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A Comparative View of Motor Vehicle Production in France

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A Comparative View of Motor Vehicle Production in France

By Carlos Maravall-Rodríguez and Anna Chiara Küffel

Summary

Motor vehicle production in France decreased by about 40% between the years 2000 to 2016. In contrast, motor vehicle production in the EU as a whole only decreased by 0.1% and motor vehicle production by the two French motor vehicle groups (PSA and Renault-Nissan) increased by about 52% across the world during this period. Why the difference?

Following the creation of the EU Single market, the distribution of motor vehicle production in the EU has become concentrated in two areas: one central zone (a corridor running northwest-southeast between the Danube River and the North Sea) and a peripheral one (Spain). In this context, cost competitiveness losses can trigger a reallocation of production to the corridor which is difficult to revert once settled. In France in particular these forces seem to have been a major factor behind a significant impact in its motor vehicle production capacity. They also help explain why production reallocation decisions are costly and difficult to revert by policy. Additionally, agglomeration can also help explain why production decisions are asymmetric: production might not return to a given location, even if competitiveness losses are redressed.

Countering agglomeration economies and moving production to the corridor is possible: avoiding cost competitiveness losses helps explain the different evolution of production in Spain compared to France. Overall, the corridor helps explain the stability of motor vehicle production in the EU between 2000 to 2016 compared to the volatility experienced by individual Member States such as France.

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Introduction

The number of motor vehicles produced¹ in France decreased by about 40% between the years 2000 and 2016. In absolute terms, this represents approximately 1.2 million vehicles, starting from 3.3 million vehicles in 2000 (see table 1). In contrast, production by the French motor vehicle groups increased by about 52% during this time, representing about 4.1 million extra vehicles (reaching 12.1 million in 2016)². While France's vehicle output loss was the largest in absolute terms in the EU, Belgium, Italy, Netherlands, and Portugal also suffered production falls of 40% or more.

Instead, motor vehicle production in the EU remained virtually stable during this period. Compared to the significant drop in France and other EU Member States, motor vehicle production in the EU fell -0.1% between 2000 and 2016, a marginal loss of approximately 26,000 vehicles (see table 1).

Table 1: Motor vehicle production in EU Member States: 2000, 2016 and change (000s)

	2000	2016	Change (levels)	Change (%)
France	3,348.4	2,082.0	-1,266.4	-37.8%
Italy	1,738.3	1,103.5	- 634.8	-36.5%
Belgium	1,033.3	399.4	- 633.9	-61.3%
Netherlands	267.3	44.4	- 222.9	-83.4%
Spain	3,032.9	2,885.9	- 147.0	-4.8%
Portugal	246.7	143.1	- 103.6	-42.0%
Sweden	301.3	205.4	- 96.0	-31.8%
Austria	141.0	108.0	- 33.0	-23.4%
UK	1,813.9	1,816.6	2.7	0.1%
Slovenia	122.9	133.7	10.8	8.8%
Finland	38.9	55.3	16.4	42.1%
Poland	505.0	681.8	176.9	35.0%
Romania	78.2	359.3	281.1	359.7%
Hungary	137.4	472.0	334.6	243.5%
Germany	5,526.6	6,062.6	535.9	9.7%
Slovakia	181.8	1,040.0	858.2	472.1%
Czech Rep.	455.5	1,349.9	894.4	196.4%
EU TOTAL	18,969.5	18,943.0	- 26.5	-0.1%

Source: International Organisation of Motor Vehicle Manufacturers (OICA).

This Brief analyses the causes and consequences of such different performances. In particular it:

- Highlights the importance of motor vehicle production for the EU Member States, in terms of both value added and employment.

- Presents production patterns of the EU motor vehicle groups (BMW, Daimler, Fiat, PSA, Renault and VW), both within their EU Member State of origin plus abroad, emphasising differences between them.
- Describes the evolution of motor vehicle production across the large EU Member States and the Single market as a whole.
- Analyses the impact of the EU Single Market, relating it to agglomeration economics and the establishment of "production corridors", geographic areas that resemble a corridor where production is concentrated³
- Examines the consequences of establishing production corridors in large economic areas such as the EU, for production facilities inside the area (the EU) but outside the corridor, and the ability of corridors to retain production within the area (the EU).
- Outlines some policy implications and concludes discussing the determinants of location decisions.

This Brief only considers publicly available information. As a result, only industry aggregates (value added, employment and quality estimates) and data on the number of motor vehicles produced and sold by group and country is presented.

Importance of motor vehicle production in the EU Member States

Motor vehicle production is part of "Manufacturing of motor vehicles, trailers and semi-trailers" (henceforth 'vehicle manufacturing') **in national accounts.** The latter represents about 1.7% of gross value added of the EU economy and 1.1% of its employment. The sector's share of gross value added varies between 0.4% in France to 5.8% in Hungary. About 2.5 million employees work directly in the sector in the EU, representing 1.1% of total employment. Within the Member States, the share of the sector's employment varies between 0.2% in the Netherlands to 3.5% in the Czech Republic. Table 2 presents its direct impact⁴ in the EU and Member States' economies.

The total impact of motor vehicle production is considered to be approximately five times larger than its direct impact. According to the European

Automobile Manufacturers Association, total employment in the automotive sector of the EU, including direct and indirect employment, was about 12.6 million (5.7% of total EU employment)⁵.

Table 2: **Vehicle manufacturing: direct impact, percentage (member states with 100,000 or more vehicles produced per year)**

Value added			Employment		
	2000	2015		2000	2015
Hungary	2.9%	5.8%	Czech R.	2,2%	3,5%
Slovakia	1.9%	4.7%	Slovakia	1,0%	3,0%
Germany	3.0%	4.6%	Romania	0,8%	2,2%
Romania	0.7%	4.4%	Hungary	1,3%	2,1%
Czech R.	3.1%	4.3%	Germany	2,2%	2,0%
Sweden	2.8%	2.3%	Slovenia	1,1%	1,5%
Slovenia	1.0%	1.8%	Sweden	1,8%	1,3%
EU28	1.5%	1.7%	EU28	1,2%	1,1%
Austria	1.3%	1.3%	Spain	1,6%	0,8%
Spain	1.7%	1.3%	Portugal	1,0%	0,7%
Portugal	1.2%	1.0%	Austria	0,9%	0,7%
Italy	1.1%	0.9%	Italy	0,9%	0,7%
U. Kingdom	1.0%	0.8%	Belgium	1,4%	0,6%
Belgium	1.5%	0.6%	U. Kingdom	0,8%	0,5%
France	1.0%	0.4%	France	0,7%	0,4%
Netherlands	0.5%	0.4%	Netherlands	0,3%	0,2%

Source: European Commission (EC, 2018).

Production by the EU groups

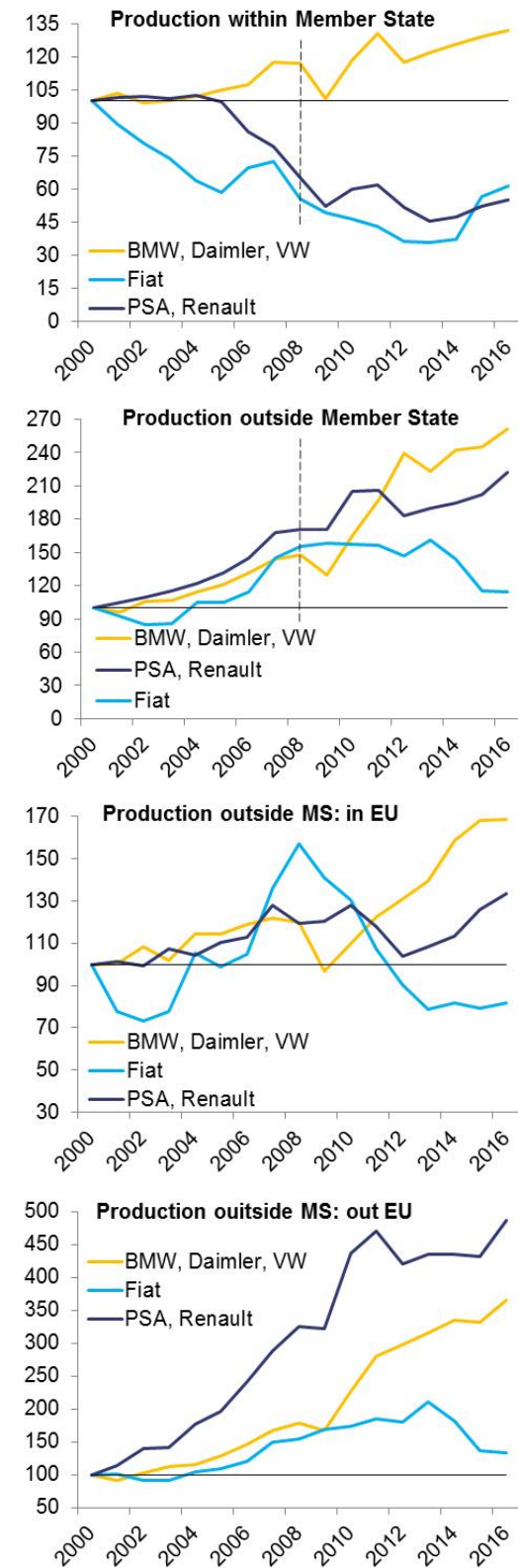
The six European car groups (BMW, Daimler, Fiat, PSA, Renault and VW) have successfully adapted to become global operators. Graph 1 presents the evolution of their production in the Member State of origin and abroad. The graph controls for brands within groups: only those within a group across the sample are considered. For instance, Chrysler production is not included within Fiat (or Daimler, as Chrysler was part of it; Nissan is also not included in Renault). Graph 1 makes evident all groups have been successful abroad⁶.

Groups differ regarding production in their home Member States. Graph 1 makes clear the different fates of groups' production in their home Member State: German groups stand on one side and French and Italian on another. That is, European automotive groups have had different evolutions of production in their home Member States.

Differences between groups also arise regarding their choice of foreign expansion location, i.e. whether to stay (German case) or not (French case) in the EU. Graph 1 presents the production of French and German groups outside their home Member State: inside the EU or third countries. The graph suggests French groups rely more on

relocating outside the EU.

Graph 1: **Motor vehicle production by the six European automotive groups (index 2000=100)**



Source: OICA

Note: Constant brands per group (Chrysler removed from Daimler and Fiat, Nissan from Renault).

Evolution of motor vehicle production in the EU Member States

France stands out among the large euro area Member States as suffering the largest output losses between 2000 and 2016. Graph 2 presents the evolution of motor vehicle production in selected EU Member States -France, Italy, Spain and Germany- since 2000, indexed to 100. That is, it includes total motor vehicle production in the Member State irrespective of whether it is produced by domestic or foreign groups (i.e. Spain is included, even if it has no home motor vehicle group). In particular, motor vehicle production in France in 2016 has fallen to about 60% of the level of 2000. In absolute numbers, this is the largest loss in the EU (see also table 1).

A large part of the pronounced drop in motor vehicle production in France appears to be structural and cannot be attributed to the crisis, as it took place before 2009. Both the 2008-2009 and 2012 crises mark temporary low-points in aggregate EU motor vehicle production (graph 2). Nevertheless, it seems that the underlying trend driving production is not due to the impact of the crisis: total production of motor vehicles in Germany is today above 2007, even if it significantly fell during the crisis.

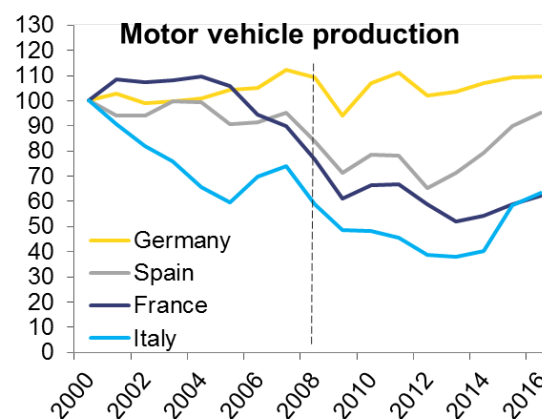
France also stands out as suffering a significant cost competitiveness loss (ULC increase), coinciding in time with the output losses. Graph 3 presents the evolution of nominal ULCs in the vehicle manufacturing national accounts sub-sector for each of these four large euro area Member States. The overall competitiveness loss seems to be consistent with the evolution of motor vehicle production observed in each Member State. That is, the ranking of nominal ULCs increases over time is the same as the ranking of the fall in motor vehicle production by Member State: Italy, France, Spain and Germany.

Dis-aggregating the national account sub-sector vehicle manufacturing presents the same cost competitiveness loss. Table 3 further decomposes nominal ULCs for this national accounts sub-sector in France, Germany and Spain using the Sectoral Performance Indicators database of the European Commission. In particular, it decomposes them as the result of three components: real wages, divided by labour productivity, and times prices. These three

elements are analysed separately to understand which one is driving the rise in nominal ULCs –as in Durán and Poissonier (2018). Table 3 shows that productivity growth in Spain and Germany outstripped real wage growth between 2000 to 2008 and 2012 to 2015. However, it did not in France. As a result, its nominal ULCs shot up.

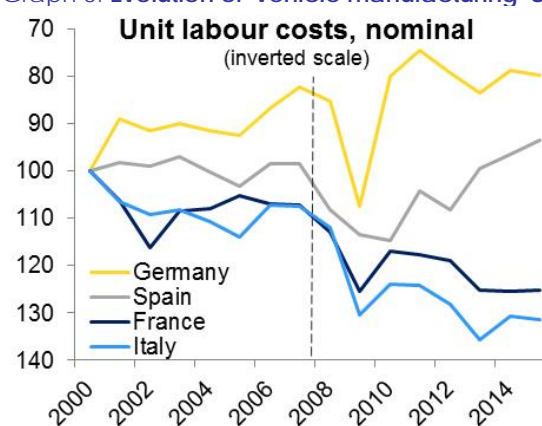
Other variables similarly evolving to ULCs could also explain production location decisions. These can include institutional aspects relevant for the business environment firms confront, measures of "red tape", firm size thresholds, the impact and importance of trade unions (even if union affiliation is limited), etc. The various Country Reports provide further discussion and explanation of the position of France in such comparisons (see CR, 2018).

Graph 2: Motor vehicle production in selected EA MS (index 2000=100)



Source: OICA.

Graph 3: Evolution of 'vehicle manufacturing' ULCs



Source: EUROSTAT, OICA.

Note: The scale for nominal ULCs is inverted.

Table 3: Nominal unit labor costs: disaggregation for the vehicle manufacturing sector

		Nominal ULC growth	Labour productivity growth	Real wage growth	Inflation
France	2000 – 2008	1.36 %	0.86 %	3.21 %	-0.95 %
	2012 – 2015	4.55 %	-2.79 %	-2.77 %	4.52 %
Germany	2000 – 2008	-2.14 %	4.30 %	1.98 %	0.09 %
	2012 – 2015	-0.85 %	3.79 %	2.75 %	0.15 %
Spain	2000 – 2008	1.27 %	4.53 %	3.83 %	1.95 %
	2012 – 2015	-5.62 %	8.06 %	0.83 %	1.15 %

Source: European Commission

The impact of the Single market: agglomeration and production corridors

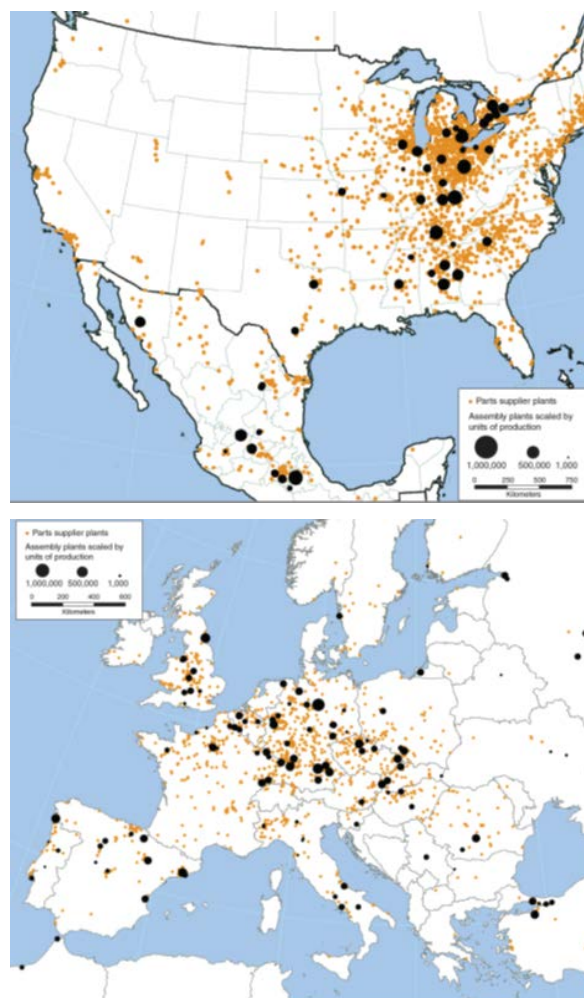
Industries can become clustered in geographic poles of activity. Graph 4 presents the distribution of motor vehicle production in Canada, Mexico and the United States (the North American Free Trade Agreement members) and the EU in 2013. The graph makes evident the clustering present in both such large integrated economic regions.

Assembly plants tend to settle in stable production clusters. The changing spatial distribution of motor vehicle production in the U.S. is instructive to understand the evolution in the EU. Clustering in North America had two distinct periods (see Klier and Rubenstein, 2016). The first period started in the 1900s in Michigan. It came about because of the existing concentration of components producers from other industries that supported the early development of motor vehicles. The second period started in the early 1980s. It arose once carmakers realised that a key factor for establishing a plant was the percentage of the nation's car dealers that could be reached within a one day drive by truck⁷. Since then, access to the interstate highways I-65 and I-75 and proximity to assembly plants in the corridor have been important factors to locate production in North America (see Klier and Rubenstein, 2016).

The EU Single Market has contributed to establish a production corridor. Prior to the EU Single Market, production was fragmented along national boundaries: collaboration between producers existed, but the "European" industry was a collection of national industries. Instead, the Single Market lowered trade barriers and established more uniform regulatory frameworks for technology (efficiency, pollution, etc.). Together with the accession of the Eastern Member States, this led to the agglomeration of production. Initially, and just

as Spain in the 1980s, the Eastern Member States were attractive because of their low ULCs. However, deciding to locate plants in these Member States also made long term sense: today, the corridor stands in the area with the highest concentration of population and economic activity in the EU (see graph 5).

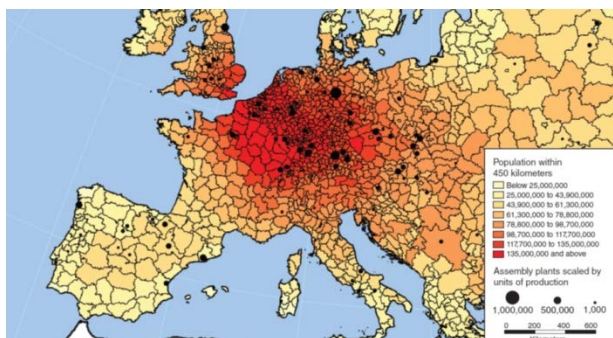
Graph 4: Auto assembly and parts supplier plants in North America and the EU in 2013



Source: Klier and Rubenstein (2016).

Motor vehicle production in Europe today is clustered in a corridor that is approximately 1300 kilometres long and 400 kilometres wide, including and extending what has been known as the "blue banana"⁸. The corridor runs northwest-southeast between the Danube River and the North Sea, extending into the United Kingdom across the English Channel (see graph 4). The corridor's ends are at approximately the maximum distance a truck driver can reach in one day from the corridor's centre in southwestern Germany. Approximately 73 percent of Europe's vehicle assembly plants and 74 percent of its part supplier plants are located in this corridor. Most motor vehicle production outside the corridor is located in a single Member State: Spain.

Graph 5: Auto assembly plants and level of population by NUTS-3 region in Europe in 2013



Source: EUROSTAT and Klier and Rubenstein (2016).

Consequences of the corridor for the EU and individual member states

Production within the EU (or NAFTA) but outside the corridor is fragile. Production inside a large integrated economic area, such as the EU or NAFTA, but outside corridors is exposed. Countries within it can suffer a decision to produce with asymmetric consequences. Competitiveness losses can trigger relocation decisions that are difficult to reverse.

At the same time, agglomeration economies can explain why ULCs are not enough to understand production location decisions. Relocation decisions can have a long term impact: assembly plants that move abroad might not return even if competitiveness improves in the original location and drops below previous levels⁹. Increasing returns in the new location justify not bringing back

production. Agglomeration economies –for instance, as presented in Krugman (1991) – provide a rationale to explain such one-sided phenomena (i.e. relocation with no reversal).

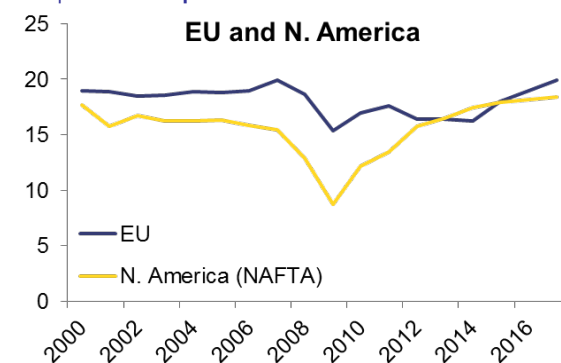
Overall, production corridors make production more stable. Deciding to move away from a given EU location can result in moving to another location within the EU or outside, to third countries. However, moving production out from corridors is unlikely. Centripetal forces drive spatial agglomeration. They were behind the opening of 17 new plants within the EU corridor between 1990 and 2013, when only 11 plants closed. By comparison, outside the corridor three plants opened and closed – see table 4. Thus, EU motor vehicle production has been more stable compared to restructuring processes taking place inside individual EU Member States, including large ones such as France. This is in common with North America, as shown in graph 6.

Table 4: Production: assembly plants in Europe

Assembly operations	Inside corridor	Outside corridor
Number of assembly plants		
Total in 1990	52	22
Opened between 1990 and 2013	17	3
Closed between 1990 and 2013	11	3
Total in 2013	58	22
Percentage of production		
1990	68	32
2013	78	22

Source: Klier and Rubenstein (2016)

Graph 6: Total production: million vehicles



Source: OICA.

To better understand the qualitative component of cars, we consider an index of quality or premium content of vehicles based on the willingness to pay of a consumer. Measuring the quality of a good or service is difficult, as it is not observable. However, the willingness of consumers to pay more for a good compared to others, all other characteristics held constant, can be considered a measure of higher quality. This is the index developed in Vandebussche (2014)¹⁰ measuring the "premium" content of motor vehicle exports. Graph 7 presents the readings of the index in several EU Member States.

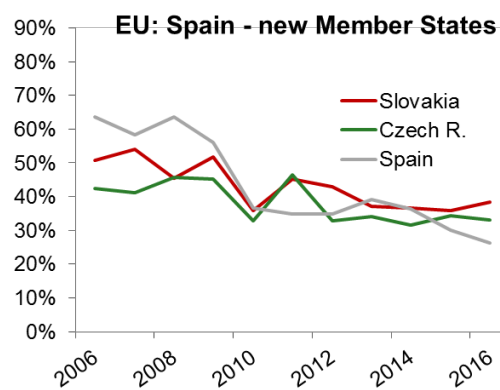
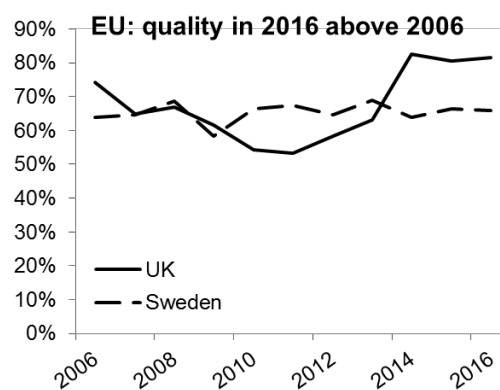
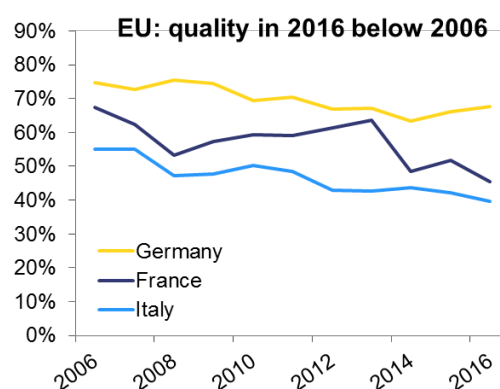
Production in the corridor is generally associated with larger vehicles and/or with higher premium content. According to the Vandebussche (2014) index, compared to other EU Member States, exports from the United Kingdom stand out as having moved up the ladder between 2006 and 2016. These trends are in line with production location decisions observed: the strengthening of the high quality brands of German groups via investments in the UK (e.g. VW with respect to Bentley and BMW with Rolls Royce).

Not all production takes place in the corridor. According to the index, vehicle exports of the four largest euro area member States experienced falls in the premium ladder. However, Germany, the country with the largest area in the corridor of the four large EU Member States, experienced the smallest loss and Spain the largest. Thus, with the exception of Germany, the other largest euro area Member States seem to have suffered a trade-off between keeping production by lowering ULCs (e.g. Spain); or experiencing a fall in production if they do not lower ULCs (France and Italy).

Production can move abroad, including to third countries, if the premium component of a good is not high enough. Qualitative variables are relevant to explain spatial location decisions. Graph 1 presented the evolution of motor vehicle production of the French and German EU motor vehicle groups outside of their home Member State, whether in another EU Member State or a third country. The graph suggests that the French groups relied more on relocating outside the EU than the German motor vehicle groups. This is in line with the information presented in graph 7 referring to the premium consideration of vehicles exported from France, compared to those exported from Germany. Moreover, trying to retain production exclusively by

lowering ULCs is not enough: the premium content of vehicles is also relevant. Spain's ULC control has come at a price as it has only kept production of lower premium vehicles. This is in line with the New Economic Geography literature's findings (see, for instance, Fujita, Krugman and Venables, 1999): that production can remain in high cost facilities, as long as the premium content of the product (its quality or non-cost competitiveness) is sufficiently high.

Graph 7: **Non-cost/qualitative competitiveness gains observed in selected countries**



Source: European Commission, Vandebussche (2014).

Implications of the corridor for policy

Economic convergence is not a distinguishing feature of agglomeration economies. Convergence, meaning per capita income convergence¹¹, with production tending to spread across a given geography, is not a distinguishing feature characterising industries with agglomeration.

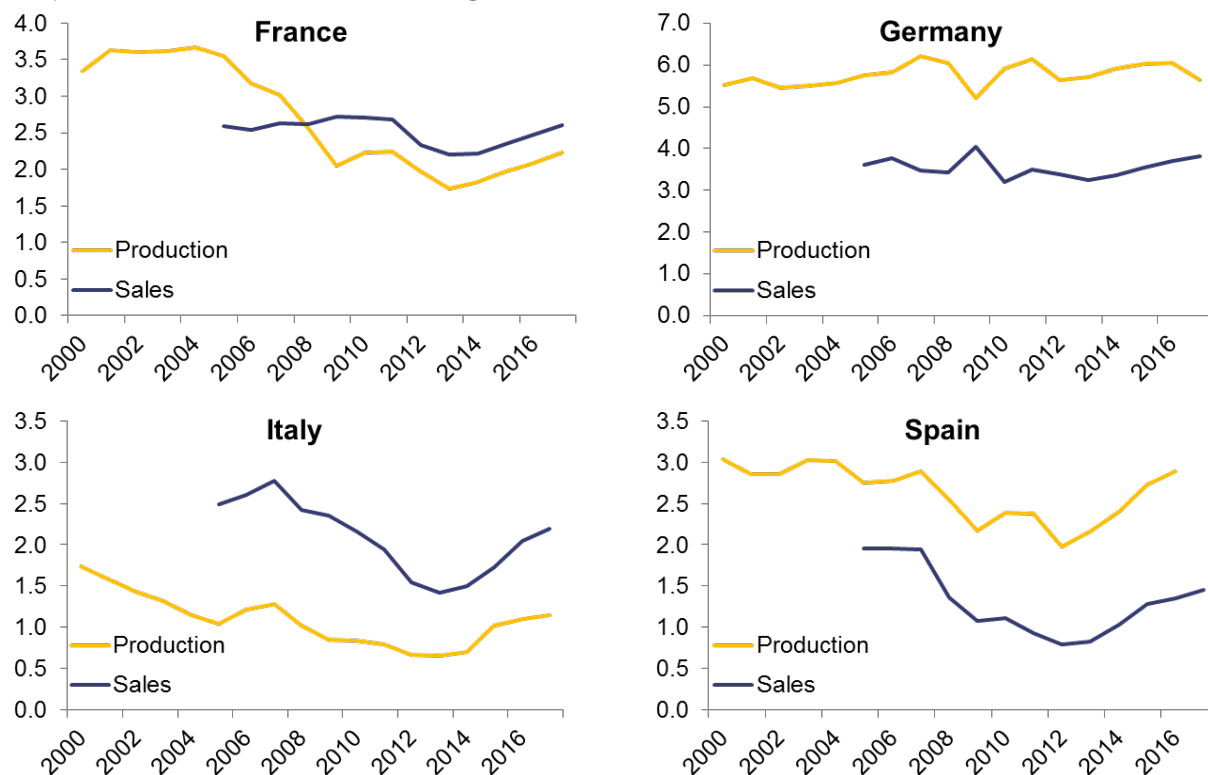
The point and purpose of characterising spatial agglomeration instead is to understand winner-takes-all types of phenomena. This is because they tend to reinforce production in a given location, as it becomes necessary to be present in it, due to increasing returns to scale limiting geographic dispersion. Thus, agglomeration economies tend to keep and concentrate economic production in one specific geographic location. Thus, the expectation that over time activity and production will spread out and establish a more even distribution of production of motor vehicles is not warranted or to be expected.

Instead, path dependence seems to characterise motor vehicle production. In economic geography, path dependence refers to the tendency for

production to remain in a given geographic location even if the original reasons that motivated settling in that location are no longer present, or are as or more present in other locations. In this case, trying to ensure a more equal distribution of production across a given geographic area might be challenging. Improving cost competitiveness will not be enough on its own to ensure production is redistributed across geographic locations. Market forces would need to be challenged to promote it.

Hence, within periods where agglomeration economies are actively concentrating production in a given location, forceful policy measures would need to be adopted to counter such agglomeration economics. Short term measures implemented during the crisis to address the impact from the crisis had limited effects to address or reverse production decisions driven by agglomeration. Graph 8 compares sales and production in the largest euro area Member States. The graph shows how the performance of Germany and Spain, on the one hand, can be distinguished from that of France and Italy, on the other. The former two Member States, which made an effort to

Graph 8: Production and sales in the largest euro area Member States



Source: OICA.

contain nominal ULCs, produce more cars than are sold in their territory. Instead, the latter two currently produce fewer cars than cars are sold in their territory. Moreover, there is little indication that this state of affairs is to change, as the evolution of production (and sales) tends to be quite stable over time. Finally, whilst France switched from being a net producer of motor vehicles (produced more in its territory than were sold in it) at the time of the crisis, the structural fall in production predates the crisis.

Nevertheless, the future is not set in stone: agglomeration economies need not last forever. The initial contribution of Krugman (1991) within the New Economic Geography literature emphasised the fact that relocation decisions might be difficult to reverse. That is, once production migrates, it might not return. Subsequent research, – i.e. Krugman and Venables (1995) or Fujita, Krugman and Venables (1999) – has developed the possibility of U-shaped patterns. These acknowledge the fact that the initial benefit to agglomerate in a given location can eventually be challenged by a subsequent fall in transport costs. At some point, the benefit of assembling in one single location falls. Eventually, production can (partly) exit core production sites (the US and EU production corridors) and eventually reach out to more distant peripheral production sites (i.e. Mexico, Spain).

Conclusion

Measures of cost competitiveness cannot fully to explain location decisions. Moving production to countries with lower unit labour costs (ULCs) represents an obvious advantage to motor vehicle groups. However, ULCs cannot explain the large differences of production between EU Member States as:

- A move can potentially take place to any location with lower ULCs, including third countries. Moreover,
- ULCs levels cannot explain why production does not tend to revert back to a Member State once a negative evolution of ULCs is addressed.

Instead, agglomeration economies unleashed by the Single Market provide a better rationale to

explain why relocation takes place within the EU and why production does not revert back to a previous location. They can explain why cost competitiveness losses become irreversible, once production moves to a new EU Member State with lower ULCs (a situation not unique to the EU, as it is also present in the NAFTA countries). Also why, once present in the corridor, a fall in ULCs would need to be quite significant to merit moving production back to the original location.

The premium content of a product also helps explain localisation decisions. Agglomeration economies counter cost competitiveness losses to a certain extent. However, if the perceived image of a car is not sufficiently "premium", production might be relocated out of the corridor, including to third countries. In this regard:

- Motor vehicle production decisions by EU groups seem to be broken into three possible premium quality grades: the EU corridor, Spain and third countries.

To sum up, the opening of national borders due to the Single market, together with the incentive to move production to lower ULC locations and perceived brand quality partly explain the differences experienced by motor vehicle production in France, Germany, Italy and Spain by the French, German and Italian motor vehicle groups. Production location decisions are made taking into account many factors, including (i) agglomeration economies; and (ii) the perceived quality of a product. The evolution of motor vehicle production in France compared to Germany presents evidence of both (i) and (ii). That is, whilst economies where ULCs increase significantly incentivise relocating, how such relocation takes place is not random. Premium products will have a tendency to remain within the EU production corridor. Instead, assembly facilities for products further down the premium range will tend to be relocated to third countries. Agglomeration economies help retain production in high cost regions, as long as the product is sufficiently high in the premium range.

Finally, in the presence of agglomeration economics, the ability of policy makers to reverse production de-localisation decisions is limited: a fall in ULCs is not sufficient to locate production back.

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¹ The term "Motor vehicles" includes passenger cars, light commercial vehicles, heavy trucks and buses and coaches. Of the 95.3mn motor vehicles produced in the world in 2016, 72.3mn were passenger cars (75.9%), 19.1mn light commercial vehicles (20.1%), 3.5mn heavy trucks (3.7%), and 0.3mn heavy buses (0.4%). The first two categories are usually considered jointly, as the most sold vehicle in the United States is a pick-up truck and it falls under the second category.

² Note: Nissan is included in the Renault group. If it is not, production of the French groups would have instead increased by about 23%, representing an increase of about 1.2 million vehicles (to reach 6.5 million).

³ With "corridor" we follow the language convention used in Klier and Rubenstein, 2016.

⁴ This includes direct employment in the manufacturing of parts and accessories (1.2 million); motor vehicles (1 million); and bodies (coachwork), trailers and semi-trailers (about 150,000) –see ACEA, 2015.

⁵ Note: besides the manufacturing of motor vehicles; bodies (coachwork) and trailers and semi-trailers; and parts and accessories (see note 3); there are employees working in manufacturing of indirect activities such as rubber tyres and tubes, re-treading and rebuilding of rubber tyres; computers and peripheral equipment; electric motors, generators and transformers; bearings, gears, gearing and driving elements; cooling and ventilation equipment. Hence, the additional 10.1 million of indirect employment includes such manufacturing activities (825,000 employees); Automobile use and the subsequent service provided by producers (4.3 million employees); transportation (4.4 million employees) and in the construction and repair of the infrastructure where motor vehicles circulate (600,000 employees) –see ACEA, 2015.

⁶ Motor vehicles is the first exporting good of the EU in value, the top world R&D investor is a European car manufacturer (VW) and, taken together, the six EU groups invested more than EUR 35 billion in R&D in 2017, being among the top 60 R&D investors worldwide –see EC, 2017.

⁷ The North American corridor runs north-south between Michigan and Alabama (see graph 3). Approximately 73 percent of North America's auto assembly plants and 62 percent of its part supplier plants are located in it. Most motor vehicle production outside the corridor is in Mexico. However, its "centre" is in Kentucky, several hundred kilometres east from its population centre in Missouri. It is more of a statistical construction, as it is not densely populated, is too far west to permit one day delivery to the densely populated East Coast markets and is not far enough west to permit reaching the other densely populated pole in California.

⁸ The Blue Banana is a discontinuous corridor of urbanisation defined in 1989 by a group of French geographers led by Roger Brunet. It is considered to spread between Western and Central Europe, within the EU15. The motor vehicle production corridor analysed in this paper extends beyond this corridor into the new EU Member States, including the Czech Republic and Slovakia.

⁹ Paul Krugman has both presented a formalisation of this phenomenon (see Krugman, 1987 or Krugman, 1991); as well as, why it can revert back, together with Anthony J. Venables (in Krugman and Venables, 1995).

¹⁰ This measure permits comparing country of origin exports (EU MS, the US, China and Japan) to the EU by normalising the quality rank of a good, within a narrow category (e.g. Motor Vehicles, Trailers and Semi-Trailers). A rank of 1 reflects the highest quality for a particular category, while 0 represents the lowest.

¹¹ See Barro and Sala-i-Martin (1992).

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