports progression ranking: FRA > DEU > ESP > GBR (18)

Interestingly, this ranking is roughly the reverse order of the initial *per automobile* far-distance importations levels (cf. table 3 and equation (8)). This state of affairs points to the appropriateness of

an interpretation in terms of a "catch-up process": France's far-distance importations had to grow as quickly, because the French automobile industry started in 2000 from a particularly low level; it had to somehow catch up its initial backlog with respect to the European "norm" of far-distance importations. Remind as well that it is much easier to deliver strong growth rates when you start from low initial levels.

There is also another explanation which has to do with the sharp decrease of France's car production over the observation period: the number of cars produced in France has decreased by 41% between 2000 and 2012. The important point is that this collapse was primarily due to the decline of French carmakers: in 2000, they produced 95% of the cars produced in France, but only 88% in 2010. At the same time, Toyota established in 2001 a new large assembly plant in Valenciennes (North of France)[17]. As a consequence, there were less and less French cars built by domestic carmakers (primarily using French-made auto parts) and more and more "French" cars produced by carmakers originated in far-distant countries – which are relying for a substantial part on auto parts imported from theirs countries of origin. This state of affairs corresponds to a scenario of an internationalisation of French GPN, namely characterized by important intrafirms flows (see arrows e or c). Chelem data confirms this explanation: in 2000, 1.87% of French auto parts imports came from Japan; in 2012, Japanese importations accounted for 3.13 %.

At the other end of the ranking, the United-Kingdom was probably less incited to further expand its far-distance importations, because in 2000, the British automotive industry was already characterized by the outstanding importance of this kind of auto parts procurement (in comparison to the German, French and Spanish automotive industries).

Table 6. *Evolution comparison ratios* of near-distance importations *per produced automobile* to Germany, France, United-Kingdom and Spain.

$\delta_{2000,2012}^{near \to DEU/FRA}$	$\delta_{2000,2012}^{near \to DEU/GBR}$	$\delta_{2000,2012}^{near \to DEU/ESP}$	$\delta_{2000,2012}^{near \to FRA/GBR}$	$\delta_{2000,2012}^{near \to FRA/ESP}$	$\delta_{2000,2012}^{near \to GBR/ESP}$
1,009	1,704	1,349	1,690	1,337	0,791

Table 7. *Evolution comparison ratios* of total importations *per produced automobile* to Germany, France, United-Kingdom and Spain.

$\delta_{2000,2012}^{WLD \to DEU/F\ RA}$	$\delta_{2000,2012}^{WLD \to DEU/GBR}$	$\delta_{2000,2012}^{WLD \to DEU/ESP}$	$\delta_{2000,2012}^{WLD \to FRA/GBR}$	$\delta_{2000,2012}^{WLD \to FRA/ESP}$	$\delta_{2000,2012}^{WLD \to GBR/ESP}$
0,989	1,699	1,343	1,717	1,358	0,791

Table 6 and 7 give the following rankings of the progressions of auto parts importations from near-distant countries, and of total auto parts importations:

Near-distance imports progression ranking: DEU > FRA > ESP > GBR (19)

Total imports progression ranking: FRA > DEU > ESP > GBR (20)

Again, we observe rankings which correspond exactly (equation (19)) or roughly (equation (20)) to the reverse order of initial *per automobile* importations levels (cf. table 3 and equations (6) and (7)).

[17] In 2000, the production of passenger cars by foreign-owned carmakers plants were equal to 114,207 (two Italian brands Fiat=10,377 & Lancia=2,265, and one German Smart=101,365). In 2012, 305,842 cars were produced in France by foreign carmakers plants (German Smart=105,321, Japanese Toyota=200,531).

Discussion and Conclusion

Taking as a starting point the *Global Production Networks* approach, we argued in this paper that inter-firm and intra-firm exchange networks govern the volumes and directions of international auto parts exchanges. These networks are mainly structured by carmakers and mega-suppliers. From this heuristic point of view, we aimed at qualifying the external GPN of four leading European automotive countries. We were namely interested in the importation patterns of these countries, i.e. the respective weights of near-distance importations (which come from the same macro-region as the importing country) and of far-distance importations (which come from other macro-regions).

In this context, we highlighted the diversity of European importation patterns. One striking point is a kind of "British exception": a relatively large proportion of British auto parts importations come from far-distant countries. On the contrary, France and Spain are characterized by low shares of far-distance importations.

We then left aside importation shares and turned to the analysis of importation levels. This change in angle of attack suggests a rather singular position of the German automotive industry: in 2000, Germany's auto parts importations were significantly higher than those of its European main competitors; what is more, German importations grew much faster over the 2000-2012 period than French, British and Spanish ones. Interestingly, this superiority in terms of importations growth is valid for both near-distance and far-distance importations. This state of affairs might indicate that the importation strategies of German carmakers have contributed to the good performances of the German automotive industry over the 2000-2012 period.[18] Did German carmakers fare much better than their European competitors, because they relied increasingly on aggressive importation strategies?

Our study does not give empirical evidence for this interpretation of the success story of the German automotive industry. In fact, auto parts importation levels should be related to car production levels. *A priori*, it is quite normal that a country that produces much more cars than its neighbours also imports much more auto parts. When it comes to compare importation levels across countries, the convenient statistical measure is the quantity of auto parts importations *per produced automobile*. Using this measure, we obtain quite different results: Germany and France are characterized by particularly low auto parts importations levels *per produced automobile*, especially in comparison with the United-Kingdom. If auto parts importations (and namely far-distance auto parts importations) were the key to success, the British automotive industry would have been the most successful all over Europe!

The change of perspective obtained by importation statistics *per produced automobile* also sheds new light on the fast progression of German auto parts importations. This phenomenon is certainly partly due to the initial weakness of German importations *per produced automobile* (in comparison with the United-Kingdom): in fact, it is much easier to deliver high growth rates when starting from low initial levels.

The analysis of the country-structure of auto parts importations gives further evidence for the existence and the persistence of pronounced national specificities. The importance of British far-distance importations is primarily due to importation flows from Japan. The German automotive industry distinguishes itself through the magnitude and the rapidity of growth of auto-parts importations from Eastern and Central Europe. These national characteristics of the external Global Production Networks are best explained by national supply chains that tend to be extended to foreign countries. For instance, the weight of British imports from Japan is a direct consequence of the location of Japanese carmakers and mega-suppliers in United-Kingdom. They import some

[18] Germany's car production level was roughly stable from 2000 to 2012; Great Britain marked a noticeable drop; France and Spain experienced a genuine collapse of their production levels.

macro-components from their domestic plants, but also meso-components or components from Japanese suppliers and mega-suppliers (like Denso). In a similar vein, German carmakers and mega-suppliers have installed important production capacities in Eastern and Central Europe, and our statistical measures capture the resulting re-importation flows.

France's importations pattern *per produced automobile* is not too different from the German one. In fact, French mega-suppliers have kept during a long time their major plants in France or near-distant countries, including in Maghrebian countries. This explains they relatively low level of far-distance importations to France (recall that in our decomposition of the world economy, North Africa belongs to the European macro-region).

Things are less clear-cut in the Spanish case. There are actually no domestic carmakers, but only foreign carmakers coming from different countries and macro-regions: France, Japan, United States and Germany. Our statistical measures highlight that Spanish far-distance importations are dominated by Japan, and near-distance importations by Western European countries. These results are consistent with an importations structure close to the British one: auto parts importations essentially come from the domestic countries of the carmakers located in Spain.

It should be noted that we have made a special effort to paint an accurate picture of the structure and the evolution of the auto parts importations of the four leading European automotive countries. Indeed, the GVC and GPN approaches are sometimes accused of being exclusively based on monographic studies (Sturgeon, Gereffi, 2009). This kind of methodology enabled to collect precise understanding about the functioning of supply networks; but it may be criticised for the fact that as a matter of principle, the generalisation of these results is questionable. By observing the patterns and dynamics of imports trade flow, we aim at contributing to this research agenda in an useful manner. The different trajectories of the different countries distinguished in our paper are in fact better explained by GPN arguments than in terms of an approach of factor endowments of the areas in question, or by a centre/periphery rationale. We can give meaning to the observed evolutions by using the 12 flow types presented in graph 2.

A first limitation of our analysis is that our statistical measures do not capture domestic supply flows. As a consequence, we are unable to take into account internal production networks. So our paper contributes to the characterization of GPN, but it tells just a part of the story - the story of the globalisation of supply chains, and of their transformation and/or stability.

Another important limitation is the lack of reliable data about auto parts prices. We had to formulate rather strong assumptions in order to cope with this problem. Finally it would be helpful to dispose of more precise data about auto parts trade. In fact, data used in this study refers to the Chelem product category "automotive parts" that assembles quite heterogeneous parts: components, meso-components and macro-components. It would be appropriate to make use of more detailed statistical data in order to improve the link between the nature of imports and the typology of auto parts

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