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Keith Head[a], Philippe Martin[b] and Thierry Mayer[c]

Car Wars: Competitiveness, Trade and the Geography of Car Production

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The push for reshoring –moving European manufacturing back to European shores– has gained momentum in the post-Covid-19 context, especially in France. Trade tensions that were already high before the pandemic experience will not abate. Furthermore, climate change requires ambitious reductions in CO_2 emissions. Finally, the Covid-19 crisis is hitting demand for durable goods. These different challenges are particularly severe for the car industry since, among manufacturing sectors, it is one of the most integrated internationally through global supply chains. It is also very footloose and a de-globalization trend, be it policy driven (trade policies) or market driven (higher costs of international transport or coordination), may rapidly change the geography of production. Who will benefit and who will lose with such scenarios? What to expect for the French and European car industry in the aftermath of the Covid-19 crisis, surrounded with global trade uncertainty, Brexit and environmental transition?

The purpose of this *Note* is to document the medium-term challenges that the car industry faces with a particular focus on France: a long-run trend of competitiveness loss, trade wars, stricter environment policies and a potential reshaping of international trade costs following the Covid-19 crisis. We analyze how these challenges affect costs and sourcing decisions of automobile manufacturers. Based on a quantitative empirical model, calibrated on very detailed data on existing car models, this *Note* considers several medium-term scenarios and provides estimates of their effects on the location of production and prices. We show that a transatlantic car war would have little effect on France but a major negative one for Germany. As for Brexit (especially with no agreement), it would generate a small positive effect for France but a large negative one for the UK. Also, trade agreements with developed countries would have a negative impact on French car production. Reshoring may come from car producers taking a fresh look at the costs of off-shoring after the Covid-19 crisis. In such a market-driven scenario, France would indeed gain production but with non-negligible costs for consumers. In a second scenario, policy driven, the competitiveness of the French car industry is improved, through cost reduction and productivity increase: this would result in gains for both producers and consumers. This is the strategy we recommend. It may involve having a policy that encourages clusters in the auto industry located in the North and East of France.

Given the magnitude of the competitiveness gap, the reshoring of the car industry to France will be at best gradual and partial however. Tariffs on EU imports of cars, that can be justified on the basis of CO_2 border adjustment mechanisms, would also lead to some modest reshoring to France but at the cost of higher prices for consumers. Such a policy, which we favor should therefore be viewed as an environmental policy rather than a form of disguised industrial policy.

[a] University of British Columbia, Sauder School Business; [b] Sciences Po, Member of the CAE; [c] Sciences Po, Member of the CAE.

The challenges of the car industry

The car industry is large enough to matter for world growth: the sector accounts for 6% of global output (8% of exports) and for 5.8% of the total employed population of the EU (nearly 5% in the US).[1] In France, it employs 210 000 (INSEE) full-time workers in 2017 and makes around 16% of the manufacturing revenues.

The car industry is also a very integrated industry and production is very footloose. Moving the assembly of a car model between factories is indeed easy. One estimate of this footlooseness is that a 1% increase in relative costs in a plant decreases by almost 8% the probability that this plant will be chosen to produce a car model (see Box 1). One reason is that all cars companies own several factories throughout the world. Toyota for instance has 63 production sites. While the creation of new factories remains costly, it is relatively easy to offshore production of a specific model from one plant to another, inside the same group.

This sector is currently at the crossroad of three of the main challenges of the world economy: the global recession, trade wars and climate change. The automobile industry has contracted in 2018, hence before the coronavirus outbreak, for the first time since the global financial crisis, contributing to the global slowdown in 2019. The Covid-19 crisis came on top of this decreasing trend: its effects for the sector are massive and will probably have long term consequences.[2]

In the car industry, vehicle sales in Europe in 2020 are predicted (based on July data) to be less than 14 million, compared to 18 million in 2019 (IHS-Markit). The fall is particularly significant for the USA and the EU. The recovery of production will take place gradually: supply constraints will be followed by a large demand deficit. This *Note* will not analyze the short-term impact of the lockdown and the recessionary impact of the crisis on the car industry. Rather, we will focus on the medium-term supply side challenges of the crisis for the industry and some debates around reshoring that re-appeared with the Covid-19 crisis. The increased trade tensions –embodied by the protectionist policy turn initiated by President Trump– weigh heavily on the industry. This *Note* will estimate the impacts of both trade wars scenarios and trade peace scenarios. Finally, the car industry is a key element in CO_2 emissions (transport by personal cars represents 18.2% of EU total emissions)[3] and any ambitious plan to reduce these emissions requires a drastic transition for the industry.

Loss of French competitiveness in the car industry (the long-term trend)

A French decline since the peak in the early 2000s

France has experienced in the past 20 years a decline in competitiveness in the car industry, illustrated by factory closures, and a decrease in employment and production as illustrated by Figure 1. The number of jobs in the car industry fell by 36% between 2000 and 2018. The French car industry ranks fifth in the EU when it used to be the second largest until 2011.[4] Figure 1 however shows a major difference between the massive decrease in production by the two French groups, compared to a relative stability of the two foreign firms that invested in France. In our conceptual framework, this difference between French car manufacturers on the one hand (PSA and even more so Renault-Nissan) and foreign car manufacturers on the other (Daimler and Toyota) can only be explained by the fact that unit labor costs in French Renault-Nissan plants are higher than at French plants in Daimler and Toyota French plants.

This difference may be partly explained by the age of the factories: new factories are generally more efficient and better equipped for the modern production process than older ones. It may also be explained by a stong heterogeneity between firms' strategies. Indeed, when Renault decided to offshore the production of the Twingo and later the Clio model abroad, Toyota decided to push forward the "Made in France" label for the Yaris production. The massive decrease in car manufacturing in France is linked to a strong offshoring trend since the early 2000s. Head and Mayer (2019) show that offshoring from France was much more significant compared to Germany, the USA, Japan or the UK.[5] The difference is further reflected when using a narrow definition of offshoring (i.e. when focusing on relocation of production intended to serve the domestic customers). For the USA and Germany, this type of offshoring remained relatively stable over the period while Italy and France largely relocated output to developing countries. Only Italy's level of offshoring compares to the one of France. Within France, Renault has witnessed the highest increase in offshoring and is one of the top five offshoring brands in the world.

The authors would like to thank Jean Beuve and Étienne Fize, Hugues Génin, respectively Scientific Advisor, Economist and trainee at the CAE. They also thank Samuel Delpeuch for his work on the simulations.

[1] International Monetary Fund (IMF) 2019): *Global Manufacturing Downturn, Rising Trade Barriers*, World Economic Outlook, October.

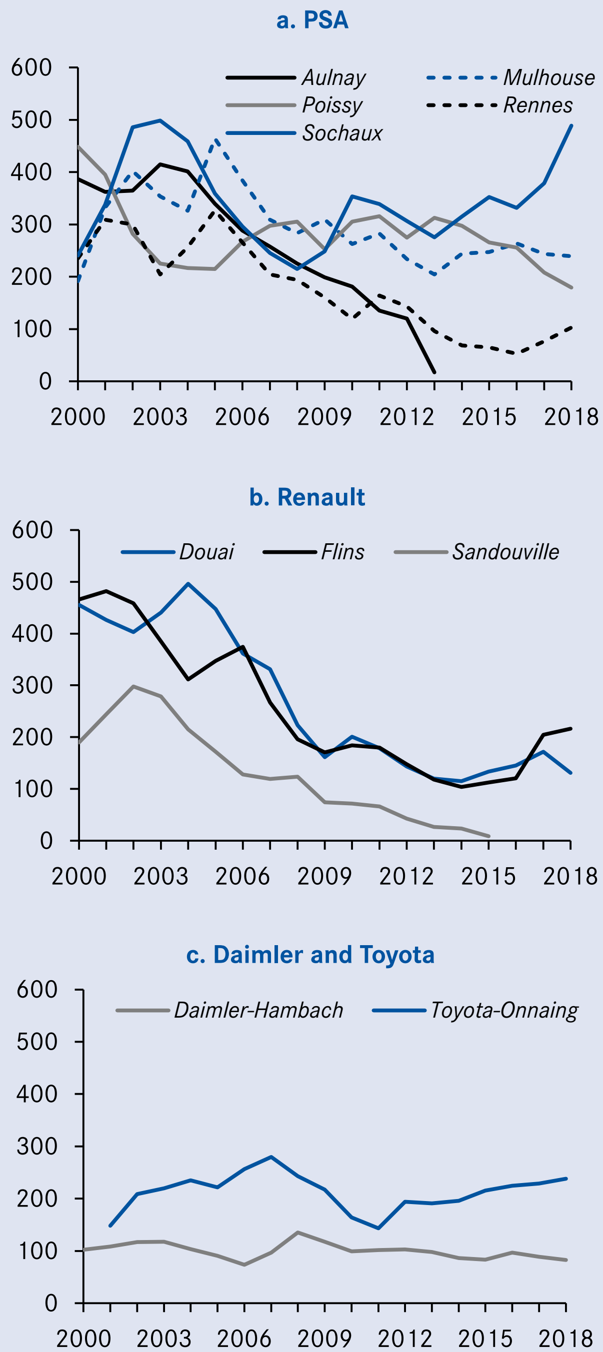
[2] Ewing J. (2020) : "The Pandemic Will Permanently Change the Auto Industry", *The New York Times*, 13 May.

[3] European Parliament (20149): *Émissions de CO_2 des voitures : faits et chiffres*, Infography. Available on https://www.europarl.europa.eu/news/fr/headlines/society/20190313STO31218/emissions-de-co2-des-voitures-faits-et-chiffres-infographie

[4] Vacher T. (2019) : "L'industrie automobile en France : l'internationalisation de la production des groupes pèse sur la balance commerciale", *INSEE* Première, no 1783, November.

[5] Head, K. and T. Mayer (2019): "Misfits in the Car Industry: Offshore Assembly Decisions at the Variety Level", *Journal of the Japanese and International Economies*, no 5, pp. 90-105.

1. Evolution of car production in French factories
in thousands



Reading: The numbers only include passenger cars (excluding light-commercial-vehicles; The vertical axis is in 1,000s of passenger cars.
Source: IHS-Markit.

It is important to distinguish in the diagnostic of French competitiveness loss what part comes from the loss of competitiveness of France as a production site, and what can be explained by the loss of attractiveness of French brands. The graphs above suggest that the loss of competitiveness is specific to French car manufacturers. To go further, we compare how different European countries have fared in terms of home car production (whether car producers are domestic or foreign) and in terms of national car producers (whether the cars are produced at home or abroad). The Figures 2a and b show the main European countries share of world car production (excluding China) and the main European producers share of world car production (again excluding China). The case of France is striking. The fall in the share of cars assembled in France was steep 2002 and stabilized after 2014. The fall of the production (and sales) accounted for by French brands (Peugeot, Renault and Citroen) has been much smaller, because of the off-shoring of production outside of France. Hence, these graphs put together suggest that the loss of competitiveness is specific to French car manufacturers producing in France. The French producers can be competitive and France can be a competitive production site but French car manufacturers producing in France have a competitiveness problem.

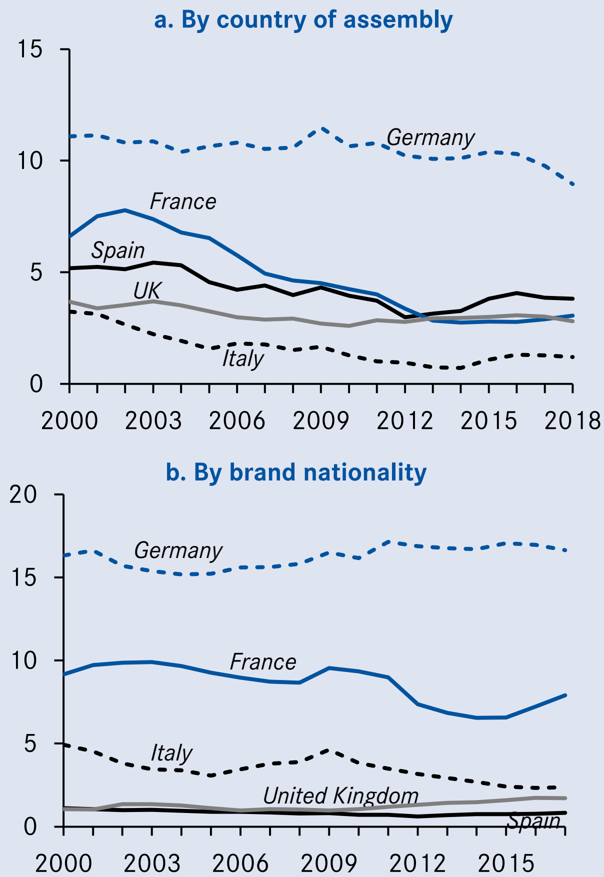
Competitiveness of the auto sector in each country can be decomposed into two major contributions. The first is low unit labor costs (wages divided by productivity), and the second is economies of scale that allow to reduce production costs and that directly relate to the size of the national industry. These economies of scale are empirically well-grounded in the manufacturing sector: the productivity of individual plants increases (or production costs fall) when the overall production located nearby increases. This is due to several types of localized spillovers which the economic literature has identified such as more effective sharing of intermediate goods, equipment and local infrastructure; more efficient local labor markets and training; localized technological externalities where the clustering of firms fosters the emergence of new knowledge and innovations. The empirical estimate by Head and Mayer (2019) for the automobile industry is that a 10% increase in national production decreases production costs by around 0.33%. There are good reasons to believe that these spillovers are even stronger at the regional than at the national level.[6]

Based on the observed decisions by brands regarding where to locate car production, we can quantify the competitiveness of each country as an assembly location.[7] We can further decompose the index to characterize each country in terms

[6] One example is Martin P., T. Mayer and F. Mayneris (2011): "Spatial Concentration and Plant-Level Productivity in France", *Journal of Urban Economics*, vol. 69, no 2, pp. 182-195, which uses French firm level data to show that a 10% increase in the number of workers in the sector and in the department where it produces increases productivity by 0.5 to 1%.

[7] This competitiveness index differs from country attractiveness because it is directly linked to the costs of assembly/productivity advantage of the country and does not depend on market size or market access.

2. Share of world output (excluding China), in %



Source: IHS-Markit.

of whether its overall competitiveness comes more from unit labor costs or local economies of scale. To do this, we build on the work and the quantitative model by Head and Mayer (2019)[8] and the use of worldwide detailed dataset on car manufacturing and shipping (Box 1). Delpeuch *et al.* (2020)[9] use data over the 2000-2018 period in order to display these contributions for 24 car-producing countries and shows that France is the median country in this set of countries. French high unit labor costs impose a disadvantage relative to most countries for example neighboring Spain. French remaining competitiveness advantage is based on its remaining relatively large production size that allows economies of scale to reduce its production costs. Countries that benefit more than France from this source of competitiveness are large producers such as the United States, Korea, Germany or Japan. However, this source of competitiveness is fragile and falling since car production in France has declined. This is an important point: as car production falls, economies of scale mean that production costs increase which further reduces competitiveness of France as a production site. The closing of one large plant may therefore have ripple effects on other production sites. We can also use our empirical model to answer the following question: how much would production costs need to fall in French production sites so that France reaches back its 2002 peak of production relative to Germany (and doubles its present production)? The answer is that costs would need to fall (or productivity to increase) by around 20% for car producers (French and foreign). This is not supposed to be a short-term realistic scenario but provides a quantitative estimate of the deterioration of competitiveness in the past 20 years.

Finding 1. France has suffered a major competitiveness loss in the car industry in the past 20 years that would require a cost reduction of around 20% to undo. It is most visible for French car makers production sites and less so for French car makers producing abroad and foreign car makers producing in France. This production fall has in turn amplified, though scale effects, the fall in competitiveness.

The cost structure of the French car industry

The decomposition of the operating costs structure of the car industry shows that, compared to the rest of the economy and even to large exporting sectors (sectors that export more than 30% of their production), this industry's costs are heavily driven by imported inputs[10]. Direct labor costs represent only 15% of operating costs (against 24% for export intensive sectors), while indirect labor costs (through the purchase of domestic intermediate inputs) are large at around 28% of total costs (against 26% for export intensive sectors). When considering together direct and indirect labor costs, it appears that low wage levels (below 1.6 minimum wage or SMIC) represent 10% of total costs and intermediate labor costs (between 1.6 and 3.5 SMIC) a share of 23%. L'Horty, Mayer and Martin (2019, *op. cit*.) had found no impact of reductions in social contributions on higher wages (above 1.6 SMIC) on manufacturing exports presumably because these reductions translate into higher wages[11] and not higher competitiveness. This does not mean that labor costs do not matter for manufacturing competitiveness but that reductions in social contributions are probably not the way to go in order to increase competitiveness in the car industry. Moreover, the stark difference between revealed unit labor costs in Renault plants, and the French Toyota plant for instance, suggests that the difference in competitiveness lies more in the plant-specific productivity side of unit labor costs than in wages.

[8] Head K. and T. Mayer (2019): "Brands in Motion: How Frictions Shape Multinational Production", *American Economic Review*, vol. 109, no 9, pp. 1-52.

[9] Delpeuch S., E. Fize, K. Head, P. Martin et T. Mayer (2020) : « Attractiveness, Trade Policy and Globalization: Additional Scenarios », *Focus du CAE*, n° 45, juillet.

[10] L'Horty Y., T. Mayer and P. Martin (2019) : "The French Policyof Payroll Tax Reductions", *Note du CAE*, n° 49, January; Koehl L. and O. Simon (2019) : "Quels poids des bas salaires, directs et indirects, dans la production des branches ?", *Focus du CAE*, no 28, January.

[11] On how lower social contributions can lead to increased wages, see Carbonnier C., L. Py and C. Urvoy (2020): "Who Benefits From Tax Incentives? The Heterogeneous Wage Incidence of a Tax Credit », *PSE Working Paper*, no 2020-08.

1. The Double CES Multinational Production Model

The core elements of this model are two *share equations*. The first share governs the source country for goods to be sold in a given market; the second determines the market share of the firm in that market. Each equation has its origins in a foundational paper for the modern approach to international trade. The sourcing share comes from Eaton and Kortum (2002)[a] whereas the market share equation is adapted from Melitz (2003).[b] Many authors contributed to the synthesis of the two equations into a full-fledged model of multinational production. The version employed in this paper owes the greatest debt to Tintelnot (2017)[c] and Arkolakis *et al*. (2019).[d]

The sourcing share equation has the following simple logic. The multinational has a range of choices over where to manufacture and assemble the cars it wishes to sell in a target market. For each variety it sells, it selects the lowest cost plant from the set of countries where it has already established production capabilities. This constitutes a *medium-run response* because it holds the set of production locations constant. Close to 90 percent of OECD car production takes place in countries where brands were already assembling in 2000.

Large multinational firms source different car models from different plants. A single parameter θ captures how substitutable countries are as assembly locations, or how "footloose" the industry is. The higher is θ, the more responsive sourcing shares will be to differences in wages, tariffs, and transport costs.

The sourcing decisions each firm makes determines its cost competitiveness in each market. Firms with facilities in low-cost, high-access countries will benefit from lower delivered costs. These cost advantages translate into higher market share according to the second CES parameter, η. This demand side parameter reflects how substitutable different car brands are in the eyes of consumers.

Higher tariffs reallocate production through several channels in our model. They first motivate each firm to shift assembly towards countries that retain low-tariff access to a market. The more dependent a brand is on the tariff-impacted source countries, the greater the loss of competitiveness it will suffer. The resulting loss in brand market share then further contributes to product reallocation. The magnitudes of these two channels are determined by our estimates of θ and η, which are themselves disciplined by past tariff variation.

Our full model adds two additional channels. First, firms will tend to drop models in markets where tariffs have made them less competitive. Second, a brand whose total profits in a market shrink too much, will ultimately drop out of the market altogether. The final channel of adjustment considered in our model operates at the national level. Reflecting the well-documented agglomeration economies existing in the car industry, all brands in a country suffer from poorer supply networks when the national production base shrinks.

The model is implemented using very detailed data on car manufacturing. The data comes from IHS-Markit and give information on the production at the plant in each country level for every model by a brand. In our dataset, there are more than 120 brands assembling vehicles in 50 countries, and selling over 2000 car models in 76 markets. The model is able to offer predictions of the impact of a tariff or a cost reduction on the increase or decrease in sales of the Toyota factory in Onnaing in each country where this factory currently sells the Yaris (the only car produced there). It also predicts how the sourcing decisions for each car model are affected (the assembly of the Yaris cars sold in France could be relocated in whole or in part to another Toyota plant in the US, Canada, Japan, etc.). However, the simulations do not allow for the opening or closing of new production sites. We should therefore interpret these results as the impact of the different scenarios over a mid-term horizon (around 5 years, which is a reasonable time frame for opening or closing a car plant).

The empirical estimate of the "footlooseness" (the θ elasticity parameter), is that a 1% increase in relative costs in a plant (for example through a change in tariffs on cars exported) decreases by almost 8% the probability that this plant will be chosen to produce.[e] The elasticity that measures how much consumers substitute between models because of changes in prices is lower at around 4.

[a] Eaton J. and S. Kortum (2002): "Technology, Geography, and Trade", *Econometrica*, vol. 70, n° 5, pp. 1741-79.

[b] Melitz M.J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, vol. 71, no 6, pp. 1695-1725.

[c] Tintelnot F. (2017): "Global Production with Export Platforms", *Quarterly Journal of Economics*, vol. 132, no 1, pp. 157-209.

[d] Arkolakis C., N. Ramondo, A. Rodríguez-Clare and S. Yeaple (2018): "Innovation and Production in the Global Economy", *American Economic Review*, vol. 108, no 8, pp. 2128-73.

[e] Head K. and T. Mayer (2019): "Brands in Motion: How Frictions Shape Multinational Production", *American Economic Review*, vol. 109, no 9,pp. 3073-3124, also see regarding offshoring: Head K. and T. Mayer (2019): "Misfits in the Car Industry: Offshore Assembly Decisions at the Variety Level", *Journal of the Japanese and International Economies*, no 52, pp. 90-105.

Rising trade tensions

The car industry is often taken as a target for protectionist attacks. President Trump has repeatedly threatened to tax imports of cars from the EU by as much as 25% based on national security threat (the so called section 232). Other countries have also retaliated to US protectionist attacks by tariffs on US car imports.[12] The US tariffs on the EU have not materialized (yet) but a transatlantic car trade war is often

[12] In August 2018, Turkey announced new tariffs on car imports from the US, in response to tariffs on Turkish steel and aluminum. In response to Trump's forthcoming tariffs on $300 billion of Chinese goods, China announced it would increase its average tariff on US autos from 12.6 to 42.6 percent (*cf*. Bown C.P. and M. Kolb (2020): *Trump's Trade War Timeline: An Up-to-Date Guide*, Peterson Institute for International Economics, March).

viewed as a credible threat that shapes the transatlantic economic relations and could push the EU to negotiate a trade deal with the US. The recent withdrawal of the US from negotiations on global tax reform discussions organized by the OECD could also renew transatlantic trade tensions.

Several "car wars" scenarios were simulated to assess their impact on the geography of production as well as on prices paid by consumers:

- Section 232 on EU: The United States imposes a 25% tariffs on EU assembled cars. The baseline scenario has no retaliation on the car industry, but the focus also shows simulations with symmetric retaliation;
- Section 232 on major producers: The same tariff is imposed to EU + Canada + Mexico + China + Japan + Korea;
- The same as first two scenarios applied to car parts as well as the final product.

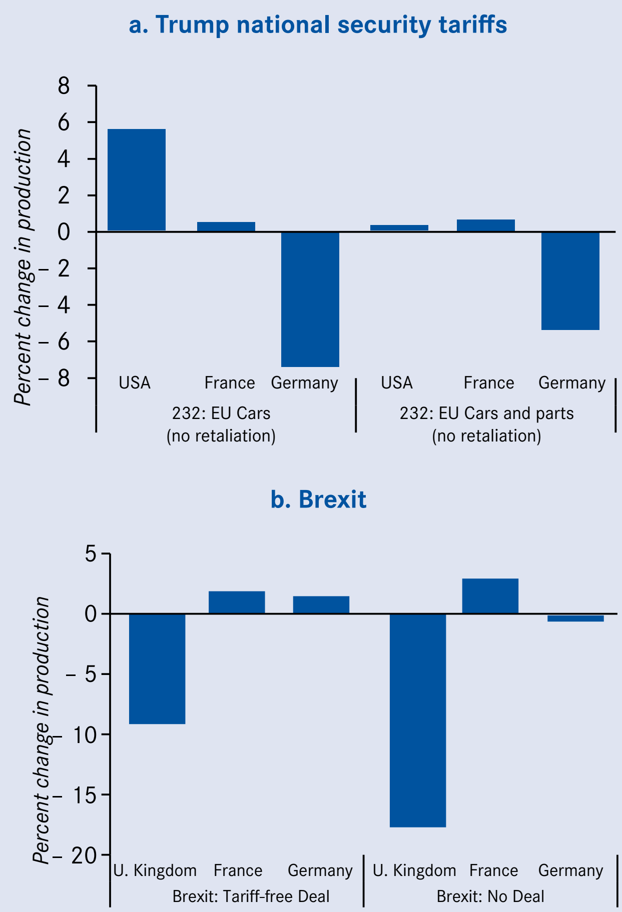
We also evaluated the perspective of "car peace" scenarios:[13]

- Agreements in force:
  - EU-Japan EPA: An agreement that entered into force on 1 February 2019, it will ultimately reduce all tariffs in the car industry between the EU and Japan to zero (which is already the case for Japan as an importer);
  - EU-Mercosur: trade pact between the EU and a bloc comprising Argentina, Brazil Paraguay, and Uruguay (agreed in 2019);
  - CETA + CPTPP: Canada's free trade agreement with the EU (September 2017), considered in combination with Canada's participation in the 11-country CPTPP (into force, December 2018).
- Potential agreements:
  - DCAA: An agreement between the EU, NAFTA, Japan and Korea were all tariffs in the car industry (cars and parts) are reduced to zero;
  - WAA: The same scenario as DCAA, but applied to the whole world;
  - TTIP: Currently moribund (12^{th} round of negotiation held in 2016) proposed trade pact between the EU and US.

Tariff wars in the car industry (Trump national security tariffs & Brexit)

Figure 3a summarizes results for Section 232 applied to EU countries for output in France, Germany and the United States for two scenarios: one where the tariff is applied on cars only, one where the 25% tariffs apply to parts as well.[14] The main conclusion is that Germany would be the main victim of the trade war whereas France would experience a small increase in production by 0.5%. This is because the losses from reduced Toyota and Smart exports to the United States are more than compensated by a rise of cars assembled in France to be sold in France and in the rest of the world. The reason is that Section 232 hurts Germany, and the UK to a large extent (the US market represents 9 and 14% of their total respective production). The fall of German and British productions reduces the external economies of scale in those two countries, increases their production costs and benefits France as a production base in all markets where those three countries are competitors.

3. Trade wars scenarios



Source: Simulation by authors, IHS Markit.

The effects on Germany and the United States are substantial and mirror images of each other in the case when tariffs are applied only to cars. The application of high tariffs on car parts would turn the US gains into negligible numbers,

[13] Acronyms: CETA (Comprehensive Economic and Trade Agreement); CPTPP (Comprehensive and Progressive Agreement for Trans-Pacific Partnership); DCAA (Developed Country Auto Accord); EPA (Economic Partnership Agreement); NAFTA (North American Free Trade Agreement); TTIP (Transatlantic Trade and Investment Partnership); WAA (World Auto Accord).

[14] We do not present here a case where the EU retaliates on US car exports because it is more likely that the EU would retaliate through tariffs on other US goods exported to the EU. See Delpeuch (2020), *op. cit.* for the case with retaliation. Under the scenarios of retaliation to Section 232, France gains even more (see Figure 5 in the appendix). This is because French production displaces SUVs imported from the US, notably those produced by BMW, Mercedez-Benz and Jeep.

because of the reduced competitiveness of car assembly when imposing 25% tariffs on key inputs. It would also reduce the losses to German car manufacturing. Our results suggest that the US threat of a trade war on the European car industry (especially if it includes car parts) must be taken seriously and should be a concern —especially for Germany. However, the risks involved by this threat for the EU countries are not large enough as to justify making concessions on a trade agreement with the US that would sacrifice other policy priorities. This in particular relates to the commitment that the EU should not sign a trade agreement with a country that has left the Paris agreement on climate change. This is consistent with the recommendation of Jean, Martin and Sapir (2018).[15]

Recommendation 1. The EU should not give in to the US threats of a car trade war and not renege on its commitment not to sign a trade agreement with any country that has left the Paris agreement on climate change.

The Covid-19 crisis has derailed the Brexit negotiations and has potentially increased the probability of a no-deal Brexit. Figure 3b shows large losses of British-based production as result of Brexit especially in a no-deal Brexit. The reason is that the UK becomes a much less attractive location to produce and export to the EU market due to the difference in market size. The predicted losses in the no-deal scenario are greater than 15%. French plants benefit modestly at home and in the rest of the EU as a consequence. The increased costs of UK plants because of lower scale, combined with the protection imposed on UK exports by the EU, dominate the lost exports in Great Britain. The positive and negative effects turn out to balance each other more equally for production of German plants.

Scenarios for regional agreements and global car deals

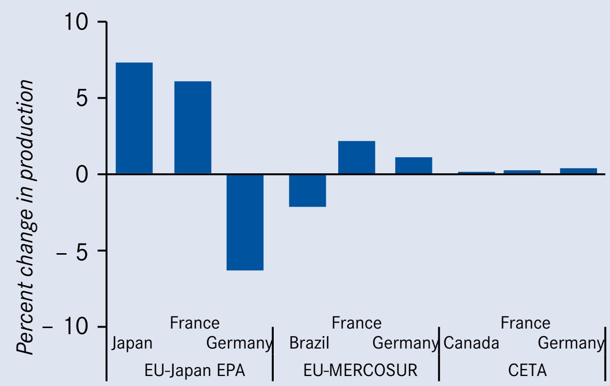
Regarding the consequences of the trade agreement scenarios, we start with recently signed (CETA, and EU-Japan) or under discussion (EU-Mercosur) agreements, summarized in Figure 4a. The first noticeable finding is that CETA is predicted to have positive but tiny production effects, due to the small size of the pre-existing flows between the EU and Canada. Furthermore, there are no European brand plants in Canada, which would benefit from deeper integration with the headquarter country as found in Head and Mayer (2019). Those plant productivity gains linked to the assembly and headquarter countries being in the same regional agreement are on the contrary very substantial for the EU-Japan EPA scenario. The consequences are estimated to be large for the production in France of Toyota (Onnaing) and Nissan (Flins) cars.

In an EU-Mercosur scenario, Peugeot gains large sales through exports, Renault much less because there are almost no exports to start out with due to the presence of large local factories in the Mercosur market (Argentina, and even more Brazil).

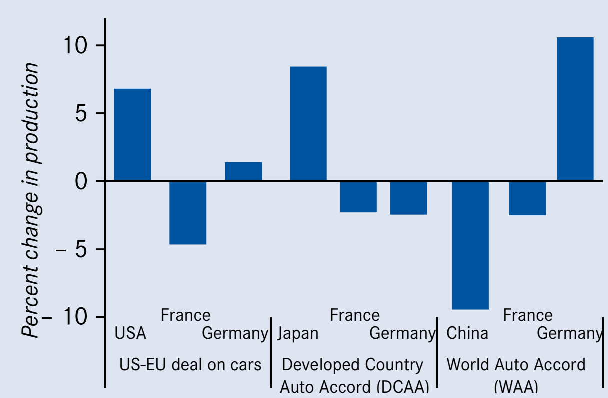
Figure 4b displays simulation results for three more possible trade agreements scenarios which are not yet in discussion. In the case of the rich country agreement (DCAA), France and Germany lose car production because of the improved access of Japanese and Korean plants to OECD markets. A worldwide agreement (WAA) would generate large car production gains for Germany because of China's opening. These gains would not exist for France because its current exports to China are almost nil. The large winners of this scenario are Japan, the United States and Germany. China would lose 8% of its production (its current tariffs being around 25%).

4. Scenarios for regional agreements and global car deals

a. Recent deals



b. Prospective regional deals



Source: Simulation by authors, IHS Markit.

[15] Jean S., P. Martin and A. Sapir (2018): "International Trade Under Attack: What Strategy for Europe?, *Note du CAE*, no 46, July.

Finally, when evaluating a EU-US deal (TTIP revived), one has to keep in mind that BMW is the largest US car exporter to the rest of the world and that more than 25% of US-made exported cars are assembled by German manufacturers. Also, more than 70% of US car exports to the EU consists of German brands (BMW and Mercedes-Benz SUVs in particular). Therefore, the efficiency gains obtained from TTIP (both car products being headquartered in Germany, a country included within the prospective agreements) benefit those two brands to a very large extent across all destinations. The effect is magnified by the opening of the EU market dropping its 10% most-favored nation (MFN) tariff on those cars. For Germany as a production country, this effect is compensated by increased sales of other cars in the US, and also by the important increase in efficiency of the Ford factory headquartered in Germany. For production in France, all those effects are negative competition shocks which dwarf the modest increase in sales of Smarts and Toyotas made in France; hence a substantial fall (over 4%) of output.

Finding 2. France gains car production from signed (CETA and Japan-EU) and under discussion trade deals (EU-Mercosur) but loses car production from potential deals that liberalize car trade with developed countries, the US or the world. French and German interests in car production are not aligned on trade agreements.

As developed in the companion *Focus* of this *Note*, there may be a trade-off between the consumer and the producer surplus in all scenarios of trade policies. This trade-off is not systematic, for instance regarding the EU-Mercosur, CETA and EU-Japan deals, France benefits from a higher production but also higher consumer surplus. However, the EU-US and the two liberalizing DCAA and WAA deals favors consumer (around + 0.5% consumer surplus for the three scenarios) but decreases production (– 4.6, – 2.2 and – 2.4% respectively).[16]

The model and data only allow us to look at car-assembly part of the industry. However, France is also a big producer of car parts that are used as intermediate consumption for the car industry. France exports and produces more car parts than cars.[17] According to the BACI database of the *Centre d'études prospectives et d'informations internationales* (CEPII), France exported around 21 billion euros of car parts[18] in 2018 and imported slightly less (19 billion). Often located close to car-assembly factories, this industry will also be affected by the same issues (e.g. trade wars, off-shoring), however probably in a different way as France has a slightly positive trade balance on car parts but a negative trade balance on cars (– 9.5 billion). In particular, France would also be hit indirectly by any trade war affecting negatively car production in Germany as it exports car parts to Germany (4 billion).

What would de-globalization and re-shoring in the car industry entail?

Re-shoring of manufacturing is a recurring debate in France which came back in the public debate with the Covid-19 crisis and an objective that is common to many past and present governments. We see three possible reshoring scenarios in the medium term:

- A market-driven de-globalization scenario where firms reevaluate the costs of off-shoring and relocate production to their main markets and their home;
- A policy-driven competitiveness scenario where re-shoring in France is driven by policies that reduce costs or induce productivity gains;
- A trade policy scenario where the EU applies import tariffs or equivalents on car imports that could be rationalized by a border carbon adjustment mechanism.

These scenarios are very different and we believe their analysis helps to clarify the debate on the quantitative trade-offs involved by each of them and in particular on the questions of who gains, who looses and how much?

A market-driven reevaluation of international trade and coordination costs

We simulated a scenario where the Covid-19 pandemic increases perceived transport and coordination costs, outside national borders. More precisely, all frictions affecting flows that cross a national border will be increased. The rationale is that the pandemic crisis severely impacted the transportation and coordination costs in the short-run with the closing of most borders, and may affect those costs in the longer run as well. These increases in costs come, for instance, from travel restrictions, increased transports costs, sanitary measures, border closing, and disrupted global value chains. It is likely that companies will face higher costs and frictions and therefore will have to re-evaluate their strategies, independently of other potential external forces such as specific trade or economic policies. We postulate an –admittedly not precise– baseline scenario where both coordination and transport costs are increased by around 20% worldwide (Delpeuch *et al*., 2020, *op. cit*., provide more scenarios).

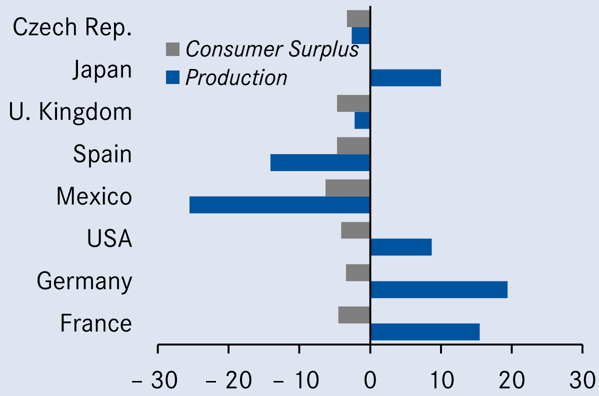
Figure 5 provides the estimation results on the change in production and consumer surplus on a chosen subset of 8 representative countries. Besides Japan, the consumer surplus decreases everywhere by 3 to 6%. The increase in these frictions ultimately transfer into price increases and are not compensated by external economies of scale.

[16] See Delpeuch *et al*. (2020), *op. cit*.

[17] See Figure 5 in Vacher (2019), *op. cit*.

[18] We use the following harmonized system codes for car parts: 870600, 870710, 8708, 840733, 840734, 840820, 840991, 840999.

5. A market-driven reevaluation of international trade and coordination costs, percent change



Source: Simulation by authors, IHS Markit.

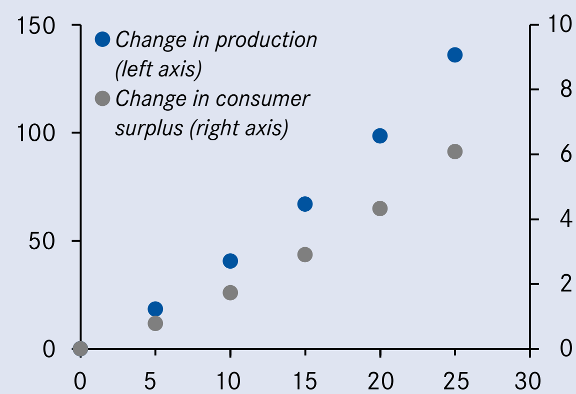
Production however evolves differently. The increase in the coordination cost makes firms more likely to relocate production in their headquarters countries, therefore benefiting countries like France, Germany or Japan and hurting countries such as Mexico, Spain and the Czech Republic. The increase in transport costs gives incentives for firms to concentrate output near demand. This will benefit large markets such as the United States. It will however hurt large net exporters such as Germany or Japan that sell an important part of their production abroad. In the baseline scenario, Germany benefits more from the coordination cost effect than it loses from the transport cost one. It is a symmetric situation for the USA: production suffers less from the increase in coordination cost than what it gains from the increase in transport costs. The effect on France is positive regarding car production for both cost increases but negative for consumers as costs and prices increase. In the baseline scenario, car production increases by 15.5% and prices for consumers increase by 4.5%. Faced with increases in coordination costs, French producers will repatriate production from their Spanish, or Eastern European factories to France. Also, because France is a net importer of cars, the increase in transportation costs will tend to raise domestic production.

Finding 3. A market-driven post Covid-19 deglobalization scenario would entail a tradeoff for France: more car production (around 15%) but at the cost of higher prices for consumers (around 5%). The tradeoff would be more favorable for Germany. In Spain, such a deglobalization scenario would entail losses for both producers and consumers.

The effects of a reduction in costs or productivity increase on production relocation and on consumer surplus

Relocation could also occur from a policy of costs reduction/productivity increase in the automobile sector in France compared to competing production bases. Figure 6 simulates the effects of 5 different levels of decreases in French production costs. In comparison to the trade policy and Covid-19-related scenarios, a unilateral drop in French car manufacturing costs would both increase production and increase consumer surplus (reduce prices). This is therefore a policy-driven re-shoring scenario that benefits both producers and consumers and this is the reason it should be given priority. As stated above, a 20% reduction in cost would double French car production, and allow it to reach the peak of production with respect to Germany (reached in 2002). It would also increase consumer surplus (decrease consumer prices) by more than 4%. Such a reduction in costs seems however overly ambitious. Reducing costs by 5% is probably more credible an objective. Such a reduction would increase production and consumer surplus by approximately 18% and 1% respectively. More ambitious reductions of 7.5% or 10% of costs would increase production by respectively 30 and 40%.

6. Effect of a French cost decrease, percent change



Source: Simulation by authors, IHS Markit.

Recommendation 2. Give a priority to a strategy that aims at reducing production costs and increasing productivity

Several avenues can be considered to achieve a decrease in costs and an increase in productivity. For instance, Martin and Trannoy (2019)[19] recommend to reduce production taxes (those that tax firms based on their turnover, value added

[19] Martin P. and A. Trannoy(2019): "Taxes on Production: The Good, the Bad and the Ugly", *Note du CAE*, no 53, June.

or real estate) that are particularly important in France: they represent 0.5% of the value added of companies in Germany and 3.6% in France, the highest level in Europe excluding Greece. In a recent *CAE Note*[20] on international corporate taxation, a worldwide minimum effective corporate tax rate is advocated and we see this as a complement to a reduction in production taxes. Indeed, taxes on corporate profits, when disciplined to avoid profit shifting, are less distortive (for example on location choices) than production taxes. Based on firm-level data, Martin and Trannoy (2019, *op. cit.*) show that the C3S (a small tax of 0.16% on turnover), the most distortive of production taxes, reduces manufacturing exports. It is also highly distortive because of "cascading effects" that are transmitted and amplified throughout the production chain because at each stage of production the tax itself is taxed again.

Another avenue towards reducing costs and increasing productivity is the adoption of robots (Box 2). The French car industry is already a very large user of robots as more than half of industrial robots in France were in that sector until 2010. However, the German car industry seems to have a lot more robots than France and their numbers are increasing.[21] This is also true when looking at the number of robots per car produced. France appears as a clear laggard in robotization relative to other countries.

The current economic literature is unanimous on the positive effect of automation on productivity. The recent work by Aghion, Antonin, Bunel and Jaravel (2020) suggests that a 1% increase in automation leads to a 0.05% fall in the industry producer price and a 0.37% increase in sales, based on French manufacturing data. Acemoglu, Lelarge and Restrepo (2020) show that French firms that adopt robots experience a 2.4% increase in productivity and among a subset of exporters, these adopting firms reduce export prices from 1% to 5.7%. Dauth *et al*. (2017) find that an additional robot per 1000 worker is linked to an increase in labor productivity by 0.5% in the manufacturing sector in general. According to Jungmittag and Pesole (2019), the increase in labor productivity is the highest in the transport sector: an increase of 1% of the number of robots is associated with a 1% labor productivity improvement. The impact of robotization on firm-level employment is debated but the recent evidence points to the possibility that (through competitiveness gains) employment increases following robotization (see Aghion *et al*. 2020). There is therefore no clear motive why robotization in the car industry should be distorted by public policies or should be discouraged.

2. Automation and reshoring

One the main reasons for offshoring to emerging markets is the production cost difference, mainly labor cost. Even though the phenomenon of reshoring is limited, the economic literature has started to tackle the subject and its link with the rise of automation and robots in the industry. Robots tend to be a substitute to low-skilled labor and a complement to high-skilled one,[a] therefore lowering the labor cost gap. Automation also allows both more flexibility and productivity (see Dachs *et al*., 2019)[b]. Krenz *et al*. (2018)[c] estimate that an increase of one robot per 1000 worker is associated to a 2.5% to 3.5% increase of reshoring activity in a sector. Faber (2018)[d] looks at the case of Mexico and the USA, showing that the increase in automation in the USA was associated with a decrease in employment in Mexico, the effect being particularly high in the case of the car industry. This decrease in employment seems to come from a decrease in exports and relocation of activities.

[a] For a discussion between technology and international trade, see Rodrik D. (2018): "New Technologies, Global Value Chains, and Developing Economies", *NBER Working Paper*, no 25164.

[b] Dachs B., S. Kinkel and A. Jäger (2019): „Bringing it all Back Home? Backshoring of Manufacturing Activities and the Adoption of Industry 4.0 Technologies", *Journal of World Business*, vol. 54, no 6.

[c] Krenz A., K. Prettner and H. Strulik (2018): *Robots, Reshoring, and the Lot of Low-Skilled Workers, University of Göttingen*,Center for European, Governance and Economic Development Research.

[d] Faber M. (2018): "Robots and Reshoring: Evidence from Mexican Local Labor Markets", *WWZ Working Paper*, no 2018/27.

Recommendation 3. Public policies, for example taxes, should not discourage the adoption of robots in the car industry.

Energy costs also impact production costs in the French car industry. We have analyzed the impact of firm level electricity costs on car exports following the analysis of Fontagné *et al*. (2018).[22] First, these costs are a smaller share of total costs (1.6%) than in the French manufacturing sector (2.7%). Second, like in the manufacturing sector, we find that an increase in electricity costs leads to an increase in export prices which itself generates a fall in the volume of exports. The size of the effect for firms in the car industry is large and similar to the rest of the French manufacturing sector: a 1% increase in electricity costs, by increasing export prices, reduces automobile export volumes by around 0.2%. Hence, for the car industry (like the rest of manufacturing) energy costs have a direct and sizable impact on competitiveness (see also Bureau, Fontagné and Martin, 2013).[23]

[20] Fuest C., M. Parenti and F. Toubal (2019): "International Corporate Taxation: What Reforms? What Impact?", *Note du CAE*, no 49, November.

[21] International Federation of Robotics (IFR) (2017): *France Outperforms Britain as Robots Transform Car Industry*, March. Availbale on https://ifr.org/ifr-press-releases/news/france-outperforms-britain-as-robots-transform-car-industry

[22] Fontagné L., P. Martin and G. Orefice (2018): "The International Elasticity Puzzle Is Worse Than You Think", *Journal of International Economics*, no115, pp.115-129. We thank Gianluca Orefice (University of Paris-Dauphine-PSL) who performed the empirical work at CEPII.

[23] Bueau D., L. Fontagné and P. Martin (2013) "Energy and Competitiveness", *Note du CAE*, no 6, May.

One issue, not specific to the car industry, is that the energy used in production does not have the same CO_2 content across production sites. France, due to the importance of its nuclear source, is on the low end of industrial CO_2 emissions. The Covid-19 crisis has led to a drastic fall of the CO_2 price on the ETS market. A minimum price for CO_2 (at least the price before the crisis) would allow to reduce CO_2 emissions and also rebalance the cost advantages that are based on electricity production with high CO_2 emissions sources.

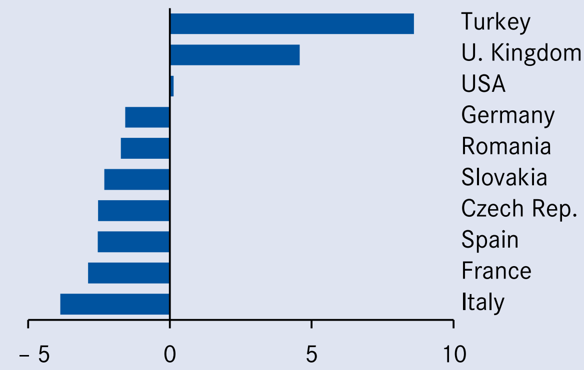
Finally, our empirical estimates on the car industry (which are consistent with other estimates on manufacturing) stress the importance of cost reductions or productivity gains due to economies of scale from localized spillovers through the labor market, the coordination of input suppliers and technology cooperation. Based on empirical estimates at the regional and national level, thanks to these local spillovers an increase of 10% in production leads to a decrease in production costs in the range of 0.33 to 1%. Clustering helps increase competitiveness. The French geography of car production has two clusters in the North and the East of France and public policies should not, on the contrary, counter this clustering. This is in particular the case when the government intervenes in investment projects in the car industry.

Recommendation 4. Encourage clusters in the auto industry located in the North and East of France. Do not attempt to stop the spatial reallocation of car manufacturing away from the historical sites outside these clusters, and facilitate coordination between car producers on matters such as technology and training in the main clusters.

Border carbon adjustment mechanism: protectionism or climate change mitigation?

We now analyze the question of how the car industry could be affected by instruments put in place to reduce the CO_2 emissions generated at the production stage. One debate pertains to the extension of the European Trading System (ETS) of carbon emission allowances to sectors not covered. One such sector is the automobile industry. An immediate issue is carbon leakage i.e. the incentive to off-shore outside the EU that higher production costs on assembly sites could generate. This is the reason why, to ensure a level playing field, the issue of introducing a border carbon adjustment mechanism on car imports is discussed as a complement to the ETS extension to a larger set of manufacturing industries. We carry out a simulation intended to approximate the aggregate impact on car production of such policies. Admittedly, is not supposed to be precise or even very realistic given that, if implemented, both the extension of the ETS to the car industry and a border adjustment mechanism would need to price CO_2 emissions of each car model differently depending on the production process (which we cannot do with the data at hand). Our counterfactual scenario adds 2% to EU-based production costs due to the obligation of EU assembly plants to purchase emission allowances on the ETS market. This 2% number is a rough approximation of the pricing of CO_2 content (around 7 tons per vehicle on average in car manufacturing) with a CO_2 price of around 40 € per ton.[24] The border carbon adjustment mechanism on car imports is modeled as a tariff of the same ad valorem rate (2%) imposed on imports of cars produced outside of the EU. In our model, those two taxes being symmetric, the relocation induced by the CO_2 emissions tax on EU production is exactly compensated by the relocation associated with the border adjustment mechanism on EU imported cars.

7. Effect of an extension of the ETS on production (+ 2%, i.e. 40 € per ton), in %



Source: Simulation by authors, IHS Markit.

Without a border carbon adjustment mechanism on car imports, our simulations suggest that the extension of the ETS to the car industry would for example generate a 3% loss of production in France. Turkey, and to a lower extent UK, if those countries do not join the ETS system, would be the main benefactors of carbon leakage in the car industry as shown in Figure 7. Symmetrically, a carbon adjustment mechanism would generate the opposite relocation impact.

Hence, these results (which we have to take with caution given the limits of the assumptions we have to make) suggest that extending the ETS system to the car industry would generate some relocation outside of the EU although to a modest extent. Symmetrically, one should not expect massive off-shoring of the car industry following the introduction of carbon adjustment mechanism at the EU border. However, the more ambitious the EU environmental strategy (the higher the CO_2 price) the more costly (in terms of lost production)

[24] These prices are high relative to current prices on the ETS market of around 25€ per ton, and should be seen as a long-term objective of the ETS policy. A doubling of this price would entail almost a doubling of the effect on location paterns.

an extension of the ETS system without a border adjustment mechanism would be. Our results therefore suggest that the extension of the ETS system to the car industry and an increase of the CO_2 price should go hand in hand with an EU border adjustment mechanism. This would indeed ensure a level-playing field that would facilitate an ambitious environmental EU strategy with a high CO_2 price. The objective of the border adjustment mechanism should not be the reshoring of the car industry per se, but it might be considered a useful tool, complementary to the primary objective of cutting global CO_2 emissions through a uniform price signal.

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Recommendation 5. Extend the ETS system to the car industry and at the same time put in place a EU border adjustment mechanism with the objective to reduce global CO_2 emissions rather than to re-shore the automobile industry.

The automative sector is facing many challenges such as trade tensions, the push for reshoring manufacturing, the requirement to reduce CO_2 emissions and the Covid crisis. We believe the main promising strategy is the one that would focus on reducing production costs and increasing productivity. ●

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Publisher Philippe Martin
Editor Hélène Paris
Electronic Publishing Christine Carl

Contact Press Christine Carl
Ph: +33(0)1 42 75 77 47
christine.carl@cae-eco.fr

TSA 20727 75334 PARIS Cedex 07 (France) Ph: +33(0)1 42 75 76 84 Fax: +33(0)1 42 75 51 27 @CAEinfo www.cae-eco.fr