

# State aid in times of crisis: is it always good aid?

## The case of the European automobile market

Laura Grigolon\*

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### **Abstract**

During the crisis, governments granted large amounts of public support to save their national automobile producers. We ask whether this aid was warranted. We first estimate a demand model with product differentiation. We then perform policy counterfactuals to assess the consequences of alternative plausible scenarios absent state aid. We simulate mergers, firm restructuring and bankruptcy of the ailing firm. We apply the analysis to the three main aid recipients during the crisis, namely Peugeot-Citroën, Renault and Opel. We find that state aid is warranted when it avoids dramatic reductions in product variety or the bankruptcy of the ailing firm. In contrast, state aid is mostly not warranted when we balance its cost with the loss of welfare caused by mergers. Our findings suggest that the European Commission's decision to relax state aid control rules during the crisis may not have been justified.

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\**Laura Grigolon*: McMaster University. Email: [Laura.Grigolon@mcmaster.ca](mailto:Laura.Grigolon@mcmaster.ca).

# 1 Introduction

In 2008 and 2009 the European economy experienced a severe recession sparked by the global financial crisis. The financial and economic crisis was tackled by a large use of public support in form of state aid, which member states regarded as the quickest and most effective policy instrument. With the adoption of a new legislative instrument aimed at the real economy and denominated Temporary Framework, the European rules on state aid control were de facto relaxed for a limited period to allow member states to grant state aid through simplified and faster procedures.<sup>1</sup> The relaxation seems to have reversed a decade of claims on the need to enhance the state aid control system to encourage ‘good aid’, namely a good use of taxpayers’ money on projects that best strengthen the economy without distorting competition.<sup>2</sup>

The automotive industry received the largest share: at least €9 billion were spent in loans and guarantees for car manufacturers, an amount equivalent to roughly 40% of the total support to the real economy.<sup>3</sup> Peugeot-Citroën (PSA) and Renault, in France, and Opel, in Germany, were among the main aid recipients. Officially, schemes approved under the Temporary Framework had a short term horizon, to provide liquidity for financially weak companies, and a long term horizon, to support the continuity of investments. We examine counterfactuals related to the three aid recipients since they were all in severe financial distress during the crisis. But the most realistic counterfactuals are perhaps the ones related to Opel, which at the time was at the verge of bankruptcy because of losses that the crisis exacerbated, but did not create. In contrast, PSA and Renault did not enter the crisis in difficulty, but suffered from the credit squeeze especially for the continuity of investments in the long term, for example to develop new models.

A key question for policymakers is whether public intervention was warranted. This question is particularly relevant to the car sector. Despite the severity of the recession, during the crisis no major carmaker exited, no major restructuring through mergers and acquisitions took place, nor a noticeable shrink in the model range of the aided firms was observed: this may be attributable to public intervention. In absence of aid, major adjustments and restructuring may have been likely and could have affected the long term structure of the industry.

This background serves as a guide for our empirical analysis on the consequence of public support which heavily interferes with the competitive forces shaping the structure of an economic sector. We collected a unique dataset on the automobile market which consists of all

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<sup>1</sup>Communication from the Commission - Temporary Community framework for State aid measures to support access to finance in the current financial and economic crisis, 2009 O.J. C 16/01.

<sup>2</sup>European Competition Forum, Brussels, 2 February 2012: <http://ec.europa.eu/competition/>.

<sup>3</sup>This calculation is based on European Commission (2011).

car models sold in nine European countries between 1998 and 2009 and covers 90% of the car sales in the European Union. We first estimate a demand model with product differentiation. Then, we combine the demand model with a model of oligopoly pricing to perform a counterfactual analysis by focusing on three possible scenarios of intra-sector restructuring that would have been likely in absence of aid. These scenarios involve the three most important recipient firms, PSA, Renault and Opel. The first scenario is a merger between manufacturers, which causes a reduction in the number of competitors and, consequently, weaker price competition. We consider several merger scenarios between players which were hypothesized in the media, on the basis of more or less concrete talks between the involved parts, during the crisis or afterwards. These mergers involve both European and Asian players.<sup>4</sup>

The second scenario is a restructuring of the ailing firms. We simulate a reduction in product variety caused by the decision of the firm to restrict the product range and cut investments related to: (i) model and brand advertisement; (ii) the development of new models or platforms; (iii) the maintenance of obsolete platforms.

With regard to model advertisement, firms may want to cut their investments in models marketed in segments where they do not have a strong image or recognition by customers. This is particularly relevant to producers in mass segments such as PSA and Renault, who have, rather unsuccessfully, tried to enter the luxury or Sport Utility Vehicles (SUV) segments. This strategy makes sense as the latter segments are more profitable, but the process of entering can take decades and implies very high fixed costs, as witnessed in the Audi case (The Economist, 2012). With regard to brand advertisement, focusing on fewer brand can be another restructuring possibility to save on costs. An example of reduction in brand portfolio is the dismissal of Talbot, which was taken over by PSA in the late 70's, but gradually phased out by the end of the 80's.

With regard to the development of new models or platforms, firms could also counter the economic downturn by delaying the launch of new models, while losing market shares on the obsolete models. For example Fiat, which did not receive public support under the Temporary Framework, decided to stop the development of new models during the crisis. The decision had severe consequences for the firm in terms of loss in market shares because of the general obsolescence of its product range (The Economist, 2012).

Finally, with regard to the maintenance costs of obsolete platforms, carmakers may redesign the product portfolio to reduce the number of platforms, which are the common

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<sup>4</sup>This counterfactual is also based on past experiences in the sector, in which several mergers have been witnessed. In particular, it is common for large size firms to take over smaller competitors in financial difficulties. Examples are Ford's takeover of Volvo, Jaguar and Land Rover or General Motors' acquisition of Saab and Daewoo.

mechanical underpinning (chassis and other components) for a range of vehicles.<sup>5</sup> Those platforms involve high development costs, but can be carried over to subsequent model generations. Reducing the number of platforms spreads the total development costs over a higher number of models, while increasing plant productivity due to a reduction in the number of differences between models. In particular, obsolete platforms can imply higher maintenance costs or be inflexible because of their incompatibility to changes that are necessary to keep the products up to date. Some firms, such as Toyota, have been very successful in developing long lasting platforms, while other firms, such as General Motors, appear to have problems in reducing the complexity in product range.

The third scenario is the exit of the ailing firm and is applied to Opel. In this scenario, we assume that all the business assets are completely depreciated and eliminated from the market. This implies both a concentration in the sector because of the reduction in the number of competitors and a loss in product variety. While past experience suggests that exit with a complete loss of product variety is rare in this sector, the severity and scope of the crisis justifies our counterfactual for Opel, at least as a worst case scenario.<sup>6</sup> Investments may be delayed because of the prolonged uncertainty over the destiny of the firm, with a consequent depreciation of the assets, which could be eliminated from the European market and scrapped or production could move to other developing markets, such as Latin America, India and China. The expectation of bankruptcy can lead to a drop in demand because of the reduction of the value of the car for forward-looking consumers, who value after-sale service provisions (warranties, spare parts). Using US data on prices of used cars, Hortaçsu et al. (2010) find strong evidence of this effect. The case of Saab case is an illustration of market exit: the company filed for bankruptcy in December 2011 and all Saab models will be taken out of the market and its assets scrapped.<sup>7</sup>

We complete the counterfactual analysis of state aid by assessing the balance between the intended benefits of state aid, namely consumer and total welfare losses avoided thanks to the aid, and the direct cost of such aid. This is in the spirit of the balancing test, which has been formalized by the European Commission as a conceptual framework to implement state aid control using a refined economic approach.<sup>8</sup>

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<sup>5</sup>Both Ford and General Motors have announced plans to drastically reduce the number of vehicle platforms. General Motors: <http://www.autoweek.com/article/20110809/CARNEWS/110809876>

Ford: [www.autonews.com/article/20120111/OEM09/120119943](http://www.autonews.com/article/20120111/OEM09/120119943)

<sup>6</sup>Notable cases of exit from the market are the ones of the Dutch manufacturer DAF, the inefficient and obsolete Eastern German firm Trabant and more recently the Swedish auto company Saab.

<sup>7</sup><http://www.topgear.com/uk/car-news/saab-bankrupt-2011-12-19>

The parent company, General Motors, did not want to allow the sale of Saab to a Chinese buyer to avoid copyright infringements linked to the fact that Saab vehicles share many fundamental mechanical components with General Motors' models.

<sup>8</sup>The balancing test was first introduced in 2005 in the State Aid Action Plan Less and better targeted

Our findings are mixed. If state aid primarily serves to prevent mergers, we find that it is in most cases not warranted or only mildly warranted. While consumers suffer from an increase in market concentration, in most cases the loss of consumer and total welfare is outweighed or in line with the direct cost of aid.

If state aid primarily serves to prevent restructuring and corresponding loss in product variety, we find that it is not warranted or only mildly warranted in case of exit of commercially unsuccessful models, since a rationalization in the product range would not affect neither consumer nor total welfare. State aid is instead warranted in case of harsh, but probably less likely, restructuring operations, for example when popular models or all the models belonging to a certain brand are eliminated in the counterfactual.

If state aid primarily serves to prevent a worst case scenario, namely to avoid the exit of the ailing firm, Opel, we find that it is warranted from the German consumers' point of view. Interestingly, 88% of the losses in consumer surplus following the exit of Opel are due to the decrease in product variety, while only 12% are due to higher prices following the increased concentration in the market.

With regard to the single recipient firms, our findings suggest that, under the most realistic counterfactual scenarios, aid to Renault and PSA is not warranted or only mildly warranted. In contrast, aid to Opel is most probably warranted given the large consequences that several plausible counterfactual scenarios exhibit on consumer or total welfare. The situation of the company was particularly difficult and state aid may have served to avoid dramatic effects on the industry structure, namely a bankruptcy or relevant losses in product availability for consumers.

In sum, the European Commission's decision to allow Member States to extensively use the Temporary Framework to support the automotive sector may not have been justified. While state aid measures, and in particular bailouts, are subject to ex-ante control to ensure that they do not distort competition and trade, the Temporary Framework exempted the Commission from this control. Thus, it is not clear how the Commission followed and evaluated countries' choices to save their domestic producers. An objective of bailout control in non-crisis times is to correct a market failure, namely the creation of market power through a merger wave or the exit of the ailing firms absent aid.<sup>9</sup> In the few cases this justification was used, the Commission did not explicitly analyze the existence or the potential creation of an oligopolistic situation.<sup>10</sup> Our paper shows that an explicit empirical assessment of state

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state aid: a roadmap for state aid reform 2005–2009 Consultation document, 2005 COM (2005)107.

<sup>9</sup>Community guidelines on State aid for rescuing and restructuring firms in difficulty, art. 8, 2004 O.J. 244/02.

<sup>10</sup>Commission Decision of 1.12.2004 in case C 10/2004, *Bull*, O.J. 2005 L 342/81; and Commission Decision of 30.7.1996 in case C 60/1995, *HTM*, O.J. 1997, L 25/26.

aid measures on the competitive structure of the market is not only feasible, but can also be used in certain sectors as it is now in merger and antitrust cases.

In this paper we focus on the effects of public support on the competitive structure of the market. The effects of these measures on the production side are also relevant when analyzing state intervention. The industry in question suffers from significant overcapacity problems due to a productivity growth that surpasses consumer demand. But car manufacturers are large regional employers, not only for direct employment in the assembly plants, but also for indirect employment in the supply chain. Governments have been willing to grant public subsidies to avoid the closure of large plants and serious ripple effects throughout the involved region. Absent state aid, capacity reductions would have been likely both in Germany and in France, which are high cost countries. The question on the impact of state aid on the production side is certainly a relevant objective for future research, especially to understand the regional spillover effects of state aid.

Empirical assessments on bailouts approved by the European Commission are mainly reduced-form analysis of factors influencing survival possibilities after the bailout (Chindooroy et al., 2007, Glowicka, 2008, Oxera, 2009). The simulation study developed by Neven and Seabright (1995) is the most similar in spirit to our approach. They develop a model to study the effect of government subsidies to Airbus. Using calibration techniques, they simulate a counterfactual in which, absent the subsidy, Airbus would not have entered the market. They conclude that the consumer surplus argument is only weakly supported. In contrast, the presence of Airbus determines a large profit shift from the US to Europe, such that Airbus has a large negative impact on world welfare but a positive impact on the European one. In our work, thanks to the extensive data availability, we can estimate rather than calibrate the demand model and use simulation techniques to provide an empirical analysis of the consequences of state aid, but we can draw conclusions only for the welfare of European consumers. Finally, our paper belongs to the literature of models of discrete choice between differentiated products, in particular to applications related to mergers (Nevo, 2000 and Capps, Dranove and Satterthwaite, 2003) and welfare gains from the introduction (or loss) of product variety (Petrin, 2002, Berry et al., 2004 and Eizenberg, 2012).

The remainder of the paper is organized as follows. Section 2 discusses the regulation for state aid during the crisis and the relevance of this type of support for the car market. We also provide an outline of the aid measures for each recipient firm. Section 3 develops a model of demand and pricing. Section 4 presents the data, the estimation issues, and the results of the demand estimation. Section 5 shows the counterfactual analysis to assess the effects of state aid. Section 6 concludes.

## 2 State aid to the European automotive sector during the crisis

**The European car industry and the Temporary Framework** Public intervention in the automotive industry has a long history in Europe. The willingness to support this industry in Europe clearly unveiled, once again, during the 2008-2009 crisis. Car manufacturers, like all producers of expensive durable goods, were hardly hit by the crisis for at least two reasons. The first is that consumers may delay the purchase of durables, including cars, because of the reduction of available liquidity and the higher probability of rejection of credit financing. Panel (a) of Figure 1 shows this effect. The recession period, characterized by a negative GDP growth, is denoted by the shaded areas. Already before the beginning of the recession, new car registrations dropped with respect to the same period of the previous year. This decrease was particularly pronounced in the second quarter of 2008. However, car sales started to recover before the end of the recession period.

The second reason, from the perspective of firms, is due to the dependency of this sector on financing, both in the short term, because of its cash flow dynamics linked to consumers' purchases, and in the long term, because of the necessity to invest in innovation, for example to meet stricter environmental standards. In sum, the car sector has a strongly cyclical profile, but the crisis may have negative implications on the sector beyond the short term.

State intervention during the crisis took a variety of forms, including state aid granted under the Temporary Framework, and sector-specific measures such as scrapping schemes. We focus on the Temporary Framework. The framework is a legislation in derogation to the existing regulations on state aid. To understand the importance and extent of the derogation, we first illustrate how state aid is disciplined in the European Union. In principle, state aid is forbidden by the European competition law, but can be granted according to a number of exemptions. To assess the compatibility of state aid, the Commission carries out an economic analysis denominated balancing test. The test tends to establish, on the one hand, whether the state aid effectively alleviates a market failure or addresses an objective of common interest, and, on the other hand, whether the distortions in competition and trade caused by the aid are sufficiently limited so that the overall balance is positive (Friederiszick et al., 2008). In normal circumstances the compatibility assessment is carried out before granting the aid, so all relevant state aid measures should be notified to the Commission *ex ante*. The assessment foresees the analysis of counterfactual scenarios, namely what would happen if state aid is not granted.

The Temporary Framework introduced greater flexibility to provide public support to companies experiencing temporary financial problems caused by the crisis. Car producers

had access to public funds without the usual procedural and substantial requirements. From a procedural point of view, the Temporary Framework allowed member states to notify only national schemes aimed at all sectors in difficulty (horizontal schemes). Once the schemes had been authorized by the Commission, aid to individual firms could be granted without further individual notifications or requirements. From a substantial point of view, the Commission did not carry out a compatibility assessment. The only substantial check performed by the Commission on the schemes was on the presence of discriminatory conditions, such as the imposition of requirements that aided activities should be carried out exclusively in a certain state.

While state aid schemes notified under the Temporary Framework formally complied with the requirement of horizontal application, some member states used them to target only the automotive sector. The most prominent examples are the loans granted to PSA and Renault by the French government and to Opel by the German government.

**State aid granted by the French government to PSA and Renault** During the crisis the situation of the two French car manufacturers, PSA and Renault, was critical, both from a financial and an industrial point of view. The accounting statements of the companies highlight that in the first half of 2009 the automobile division of PSA generated losses amounting €1 billion, mainly due to a decline in sales which was, at worst, equal to 28% with respect to the corresponding month of the previous year, as depicted in panel (b) of Figure 1.<sup>11</sup> This decline is however only a slight underperformance compared to the market average. The Renault group also presented losses amounting to €2.7 billion. But when looking at the changes in sales depicted in panel (c) of Figure 1, Renault does not underperform with respect to the market average.

The French programme, denominated ‘Le pacte automobile’, was approved in February 2009 and contained: (i) a subsidized loan amounting to €6.5 billion to the domestic car producers, PSA and Renault, to deal with the financial and industrial crisis and promote the development of green products; (ii) a subsidized loan of €2 billion to the internal banks of PSA and Renault; (iii) guarantees and funds for automobile suppliers.<sup>12</sup>

The loans to PSA and Renault had a duration of 5 years with 6% interest rate during the first two years, which could be raised to 9% afterwards. In that period, the rather low credit rating of both companies (BB+) would have implied an interest rate of around 8% for a loan with the same duration in the financial market.<sup>13</sup> In return, car companies had

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<sup>11</sup> All the information on the financial situation of the companies are retrieved from the financial reports published by PSA, Renault and General Motors.

<sup>12</sup> <http://www.gouvernement.fr/gouvernement/le-pacte-automobile>

<sup>13</sup> Source: fair value corporate corporate curve (Industrial) by Bloomberg.



to maintain their employment levels in France, invest in green technology and not close any assembly plant in France for the duration of the loan. Renault and Peugeot received the loans in April 2009 but already repaid them by April 2011, possibly due to the fact that the level of remuneration required was quite high and constituted an incentive to exit (European Commission, 2011).

In panel (b) and (c) of Figure 1, we observe that after the approval of these measures, denoted by the red horizontal line, Renault’s sales increase with respect to the corresponding month of the previous year. In general, after the loan Renault outperforms the market, while for PSA there is no clear effect. While we obviously cannot infer any causality relation, especially because in that period other demand-specific measures, such as scrapping schemes, were introduced, the aid may have contributed to restore customers’ confidence and facilitated the access to credit, especially since it was also aimed at the internal banks of the firms.

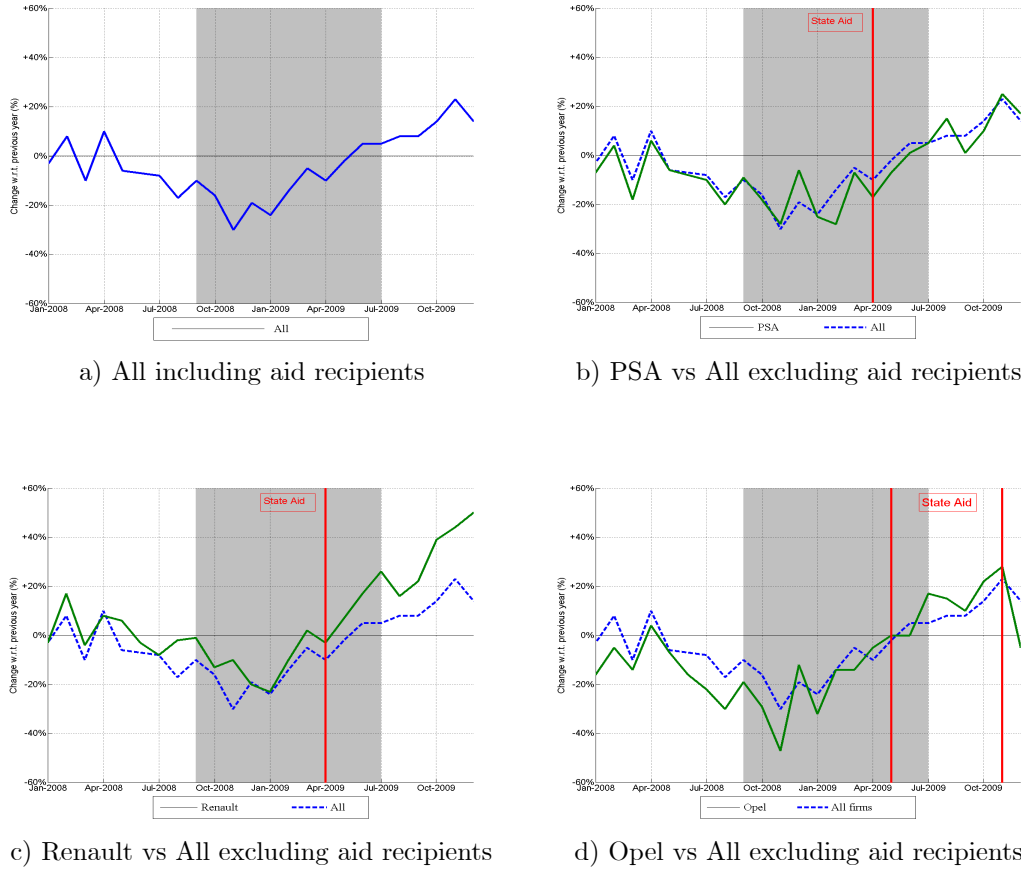
**State aid granted by the German government to Opel** Opel is the main European subsidiary of General Motors.<sup>14</sup> The situation of Opel was already difficult before the crisis, with sales lagging behind the average of the market, as shown in panel (d) of Figure 1. Already in 2008 the losses amounted to €2.8 billion, and increased by an additional €2 billion in the first quarter of 2009.

Support to the German car industry was included in the general economy stimulus programs of the German government, denominated ‘Konjunkturpaket I&II’ in December 2008 and February 2009, respectively. The German government took unprecedented actions to protect Opel from bankruptcy. Around May 2009, Opel received a bridging loan of €1.5 billion for six months at 6.5% interest rate in the context of the Temporary Framework after the parent company, General Motors, had filed for bankruptcy (European Commission, 2011). In those circumstances, the market would have been very reluctant to provide a loan to Opel. The loan allowed Opel to develop a restructuring plan. In September 2009, under the pressure of the German government, General Motors manifested the intention to sell Opel. Media speculated on several buyers, among which Fiat and Asian firms such as Hyundai. Fiat and China’s Beijing Automotive put a bid, but the most concrete offer was by a consortium led by Magna, a Canadian auto parts supplier. The European Commission intervened in the negotiations ex-officio, to assure the further state aid promised by the German government was not tied to the location of production activities or the winner of the auction. However, in November 2009 the parent company cancelled the sale to Magna and

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<sup>14</sup>Opel vehicles are sold in the UK under the brand Vauxhall. In the paper, we refer to Opel including also Vauxhall Motors, which together form General Motors Europe.

Figure 1: Year-on-year changes in sales



The Figure reports the year-on-year changes in monthly vehicle sales. Shaded areas denote the crisis period. The red bar denotes the year/month when the aid was granted. For the Opel case, the loan was repaid within the considered period, hence the second red bar to indicate the end of the grant.

the loan to the German government was repaid.<sup>15</sup> In Figure 1, we notice that Opel, after heavy losses in terms of sales with respect to the previous year, seems to outperform the market and recover, in terms of sales, between June and November, during the duration of the loan. One of the reasons of recovery could be the success of the new Opel model called Insignia (a follower model of Opel Vectra).

<sup>15</sup><http://online.wsj.com/article/SB125728725957326159.html>

## 3 The model

### 3.1 Demand

We consider  $T$  markets,  $t = 1, \dots, T$ . In each market  $t$  there are  $L_t$  potential consumers. Each consumer  $i$  may either choose the outside good 0 or one of the  $J$  differentiated products,  $j = 0, \dots, J$ . We suppress the market subscript  $t$  from the utility formula for the moment, since consumers are assumed to purchase the car only in the market where they are located. Consumer  $i$ 's conditional indirect utility for the outside good is  $u_{i0} = \varepsilon_{i0}$ . For products  $j = 1, \dots, J$  it is:

$$u_{ij} = x_j\beta - \alpha_i p_j + \xi_j + \varepsilon_{ij}.$$

The vector of observed product characteristics,  $x_j$ , includes horsepower, fuel efficiency, width, height and a dummy variable for the product's country of origin (domestic or foreign). The price parameter  $\alpha_i$  is specified as  $\alpha/y_i$ , where  $y_i$  is the income of individual  $i$ .  $y_i$  is a random variable following a known distribution equal to the empirical distribution of income.<sup>16</sup>

The product specific taste parameter  $\varepsilon_{ij}$  is a "love for variety" taste term. The error term follows the distributional assumptions of the two-level nested logit model. Following Verboven (1996), we interpret this nesting structure as localized competition: vehicles belonging to the same nest may be closer substitutes than vehicles belonging to different nests. Product variety serves two functions. On the one hand, consumers love variety because of the greater breadth of choices to find the product matching their preferences. On the other hand, firms prefer to differentiate because they can relax the aggressive competition that would arise from selling identical products. But products can only be differentiated up to a certain extent. Localized competition is modeled in the nested logit model by observing that consumer's valuation for one model conveys information about his valuation for another model, unlike the traditional logit model which assumes that the taste term is independent and identically distributed across products and consumers.

Following Goldberg and Verboven (2001), we use the insights from the marketing literature to establish the dimensions of differentiation characterizing the car industry, namely (i) market segment and (ii) country of origin. Specifically, the upper level of the nesting structure consists of seven different market segments (e.g. compact or luxury) and one separate segment for the outside good. Each nest (except the one for the outside good) is subdivided in two sub-nests according to the model's origin (domestic or foreign). Countries with

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<sup>16</sup>This utility specification approximates Berry et al.'s (1995) Cobb-Douglas specification  $\alpha \ln(y_i - p_j)$  when the price is small relative to (capitalized) income.

domestic cars are France, Germany, Italy, Spain and the UK. The remaining countries, Belgium, Greece, Portugal and the Netherlands, do not have a domestic brand, so the sub-nests of domestic cars are empty.

Given this set of assumptions, we obtain the following choice probability of individual  $i$  for product  $j$ , conditional on the empirical distribution of income  $y_i$ :

$$s_{ij}(p) = \frac{\exp((x_j\beta - \alpha_i p_j + \xi_j) / (1 - \sigma_{hg}))}{\exp(I_{ihg} / (1 - \sigma_{hg}))} \cdot \frac{\exp(I_{ihg} / (1 - \sigma_g))}{\exp(I_{ig} / (1 - \sigma_g))} \cdot \frac{\exp I_{ig}}{\exp I_i} \quad (1)$$

where  $I_{ihg}$ ,  $I_{ig}$ ,  $I_i$  are McFadden (1978) individual ‘inclusive values’ defined by:

$$\begin{aligned} I_{ihg} &= (1 - \sigma_{hg}) \ln \sum_{j=1}^{J_{hg}} \exp((x_j\beta - \alpha_i p_j + \xi_j) / (1 - \sigma_{hg})), \\ I_{ig} &= (1 - \sigma_g) \ln \sum_{h=1}^{H_g} \exp(I_{ihg} / (1 - \sigma_g)), \\ I_i &= \ln \left( 1 + \sum_{g=1}^G \exp I_{ig} \right). \end{aligned}$$

Following Brenkers and Verboven (2006), the unconditional aggregate market share of car model  $j$  is obtained by averaging the choice probabilities over the number of individuals drawn from the empirical distribution of income  $y_i$ .

The resulting model is a special case of a random coefficients model estimated by Berry et al. (1995). On the one hand, we allow the market segment and origin dummy variables, assigning products to mutually exclusive nests, to take on the nested logit form, and, on the other hand, we interact the price variable with income, drawn from the empirical distribution, to account for heterogeneity in preferences on a variable which is very important to obtain reasonable substitution patterns.

Finally, following Grigolon and Verboven (2011), we exploit the panel features of the dataset to specify the error term capturing unobserved product characteristics. For this purpose, we reintroduce the market subscript  $t$ . Specifically, we assume that the product-related error term follows the following structure:  $\xi_{jt} = \xi_j + \xi_t + \Delta\xi_{jt}$ , where  $\xi_j$  represents time-invariant car model fixed effects,  $\xi_t$  reflects the country-specific fixed effects, interacted with a time trend and squared time trend, and  $\Delta\xi_{jt}$  captures remaining unobserved characteristics. Since our data are at annual level, we also control for the number of months each model was available in a country within a given year for models introduced or dropped within a year.

### 3.2 Oligopoly pricing

We use a multi-product Bertrand pricing assumption to recover marginal cost. As before, the market subscript  $t$  is suppressed. Formally, the general profit maximization problem of a multi-product firm  $f$  using prices as its control variable is:

$$\max_{\{p_f \in R_f\}} \Pi_f(p) = \sum_{j \in R_f} L \cdot s_j(p) \cdot (p_j - mc_j),$$

where  $R_f$  is the set of all goods produced by firm  $f$ ,  $\Pi_f$  is the profit function for firm  $f$ ,  $L$  is the potential market size,  $s_j(p)$  is the share of model  $j$  which depends on the vector  $p$  of prices of all differentiated models in the market,  $mc_j$  is the constant marginal cost. Each firm sets prices to maximize profits, taking the prices set by other firms as given.<sup>17</sup> The necessary first order conditions form a system of equations which is simultaneously solved by all firms:

$$s_j(p) + \sum_{k \in R_f} \frac{\partial s_k(p)}{\partial p_j} (p_k - mc_k) = 0. \quad (2)$$

This system of equations can be written in matrix form and inverted to solve for the marginal costs as follows:

$$mc = p + (\theta^F \odot [\nabla_p s(p)]')^{-1} s(p), \quad (3)$$

where  $p$ ,  $mc$  and  $s$  are  $J \times 1$  vectors of prices, marginal costs and quantities, while  $\theta^F$  is the manufacturing firms' product ownership matrix whose typical  $ij$  element is one if products  $i$  and  $j$  are produced by the same firm, and zero otherwise, and  $\nabla_p s(p)$  is the  $J \times J$  Jacobian matrix of first derivatives.

All the elements but marginal costs in (3) are observed (prices and shares), or derived from the estimation of the demand function (cross price derivatives in  $\nabla_p s(p)$ ). The marginal cost vector can thus be identified from the first order conditions of the profit maximization problem using the estimated demand coefficients.

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<sup>17</sup>State aid can affect the objective function of firms, which could change from profit to output maximization, such that the company becomes "too big to fail". The issue is discussed in Cheng and Cayseele (2011). In the paper the authors do not reject the hypothesis that receiving state aid triggers a conduct prone to moral hazard. If the objective function changes from profit to output maximization, in this modeling framework we would obtain that firms will just want to produce as much variety as possible and there would be no price effect in removing products, but just a variety effect. Since we find that variety effects are very relevant, our estimates are probably conservative if indeed state aid causes a change in the objective function.

### 3.3 Welfare analysis

We use equation (3) to solve for new equilibrium price vectors. Define  $p_{cf}$  as the new price vector obtained under the different counterfactuals. The new equilibrium price vector is obtained under the counterfactual ownership matrix, in case of merger, or the counterfactual choice set excluding the designated car models in case of restructuring or exit. The new price vector is used to compute:

- (i) the change in variable profit for each firm  $\Delta PS_f = \Pi_f(p_{cf}) - \Pi_f(p_0)$ , where  $p_0$  is the initial set of prices;
- (ii) the change in consumer surplus, which is obtained by averaging the individual change in consumer surplus  $\Delta CS_i = \frac{I_i(p_{cf})}{\alpha_i} - \frac{I_i(p_0)}{\alpha_i}$  over the drawn individuals;
- (iii) total expected welfare change  $\Delta Welf$  which is the sum of the change in total consumer surplus and firm variable profits.

## 4 Data and estimation

### 4.1 Data

We use a unique dataset on the automobile market maintained by JATO. The data are at the level of the car model (e.g. VW Golf ) and include essentially all passenger cars sold between 1998 and 2009 in nine West-European countries: Belgium, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain and the UK. For each model/country/year, we build a dataset including information on sales and list prices and various characteristics such as vehicle size (curb weight, width and height), engine attributes (horsepower and displacement) and fuel consumption (liter/100 km or €/100 km). Starting from JATO's classification, we attribute each model to a marketing segment. Specifically, we have seven marketing segments (subcompact, compact, standard, intermediate, luxury, SUV and sports). Moreover, we assign each model to the brands' specific perceived country of origin. Models sold under the brand of Citroën, Peugeot and Renault are perceived as French cars, even though the production can take place in different locations. Audi, BMW, Ford, Mercedes, Opel, Porsche and Volkswagen are all German brands, Alfa Romeo, Ferrari, Fiat and Lancia are Italian brands, Seat is a Spanish brand and Jaguar, Land Rover, Mini and Vauxhall are British brands. Finally, the dataset is augmented with macro-economic variables including the number of households for each country, the population size and GDP. The resulting dataset

Table 1: Summary Statistics

	All countries		France		Germany	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Sales (units)	5,350	13,876	7,799	18,852	10,776	20,145
Price/Income	1.21	0.96	0.97	0.60	0.98	0.69
Horsepower (in kW)	94.6	46.9	93.8	43.8	98.6	50.1
Fuel efficiency (€/100 km)	9.7	3.3	9.8	2.8	10.0	3.2
Width (cm)	174.3	8.9	174.5	9.1	174.7	9.1
Height (cm)	149.1	13.8	149.8	13.9	148.9	14.2
Foreign (0-1)	0.92	0.27	0.86	0.34	0.70	0.46
Months present (1-12)	9.82	2.60	9.67	2.66	9.80	2.55

The table reports means and standard deviations of the main variables. The total number of observations (models/markets) is 25,903, where markets refer to the 9 countries and 12 years.

consists of 25,903 model/country/year observations or on average about 240 models per country/year.

A more detailed description of the dataset for a shorter number of years (1998-2006) is provided in Grigolon and Verboven (2011). Table 1 provides summary statistics for sales, price and the other product characteristics used in our empirical demand model. The table reports the summary statistics for all countries and for France and Germany separately. Our counterfactuals will focus on state aid granted by France and Germany. We will consider both the consumer and total expected welfare effects on these countries, in which the taxpayers directly contributed to the aid, and the spillover effects that aid have on the other European consumers.

## 4.2 Estimation

The estimation of the demand parameters follows Berry et al. (1995). After solving for the error term  $\Delta\xi_{jt}$ , we interact  $\Delta\xi_{jt}$  with a vector of instrumental variables  $z_{jt}$  that is uncorrelated with the error term. These instruments are essential to account for the correlation between the error term, on the one hand, and price and the conditional market share terms on the other hand. The instruments follow Berry (1994)'s discussion, and include the vector of product characteristics and (i) the sum of the characteristics of the other products of the same firm, (ii) the sum of the characteristics of the other products of the same nest and (iii) the sum of the characteristics of the other products of the same sub-nest.

GMM estimation of the demand parameters using the moment conditions follows the

method suggested by Berry et al. (1995) and detailed in Grigolon and Verboven (2011) to ensure a correct execution of the optimization procedure and the correction for heteroskedasticity.

### 4.3 Demand estimates

In the estimation, we use a fixed nesting parameter for each of the two nesting layers. We use a parsimonious specification in which the nesting parameter  $\sigma_g$  is constrained to be the same for all nests, indicating identical correlation in each of the market segments (nests), and the sub-nesting parameter  $\sigma_{hg}$  is constrained to be the same across all sub-nests, indicating identical correlation in each of the origin sub-nests.

Results are reported in Table 2. The price parameter and the mean valuation parameters have the expected sign and are all significantly different from zero. In terms of magnitude,  $\sigma_g = 0.41$  and  $\sigma_{hg} = 0.45$ , which is consistent with the requirement of random utility maximization ( $0 < \sigma_g < \sigma_{hg} \leq 1$ ). Alternative nesting specifications did not lead to estimates consistent with the requirements of random utility maximization. The hypothesis that the nesting parameters are equal is rejected at 5% significance level. The results imply that consumer preferences are more strongly correlated across vehicles belonging to the same marketing segment and origin rather than cars belonging to the same marketing segment but different origins. Results are in line with the ones of Grigolon and Verboven (2011), with the same set of countries but a shorter time span which did not include the years of the crisis. The two-level nesting structure is however not as strongly supported in the data as it was in previous work (Goldberg and Verboven, 2001 and Brenkers and Verboven, 2006). While during the 2008-2009 crisis the market size shrank for all producers, European firms have been losing market shares relatively more than the non-domestic firms (essentially Asian firms).

## 5 The effect of state aid

We examine the impact of state aid by performing several counterfactuals. The counterfactual scenarios are grouped into three parts, corresponding to the three aid recipient firms, PSA, Renault and Opel. For each firm, we first consider the effects of mergers between the recipient firms and other players over which there has been some debate in the media during or after the crisis (since state aid may have merely postponed those mergers). Then we consider a restructuring scenario of the recipient firm, which implies several possibilities. One consists in eliminating models that require high investments related to advertisement



Table 2: Parameter Estimates for Two-level Nested Logit Demand Model

	Param.	St. Er.
Price/income	- 2.51	0.11
Horsepower (kW/100)	1.10	0.06
Fuel (€/10,000 km)	- 1.91	0.34
Width (cm/100)	2.10	0.21
Height (cm/100)	1.87	0.17
Foreign (0/1)	- 0.64	0.03
Subsegment $\sigma_{hg}$	0.45	0.03
Segment $\sigma_g$	0.41	0.03
Model fixed effects	Yes	
Market fixed effects	Yes	
Income distribution	Yes	
# inelastic demands	0	
$\chi^2$ test $\sigma_{hg} = \sigma_g$	6.024	
Prob.> $\chi^2$	0.014	

The table shows the parameter estimates and standard errors for the nested logit demand model with income distribution. The total number of observations (models/markets) is 25,903, where markets refer to the 9 countries and 12 years.

costs, development costs for new vehicles launched during the crisis or maintenance costs because of the obsolete platforms on which they are based. For PSA we consider a radical form of restructuring, i.e. we simulate the reduction of the firm to only one brand. For Opel, we consider the exit of the entire firm.

A word of caution on the restructuring counterfactuals at model level is warranted. A perhaps more realistic way to simulate restructuring would consist in estimating demand using controls for the age of each model. In the counterfactual analysis, we could extend the life of incumbent models, rather than just eliminating new models. This requires further work on the dataset, that has high priority in our research agenda, to extract the information on model age. The effect of model age on sales has been investigated by Moral and Jaumandreu (2007) for the Spanish market.

First, we present a summary table to document the size of the analyzed firms and their most important competitors both in their domestic and non-domestic markets (Table 3). After, we present a separate table to show the effects of the counterfactual scenarios for each manufacturer. The structure of each table is identical. For each scenario, the left hand side of the table reports the effects on consumers in terms of predicted price effects and consumer surplus change for each household in the domestic market of the recipient firm and in the rest of Europe. In case of restructuring, we also provide a decomposition of the effects on consumers (and producers in the Appendix) into two elements. The first element is related to changes of consumer welfare due to changes in price, holding the counterfactual choice set constant. The second element is the change of consumer welfare due to changes in the choice set holding prices constant. The two elements add up into the total consumer welfare.

The right hand side reports the effects of the counterfactuals on aggregate measures of consumer surplus, profit and welfare. These numbers, which represent the benefit implied by state aid (or, equivalently, costs that would have arisen absent state aid), can be compared against the cost of state aid, as quantified for each recipient firm. For the loans granted to the three producers, which were applied at advantageous conditions with respect to the market loans, we calculated the aid element (or, equivalently, the direct cost for the taxpayer) on the basis of the practice of the Commission when the aid element is not provided by a member state in its annual report on aid expenditure to the Commission. In practice, we consider 15% of the total amount of the loan as a proxy for the aid element.<sup>18</sup>

While in merger analysis consumer welfare is the yardstick that the authority applies when deciding to allow a merger, in the field of state aid the welfare standard is not established (Friederiszick et al., 2008), so we will balance this cost of aid against both consumer and

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<sup>18</sup>We refer to the Commission’s documentation titled “Scoreboard - Conceptual and methodological remarks”, available at [http://ec.europa.eu/competition/state\\_aid/studies\\_reports/conceptual\\_remarks.html](http://ec.europa.eu/competition/state_aid/studies_reports/conceptual_remarks.html)

Table 3: Market shares by firm and by country

	Belgium	France	Germany	Greece	Italy	Netherlands	Portugal	Spain	UK
BMW	8.0	3.5	8.3	3.7	4.9	4.1	6.0	5.0	7.8
Daimler	3.9	2.0	6.8	3.8	4.0	1.7	5.5	2.6	3.6
Fiat	4.5	5.1	5.1	7.0	29.2	5.0	6.8	2.8	3.8
Ford	11.5	6.7	8.7	8.2	12.0	11.7	9.3	10.3	18.2
Hyundai	4.6	2.3	4.3	8.9	1.0	5.2	3.3	3.6	5.8
Nissan	2.4	1.9	1.6	4.8	2.4	2.0	2.0	3.4	3.1
Opel	9.4	4.6	9.6	10.2	6.8	7.0	9.1	9.8	13.0
PSA	14.8	31.6	5.7	6.0	10.2	11.4	13.5	16.4	7.5
Renault	8.2	21.8	5.1	1.8	4.4	5.2	11.7	9.3	2.9
Toyota	4.9	4.2	4.2	11.8	6.5	15.3	5.8	5.5	5.4
Volkswagen	21.6	12.8	33.6	19.2	12.7	24.6	21.3	24.5	16.7
Others	8.7	5.4	8.6	19.5	8.3	8.8	7.7	10.1	15.3

The table reports percentage market shares by firm for the 9 European countries in our sample.

total welfare changes. Note that the cost of aid should comprehend not only the direct cost of the subsidy, but also the deadweight losses due to the distortions provoked by the act of raising public funds. In the public economics literature, the cost of public funds, and the magnitude of deadweight loss in particular, is a fundamental issue. Deadweight losses can be substantial, with a range between 15 and over 300% of tax revenues, depending on the type of taxation (corporate, income, labour) and on the modeling framework (partial or general equilibrium).<sup>19</sup> In conclusion, one should be cautious in drawing conclusions on whether state aid is warranted in cases where the direct aid costs and the benefits are almost in balance.

## 5.1 The PSA case

In the PSA case we analyze the implications of the following counterfactuals absent state aid: (i) two possible mergers, with Opel and Fiat; (ii) a partial restructuring of the firm by the removal of certain models; (iii) a radical restructuring of the firm by the removal of all the models marketed under the Citroën brand. Table 4 reports the result of the counterfactuals applied to the PSA case. In the Appendix, Table A.1 and Table A.2 report further detail on the effects on consumers and producers by country and firm.

For the cost-benefit analysis, the direct cost element of the aid granted to PSA ranges between 450 and 600 million, depending on whether we consider only the loan of around €3

<sup>19</sup>Economists have attempted to estimate the distortions created by income taxes since Harberger's seminal paper on deadweight loss. See Auerbach and Hines (2002) for a review of the literature.

billion to the automotive division, or also the loan of €1 billion to the internal bank of the company.

**Merger** With regard to the first merger, PSA-Opel, the two companies have recently formed an alliance to develop vehicles together and reach a critical scale to compete with Volkswagen.<sup>20</sup> A merger could have been a possibility during the crisis absent state aid. PSA is a strong incumbent in the domestic market, France, with a market share of 32%. On the contrary, the market share of Opel in France is rather small (around 5%). For this reason, the merger entails only modest price increases (less than 1%), amounting to a loss of consumer surplus equal to €23 per household.

We now turn to the right hand side of the table. If we balance the cost of aid and consumer welfare losses (€586 million), state aid does not seem to be warranted, both because the effective cost of aid can be higher than the benefit of avoiding the welfare losses implied by the merger, and because the indirect aid cost is not accounted for.

Gains in industry profits amount to €84 million, so that the total welfare decrease from the merger amounts to €503 million. On balance, if we consider total welfare, state aid is even less warranted.

The second merger involves Fiat. Media have also speculated about a partnership between PSA and Fiat, which could be likely since the two firms have already engaged in industrial agreements to co-develop some vehicles (The Economist, 2012). Fiat detains only a slightly higher market share with respect to the Opel. Hence, predicted price increases and consumer surplus losses are in line with the first merger and the same conclusions can be drawn.

Interestingly, the merger also implies relevant international effects, in particular in the domestic market of Fiat, Italy. In this country, the price index would increase by more than 1% and consumer surplus would decrease by €1,017 million, or €43 per household. The aid granted by the French government, even if only mildly warranted from the French taxpayer's point of view, could avoid a harmful concentration in another country and have indirect beneficial effects for other European consumers.

**Restructuring of the model range** In the simulation of partial restructuring of PSA, we consider the removal of models which (i) are commercially unsuccessful, (ii) based on obsolete technology and (iii) in most cases marketed in segments such as SUV and luxury, while PSA is mostly focused on mass segments. In some cases the removal is an anticipation of a rationalization in the product range that we have observed after the end of the public

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<sup>20</sup><http://www.bloomberg.com/news/2012-03-02/gm-peugeot-pact-heightens-pressure-on-opel-s-limbo-plants.html>

subsidies. In the Appendix, Table A.7 presents the full list of models marketed by the firm and details the reason for each removal choice. The removal implies a loss of 1.3% of the product varieties available for consumers.

This partial restructuring would not lead to dramatic consequences from a consumer's point of view, as consumer welfare would decrease by €9.5 per household. This decrease is due only to the reduction in product variety, since the price effect is practically not different from zero. At aggregate level, state aid would not be warranted even after considering the decrease in variable profits suffered by the producers.

**Restructuring of the brand portfolio** Finally, we consider the removal of one of the two PSA brands, Citroën, which implies a reduction of product variety amounting to around 3.4% of the total available models. A precedent of this hypothetical counterfactual dates back to the late 70's, when PSA first acquired Talbot from Chrysler Europe and, a few years later, decided to drop this brand. Some Talbot models were rebadged as Peugeot, but most of them were just eliminated. Talbot accounted for less than a third of PSA's sales at the time of acquisition. In our case, the situation is not very different since Citroën accounts for 36% of PSA sales. But many Citroën models share the same platforms and components with Peugeot models. In this sense, this scenario is perhaps unrealistic, but constitutes a useful illustration of the possible effects of a radical restructuring prompted by the crisis and avoided by state intervention.

The removal of Citroën would substantially decrease consumer welfare by €157 per household. Because of the heterogeneity in price sensitivities introduced by income distribution, price would actually slightly decrease, with a positive effect for consumer welfare, which would increase by €5.9 per household. But the positive effect is largely outweighed by the negative change in consumer surplus caused by reduction in product variety (€163).

At aggregate level, the dramatic shrink in product variety determines dramatic losses of welfare for consumers (€4.1 billion) and in total (€7 billion), such that state aid would clearly be warranted under this worst case scenario.

At international level, Belgian consumers would mostly suffer from Citroën's exit, with a loss of €100 per household.

## 5.2 The Renault case

In the Renault case, we analyze the implications of several possible counterfactuals absent state aid, namely (i) two possible mergers, with Opel and Fiat, the same ones simulated in the PSA case; and (ii) a partial restructuring of the firm with the removal of certain models. We

Table 4: PSA Case

	Consumer effects			Total effect		
	Avg. $\Delta$ Price (%)	Avg. $\Delta$ CS /househ. (€)	of which price (€)	$\Delta$ CS (10 <sup>6</sup> €)	$\Delta$ PS (10 <sup>6</sup> €)	$\Delta$ Welf. (10 <sup>6</sup> €)
	Merger PSA + Opel					
Domestic	0.75	-22.6		-586	84	-503
Other Europe	0.45	-14.1		-1,591	219	-1,373
Total Europe	0.48	-15.0		-2,178	302	-1,876
Non-Europe					82	
	Merger PSA + Fiat					
Domestic	0.79	-23.7		-617	70	-547
Other Europe	0.37	-11.7		-1,636	213	-1,423
Total Europe	0.41	-13.0		-2,253	283	-1,970
Non-Europe						
	Partial restructuring PSA = model exit					
Domestic	0.02	-9.5	-0.5	-246	-181	-428
Other Europe	0.01	-2.9	-0.2	-325	64	-261
Total Europe	0.01	-3.7	-0.3	-571	-117	-689
Non-Europe					27	
	Radical restructuring PSA = brand exit					
Domestic	-0.24	-157.3	5.9	-4,091	-2,907	-6,998
Other Europe	0.05	-50.0	-1.4	-5,420	859	-4,562
Total Europe	0.02	-62.0	-0.6	-9,512	-2,048	-11,560
Non-Europe						

The table reports the effects of several counterfactuals absent state aid for PSA. On the left hand side, the table reports the effects on consumers in terms of predicted industry price changes and consumer surplus change for each household in the domestic market of the recipient firm (France) and in the rest of Europe. When applicable, we show the effects due to changed prices. The right hand side reports the effects on total consumer surplus, profits and welfare. CS = Consumer Surplus; PS = Producer Surplus; Welf.=Total Welfare.

do not simulate brand restructuring because Renault does not have separate brands, apart from Dacia, an Eastern European brand whose models are produced in Romania. Table 5 reports the result of the counterfactuals applied to the Renault case. In the Appendix, Table A.3 and Table A.4 report further detail on the effects on consumers and producers by country and firm.

For the cost-benefit analysis, consider the direct cost element of the aid granted to Renault roughly equal to the one of PSA.

**Merger** With regard to the merger scenarios, we consider that same possible partners as in the PSA case since both firms are focused in the same mass segments and present similar characteristics in terms of production location. Renault is smaller with respect to PSA, with a market share of 22% in France.<sup>21</sup> Intuitively, the Renault-Opel merger and the Renault-Fiat merger will entail more modest price increases with respect to the corresponding mergers involving PSA. In sum, state aid seems not to be warranted under these counterfactuals.

**Restructuring of the model range** We also consider the possibility of a partial restructuring of the firm. We remove two models that (i) are based on old technology, (ii) are not commercially successful, and (iii) belong to a marketing segment which is not in the focus of Renault, namely an SUV, Renault Koleos, and a luxury model, Renault Vel Satis. In the Appendix, Table A.8 presents the full list of models marketed by the firm and details the reason for each removal choice.

The impact of the removal is very limited from the consumer point of view. Consumer welfare would decrease by only €5 per household. This decrease is only due to the reduction in product variety, since the price effect is practically not different from zero. As in the PSA case, at aggregate level, state aid would not be warranted even after considering the decrease in variable profits suffered by the producers.

### 5.3 The Opel case

In the case of Opel, we discuss the following counterfactuals. First, we examine mergers with three possible partners: Fiat, Volkswagen and an Asian player, Hyundai. Then we investigate the possibility of a rationalization of the product range of Opel. Finally, we examine the effect of the bankruptcy of Opel, implying the removal of all the products of the firm from the European market. Table 6 reports the result of the counterfactuals applied to

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<sup>21</sup>Renault has an industrial and commercial alliance with Nissan. In 2011 the Renault-Nissan group was the third-world biggest carmaker (behind General Motors and Volkswagen). Those may be the reasons why no concrete partners have been discussed in response to the crisis.

Table 5: Renault Case

	Consumer effect			Total effect		
	Avg. $\Delta$ Price (%)	Avg. $\Delta$ CS /househ. (€)	of which price (€)	$\Delta$ CS (10 <sup>6</sup> €)	$\Delta$ PS (10 <sup>6</sup> €)	$\Delta$ Welf. (10 <sup>6</sup> €)
	Merger Renault + Opel					
Domestic	0.51	-15.0		-389	63	-327
Other Europe	0.25	-7.7		-902	139	-763
Total Europe	0.28	-8.5		-1,291	202	-1,089
Non-Europe					50	
	Merger Renault + Fiat					
Domestic	0.55	-16.3		-424	57	-367
Other Europe	0.17	-5.4		-719	106	-613
Total Europe	0.21	-6.6		-1,143	164	-979
Non-Europe					41	
	Partial restructuring Renault = model exit					
Domestic	0.01	-5.3	-0.3	-137	-141	-278
Other Europe	0.00	-2.6	-0.1	-303	54	-249
Total Europe	0.00	-2.9	-0.1	-440	-87	-526
Non-Europe					29	

The table reports the effects of several counterfactuals absent state aid for Renault. On the left hand side, the table reports the effects on consumers in terms of predicted industry price changes and consumers surplus change for each household in the domestic market of the recipient firm (France) and in the rest of Europe. When applicable, we show the effects due to changed prices. The right hand side reports the effects on total consumer surplus, profits and welfare. CS = Consumer Surplus; PS = Producer Surplus; Welf.=Total Welfare.



the Opel case. In the Appendix, Table A.5 and Table A.6 report further detail on the effects on consumers and producers by country and firm.

For the cost-benefit analysis, the direct cost element of the aid granted to Opel amounts to roughly €220 million.

**Merger** With regard to the merger between Fiat and Opel, recall that Fiat was one of the potential buyers of Opel when, in July 2009, the parent company General Motors filed for bankruptcy and concretely considered the possibility of selling Opel. Opel is present in two domestic markets, Germany and the UK, with a market share of 10 and 13%, respectively, while Fiat detains only a limited market share of 5 and 4%, respectively. Conversely, Fiat exhibits a strong presence in its domestic market, Italy, with a market share of 29%, where Opel detains 7% of the market.

The merger entails modest price increases (less than 1%), both in the domestic market and in the whole of Europe. This is confirmed by the modest loss in consumer surplus, which amounts to €8 per household. The biggest price increase and, correspondingly, loss in consumer welfare, is verified in Italy, where the concentration of market shares of the merging firms is the highest.

We now turn to the right hand side of the table. If we balance the cost of aid (around €220 million) and consumer welfare losses (€322 million), one could conclude, at first sight, that state aid is warranted since consumer surplus losses, absent state aid, are higher than the effective aid cost. But the balance is too narrow to draw this conclusion, especially when considering the indirect costs of raising public funds. Gains in industry profits amount to €106 million, so that the decrease of total welfare amounts to €216 million. On balance, if we consider total welfare we can conclude that state aid was not warranted in this counterfactual scenario.

Finally, since this is a merger between firms having a relevant presence in different countries, we briefly consider its international effects. The merger would have relevant effects in the domestic market of Fiat, Italy. In this country, consumer welfare would decrease by €650 million. In this sense, the aid granted by the German government, even if not warranted from the German taxpayer's point of view, could avoid a harmful concentration in another country with an indirect beneficial effect for other European consumers.

With regard to the merger Opel-Volkswagen, speculations have recently centered on a possible take over of Opel by Volkswagen. This counterfactual is also interesting in comparison with the first merger, because both manufacturers are German. Opel and Volkswagen detain a combined market share of 43% in Germany, and 30% in the UK. In both markets, the merger involves the first and the second biggest seller.

Notwithstanding the market concentration, according to our simulations the merger would not be blocked by the Commission, since it would imply a price increase equal to around 1.6% in the domestic market (Germany). Correspondingly, consumer losses per household would amount to €60. Given the size of the German population, the overall consumer losses are relevant (€2.3 billion). The size of profit gains is relatively small, so total welfare losses are roughly equivalent to consumer welfare losses (€1.9 billion).

If we balance the cost of aid with the gains from avoiding welfare losses due to mergers, state aid would be more clearly warranted with respect to the previous merger under both consumer and total welfare standards.

Finally, international effects of this merger are more limited relatively to the first merger. In other words, in the first merger the domestic welfare effect accounts for around 18% of the total welfare change, whereas in the second merger the domestic welfare effect accounts for around 48% of the total welfare change.

The third merger with the Asian firm Hyundai, including the Kia brand, was speculated both in 2009 and more recently in 2011 as problems for Opel seem to persist. The merger entails a moderate concentration in the German market, with a combined market share of the two firms before the merger of 14%. Intuitively, price increases are modest and state aid is not warranted in this counterfactual scenario. The European effects of the merger are also limited.

**Restructuring of the model range** We also consider the possibility of a partial restructuring of the firm. As we did for PSA and Renault, we remove two models that are based on old platforms and developed (or co-developed) by Opel. We also remove a model family constituted by Opel Vectra and its successor Opel Insignia. This is a popular model for Opel. Since we are interested in understanding the impact of the crisis on Opel, we use the example of Opel Insignia to simulate the impact of postponing the launch of new models due to the crisis, where at the same time the obsolete Opel Vectra remains unsold. The example is mainly illustrative, since Opel Insignia was mostly developed before the crisis. In the Appendix, Table A.9 presents the full list of models marketed by the firm and details the reason for each removal choice.

The effects of this counterfactual are quite dramatic, especially if we consider that it entails a loss of only 3% of the total product availability. Consumer welfare decreases in Germany by €1.5 million (€39 per household), and total welfare losses amount to €2.6 million. State aid would clearly be warranted under this counterfactual scenario.

The international effects of Opel’s model range restructuring are also quite strong, with around 70% of the loss in total European consumer welfare occurring abroad, especially in

the UK.

**Exit** Finally, we simulate the bankruptcy of Opel, which implies the removal of all the models marketed by Opel under the counterfactual choice set. This is a worst case scenario implying a dramatic reduction in product variety (roughly 8% of available models in the choice set) where we assume that all business assets are completely depreciated and scrapped or moved to developing countries.

Compared to the merger or restructuring simulation, the exit of Opel causes both a reduction in the number of competitors and in product variety. Consumer surplus would decrease by €172 per household. Price increases, deriving from the decreased number of competitors present in the market, account only for a small part of the loss in consumer welfare (€21 per household). The biggest part of the decrease in consumer surplus is due to the reduction in product variety (€151).

At aggregate level, the dramatic shrink in product variety determines dramatic losses of welfare for consumers (€6.7 billion) and in total (€11.1 billion). State aid would clearly be warranted under this counterfactual scenario.

The international effects of Opel's exit are also quite strong. The loss per household caused by reduced product variety in the UK (€195) is even higher than in Germany.

## 6 Conclusion

In this paper we examine the consequence of public aid granted during the crisis to the automobile sector. We are especially concerned about how state aid interfered with the competitive forces shaping the structure of the sector. We quantify how welfare would have been affected in absence of state aid under several counterfactual scenarios involving the three main aid recipient producers, PSA, Renault and Opel, where counterfactuals for Opel are probably the most realistic ones. We balance the cost of aid against the welfare losses provoked by mergers, restructuring and bankruptcy of the recipient firms.

Our results are mixed. In case of merger, state aid would be clearly warranted in only one merger case between two domestic producers. Under this counterfactual, the Commission's decision to allow member states to save their domestic producers may still be motivated by considerations that are closer to equity rather than efficiency. In particular, both the Commission and the national governments may have been willing to avoid the closure of large plants in disadvantaged regions, where often car plants are located.

In case of restructuring, state aid would be warranted only if the restructuring implies removing popular models or an entire brand. In case of bankruptcy, state aid would be more

Table 6: Opel Case

	Consumer effect			Total effect		
	Avg. $\Delta$ Price (%)	Avg. $\Delta$ CS /househ. (€)	of which price (€)	$\Delta$ CS (10 <sup>6</sup> €)	$\Delta$ PS (10 <sup>6</sup> €)	$\Delta$ Welf. (10 <sup>6</sup> €)
	Merger Opel + Fiat					
Domestic	0.23	-8.2		-322	106	-216
Other Europe	0.26	-7.9		-1,060	83	-977
Total Europe	0.26	-8.0		-1,382	189	-1,193
Non-Europe					56	
	Merger Opel + VW					
Domestic	1.61	-59.6		-2,340	375	-1,965
Other Europe	0.75	-23.0		-2,249	192	-2,057
Total Europe	0.88	-27.1		-4,589	567	-4,023
Non-Europe					176	
	Merger Opel + Hyundai					
Domestic	0.19	-6.9		-272	84	-188
Other Europe	0.15	-4.5		-436	39	-397
Total Europe	0.16	-4.8		-708	123	-585
Non-Europe					28	
	Partial restructuring Opel = model exit					
Domestic	0.19	-38.7	-6.8	-1,518	-1,063	-2,581
Other Europe	0.11	-34.8	-3.1	-3,619	189	-3,430
Total Europe	0.12	-35.2	-3.5	-5,137	-875	-6,011
Non-Europe					182	
	Opel exit					
Domestic	0.63	-172.2	-21.2	-6,759	-4,385	-11,144
Other Europe	0.39	-123.1	-10.8	-13,747	929	-12,818
Total Europe	0.42	-128.6	-11.9	-20,507	-3,455	-23,962
Non-Europe					720	

The table reports the effects of several counterfactuals absent state aid for Opel. On the left hand side, the table reports the effects on consumers in terms of predicted industry price changes and consumer surplus change for each household in the domestic market of the recipient firm (Germany) and in the rest of Europe. When applicable, we show the effects due to changed prices. The right hand side reports the effects on total consumer surplus, profits and welfare. CS = Consumer Surplus; PS = Producer Surplus; Welf.=Total Welfare.

clearly warranted.

With regard to the single producers, in the cases of PSA and Renault, state aid does not seem to be entirely warranted. In the case of Opel, state aid would be warranted under several reasonable counterfactuals, but not under all of them.

Our analysis reveals several policy insights regarding the impact of aid on the European internal market. In particular, giving aid in one location may have positive spillovers on consumers in the other European locations. This is especially important in view of the fact that the Commission intends to refocus state aid control on cases that have a strong impact on the internal market while simplifying the procedural treatment of state aid cases implying only local effects. According to our results, the aid to Opel seems to have benefitted all consumers across Europe, while the aid to PSA and Renault have mainly prevented losses to local (French) consumers.

Our paper shows that an explicit empirical assessment of state aid measures on the competitive structure of the market is feasible. We conclude that this assessment should also be applied during the exceptional circumstances of the crisis to ensure that competitive forces are not distorted by public intervention in a way that is detrimental for consumer and total welfare.

## A Appendix

Table A.1: Details on Consumer Surplus (Delta CS/household) for the PSA case specified by country

	$\Delta$ Price (%)	$\Delta$ CS /househ (€)	$\Delta$ CS due to prices (€)	$\Delta$ CS at const. prices (€)
Merger PSA + Opel				
Belgium	0.66	-30.9		
France	0.75	22.6		
Germany	0.28	9.9		
Greece	0.24	-6.3		
Italy	0.36	-10.5		
Netherlands	0.38	-9.6		
Portugal	0.42	-10.0		
Spain	0.64	-21.4		
UK	0.52	-13.8		
Merger PSA + Fiat				
Belgium	0.31	-14.7		
France	0.79	-23.7		
Germany	0.18	-6.4		
Greece	0.18	-4.7		
Italy	1.41	-43.1		
Netherlands	0.29	-7.4		
Portugal	0.30	-7.2		
Spain	0.17	-5.7		
UK	0.17	-4.4		
Partial restructuring PSA = model exit				
Belgium	0.01	-8.5	-0.6	-7.9
France	0.02	-9.5	-0.5	-9.0
Germany	0.01	-2.4	-0.2	-2.2
Greece	0.00	-1.3	-0.1	-1.2
Italy	0.01	-3.3	-0.3	-3.0
Netherlands	0.01	-2.2	-0.2	-2.0
Portugal	0.00	-0.8	-0.1	-0.7
Spain	0.01	-3.6	-0.3	-3.3
UK	0.00	-1.4	-0.1	-1.3
Radical restructuring PSA = brand exit				
Belgium	0.03	-100.3	-1.3	-99.1
France	-0.24	-157.3	5.9	-163.3
Germany	0.06	-28.5	-2.0	-26.5
Greece	0.01	-20.2	-0.3	-19.9
Italy	0.13	-61.9	-3.8	-58.1
Netherlands	0.07	-41.8	-1.6	-40.2
Portugal	0.05	-43.9	-1.3	-42.6
Spain	0.01	-78.3	-0.4	-77.9
UK	0.03	-25.5	-0.7	-24.7

This table reports the detail by country of the consumer effects under different counterfactual scenarios absent state aid for the PSA case. The first column reports the change of the industry price index. The second column reports the change of the consumer surplus per household ( $\Delta$  CS). Changes in consumer surplus are split into a change due to changed prices and a change at constant prices (product variety effect).

Table A.2: Details on Producer Surplus effects for the PSA case specified by firm

	$\Delta$ PS ( $10^6\text{€}$ )	$\Delta$ PS due to prices ( $10^6\text{€}$ )	$\Delta$ PS at const. prices ( $10^6\text{€}$ )
Merger PSA + Opel			
PSA + Opel	38		
BMW	17		
Daimler	8		
Fiat	37		
Ford	57		
Hyundai	17		
Renault	51		
Toyota	28		
Volkswagen	94		
Others	27		
Merger PSA + Fiat			
PSA + Fiat	52		
BMW	15		
Daimler	11		
Ford	53		
Hyundai	14		
Opel	37		
Renault	51		
Toyota	33		
Volkswagen	64		
Others	23		
Partial restructuring PSA = model exit			
PSA	-191	1	-192
BMW	12	1	11
Daimler	9	1	9
Fiat	3	0	3
Ford	12	1	12
Hyundai	4	0	4
Opel	4	0	3
Renault	10	0	10
Toyota	6	0	6
Volkswagen	23	1	22
Others	16	1	15
Radical restructuring PSA = brand exit			
PSA	-3,166	23	-3,189
BMW	56	1	56
Daimler	30	1	28
Fiat	141	0	142
Ford	182	3	178
Hyundai	46	0	46
Opel	141	4	137
Renault	269	-21	289
Toyota	102	1	101
Volkswagen	309	-3	311
Others	92	3	89

This table reports the detail by firm of the producers' effects under different counterfactual scenarios absent state aid for the PSA case. The first column reports the change of the producer surplus ( $\Delta$  PS). This change in producer surplus is split into a change due to changed prices and a change at constant prices (product variety effect).



Table A.3: Details on Consumer Surplus (Delta CS/household) for the Renault case specified by country

	$\Delta$ Price (%)	$\Delta$ CS /househ (€)	$\Delta$ CS due to prices (€)	$\Delta$ CS at const. prices (€)
Merger Renault + Opel				
Belgium	0.36	-16.9		
France	0.51	-15.0		
Germany	0.25	-8.9		
Greece	0.07	-1.8		
Italy	0.15	-4.4		
Netherlands	0.16	-4.1		
Portugal	0.37	-8.8		
Spain	0.34	-11.4		
UK	0.19	-5.1		
Merger Renault + Fiat				
Belgium	0.17	-7.7		
France	0.55	-16.3		
Germany	0.11	-4.0		
Greece	0.05	-1.2		
Italy	0.54	-16.6		
Netherlands	0.11	-2.8		
Portugal	0.25	-6.1		
Spain	0.09	-3.0		
UK	0.06	-1.5		
Partial restructuring Renault = model exit				
Belgium	0.00	-6.8	-0.1	-6.7
France	0.01	-5.3	-0.3	-5.0
Germany	0.00	-1.7	-0.1	-1.6
Greece	0.00	-0.9	-0.1	-0.8
Italy	0.00	-4.1	0.0	-4.1
Netherlands	0.00	-1.9	-0.1	-1.8
Portugal	0.00	-0.2	0.0	-0.2
Spain	0.00	-3.4	-0.2	-3.3
UK	0.00	-1.5	0.0	-1.5

This table reports the detail by country of the consumer effects under different counterfactual scenarios absent state aid for the Renault case. The first column reports the change of the industry price index. The second column reports the change of the consumer surplus per household ( $\Delta$  CS). Changes in consumer surplus are split into a change due to changed prices and a change at constant prices (product variety effect).

Table A.4: Details on Producer Surplus effects for the Renault case specified by firm

	$\Delta$ PS ( $10^6\text{€}$ )	$\Delta$ PS due to prices ( $10^6\text{€}$ )	$\Delta$ PS at const. prices ( $10^6\text{€}$ )
	Merger Renault + Opel		
Renault + Opel	18		
BMW	11		
Daimler	4		
Fiat	19		
Ford	31		
Hyundai	12		
PSA	52		
Toyota	15		
Volkswagen	67		
Others	16		
	Merger Renault + Fiat		
Renault + Fiat	21		
BMW	7		
Daimler	5		
Ford	25		
Hyundai	8		
Opel	19		
PSA	52		
Toyota	16		
Volkswagen	35		
Others	12		
	Partial restructuring Renault = model exit		
Renault	-148	-148	0.2
BMW	9	9	0.3
Daimler	7	6	0.3
Fiat	2	2	0.1
Ford	12	11	0.4
Hyundai	5	5	0.2
Opel	3	3	0.2
PSA	7	7	0.2
Toyota	6	6	0.2
Volkswagen	20	20	0.4
Others	18	17	0.4

This table reports the detail by firm of the producers' effects under different counterfactual scenarios absent state aid for the Renault case. The first column reports the change of the producer surplus ( $\Delta$  PS). This change in producer surplus is split into a change due to changed prices and a change at constant prices (product variety effect).

Table A.5: Details on Consumer Surplus (Delta CS/household) for Opel case specified by country

	$\Delta$ Price (%)	$\Delta$ CS /househ (€)	$\Delta$ CS due to prices (€)	$\Delta$ CS at const. prices (€)
Merger Opel + Fiat				
Belgium	0.18	-8.1		
France	0.13	-3.7		
Germany	0.23	-8.2		
Greece	0.25	-6.4		
Italy	0.91	-27.8		
Netherlands	0.15	-3.8		
Portugal	0.19	-4.6		
Spain	0.10	-3.3		
UK	0.22	-5.8		
Merger Opel + VW				
Belgium	0.88	-41.0		
France	0.27	-7.8		
Germany	1.61	-59.6		
Greece	0.94	-24.7		
Italy	0.42	-12.5		
Netherlands	0.82	-21.4		
Portugal	0.64	-15.6		
Spain	0.90	-30.5		
UK	1.14	-30.4		
Merger Opel + Hyundai				
Belgium	0.19	-8.8		
France	0.05	-1.5		
Germany	0.19	-6.9		
Greece	0.27	-7.1		
Italy	0.03	-1.0		
Netherlands	0.15	-3.7		
Portugal	0.09	-2.2		
Spain	0.12	-4.0		
UK	0.30	-8.1		
Partial restructuring Opel = model exit				
Belgium	0.11	-57.8	-5.0	-52.8
France	0.07	-18.0	-1.9	-16.1
Germany	0.19	-38.7	-6.8	-31.9
Greece	0.23	-43.0	-5.8	-37.2
Italy	0.09	-34.7	-2.5	-32.1
Netherlands	0.14	-36.8	-3.4	-33.4
Portugal	0.06	-17.0	-1.4	-15.6
Spain	0.06	-25.9	-1.9	-24.0
UK	0.12	-45.1	-3.1	-42.0
Opel exit				
Belgium	0.38	-198.7	-16.6	-182.1
France	0.30	-71.5	-8.3	-63.2
Germany	0.63	-172.2	-21.2	-151.1
Greece	0.43	-118.8	-10.5	-108.3
Italy	0.39	-108.7	-10.9	-97.8
Netherlands	0.37	-91.0	-8.9	-82.1
Portugal	0.26	-74.8	-5.8	-69.0
Spain	0.32	-126.3	-10.1	-116.3
UK	0.63	-195.1	-15.1	-180.0

This table reports the detail by country of the consumer effects under different counterfactual scenarios absent state aid for the Opel case. The first column reports the change of the industry price index. The second column reports the change of the consumer surplus per household ( $\Delta$  CS). Changes in consumer surplus are split into a change due to changed prices and a change at constant prices (product variety effect).

Table A.6: Details on Producer Surplus effects Opel case specified by firm

	$\Delta$ PS ( $10^6\text{€}$ )	$\Delta$ PS due to prices ( $10^6\text{€}$ )	$\Delta$ PS at const. prices ( $10^6\text{€}$ )
Merger Opel + Fiat			
Opel + Fiat	26		
BMW	11		
Daimler	8		
Ford	38		
Hyundai	10		
PSA	37		
Renault	19		
Toyota	21		
Volkswagen	50		
Others	18		
Merger Opel + VW			
Opel + VW	150		
BMW	61		
Daimler	29		
Fiat	46		
Ford	132		
Hyundai	36		
PSA	87		
Renault	59		
Toyota	50		
Others	71		
Merger Opel + Hyundai			
Opel + Hyundai	8		
BMW	8		
Daimler	3		
Fiat	11		
Ford	22		
PSA	17		
Renault	12		
Toyota	10		
Volkswagen	41		
Others	14		
Partial restructuring Opel = model exit			
Opel	-1,586	3	-1,589
BMW	29	3	26
Daimler	20	2	18
Fiat	48	3	45
Ford	167	17	150
Hyundai	17	1	15
PSA	98	10	88
Renault	42	5	37
Toyota	69	9	61
Volkswagen	304	17	287
Others	91	11	81
Opel exit			
Opel	-6,356	0	-6,356
BMW	237	24	213
Daimler	108	12	96
Fiat	259	25	234
Ford	549	54	495
Hyundai	136	16	119
PSA	424	42	382
Renault	246	31	215
Toyota	222	25	196
Volkswagen	1,068	62	1,006
Others	285	33	252

This table reports the detail by firm of the producers' effects under different counterfactual scenarios absent state aid for the Opel case. The first column reports the change of the producer surplus ( $\Delta$  PS). This change in producer surplus is split into a change due to changed prices and a change at constant prices (product variety effect).

## A.1 Selection of model families in the restructuring analysis

**The PSA case** Restructuring of PSA consists in dropping the following model families, which are listed in Table A.7:

1. Citroën C-Crosser and Peugeot 4007: both vehicles are based on a Mitsubishi platform. The vehicles are commercially unsuccessful. They both belong to a marketing segment (SUV) in which PSA's brands are not strongly recognized by consumers;
2. Citroën C6: this is an old vehicle (launched in 2005) which is commercially unsuccessful. It belongs to a marketing segment (luxury) in which PSA's brands are not strongly recognized by consumers. The platform is in common to Citroën C5, a successful intermediate vehicle, but economies of scale are limited since the two vehicles belong to different segments and are characterized by different body styles;
3. Peugeot 1007: this is an old vehicle (launched in 2004) which is commercially unsuccessful. The platform is in common to Citroën C1 and C2 and Peugeot 207, but economies of scale are limited since it presents unique features in terms of body style with respect to the other models. The vehicle was phased out in 2010;
4. Peugeot 607: this is an old vehicle (launched in 2000) which is commercially unsuccessful. It is based on an obsolete platform. It belongs to a marketing segment (luxury) in which PSA's brands are not strongly recognized by consumers. The vehicle was phased out in 2011. The successor is a vehicle belonging to the intermediate segment, rather than the luxury one.

Table A.7: Models marketed by PSA in 2009

Model family	Model variants	Segment	% firm sales	Quartile segm. sales	Platform	Model year	Platform year
<i>Citroen C-Crosser</i>	<i>C-Crosser</i>	<i>SUV</i>	<i>0.5</i>	<i>1</i>	<i>Mitsubishi GS</i>	<i>2007</i>	<i>2003</i>
Citroen C1	C1	Subc.	8.6	2	Toyota NBC	2005	1998
Citroen C2	C2	Subc	3.3	1	PF1	2003	2001
Citroen C3	C3, C3 Classic, C3 first	Subc/	11.5	2/3	PF1	2009	2001
Citroen C4	C3 pluriel, Saxo C4, Xsara, ZX	Sports Comp	6.6	2	PF2	2004	2001
Citroen C5	C5, Xantia	Interm.	5.8	2	PF3	2008	1999
<i>Citroen C6</i>	<i>C6</i>	<i>Lux</i>	<i>0.1</i>	<i>1</i>	<i>PF3</i>	<i>2005</i>	<i>1999</i>
<i>Peugeot 1007</i>	<i>1007</i>	<i>Subc</i>	<i>0.4</i>	<i>1</i>	<i>PF1</i>	<i>2004</i>	<i>2001</i>
Peugeot 107	106, 107	Subc	8.5	2	Toyota NBC	2005	1998
Peugeot 207	205, 206, 206+ 206SW, 207	Subc/ Sport	32.7	4	PF1	2006	2001
Peugeot 308	3008, 306, 307 307SW, 308, RCZ	Comp/ Sport	18.9	3	PF2	2007	2001
Peugeot 4007	4007	SUV	0.5	1	Mitsubishi GS	2007	2003
Peugeot 407	405, 406 407, 407 SW	Interm/ Sport	2.5	1/2	PF3	2004	1999
<i>Peugeot 607</i>	<i>605, 607</i>	<i>Lux</i>	<i>0.1</i>	<i>1</i>	<i>XM/605/Z8</i>	<i>2000</i>	<i>1999</i>

This table reports all the model families marketed by PSA in 2009 with their share with respect to the total firm's sales and the share of sales within the marketing segment to which each model belongs to. The table also reports information the automobile platform on which the model is built and the year of launch of the model. Subc=subcompact, Comp=compact, Interm=intermediate, Stand=standard, Lux=Luxury, SUV=Sport Utility Vehicle. The model families that are removed in our simulation are reported in italic.

**The Renault case** Restructuring of Renault consists in dropping the following model families, which are listed in Table A.8:

1. Renault Koleos: this is a vehicle co-developed between Renault and Nissan. It is commercially unsuccessful. It belongs to a marketing segment (SUV) in which Renault is not strongly recognized by consumers;
2. Renault Vel Satis: this is an old vehicle (launched in 2000) which is commercially unsuccessful. It is based on an obsolete platform. It belongs to a marketing segment (luxury) in which Renault is not strongly recognized by consumers. The vehicle was phased out in 2010.

Table A.8: Models marketed by Renault in 2009

Model family	Model variants	Segment	% firm sales	Quartile segm. sales	Platform	Model year	Platform year
Dacia Logan	Logan	Comp	0.7	1	X85/B	2004	2002
Dacia Sandero	Sandero	Comp	10.7	2	X85/B	2007	2002
Renault Clio	Clio	Subc	34.8	4	X65, X85, X85B	2006	2002
<i>Renault Koleos</i>	<i>Koleos</i>	<i>SUV</i>	<i>2.2</i>	<i>2</i>	<i>X84/C</i>	<i>2008</i>	<i>2002</i>
Renault Laguna	Laguna Nevada	Interm	5.6	2	D	2007	1993
Renault Megane	19, Fluence Megane	Comp/ Sports	24.8	3	X84/C	2008	2002
Renault Twingo	Twingo	Subc	21.0	3	X65	2007	2004
<i>Renault Vel Satis</i>	<i>Vel Satis</i>	<i>Luxury</i>	<i>0.1</i>	<i>1</i>	<i>X73/81/74</i>	<i>2000</i>	<i>2000</i>

This table reports all the model families marketed by Renault in 2009 with their share with respect to the total firm's sales and the share of sales within the marketing segment to which each model belongs to. The table also reports information the automobile platform on which the model is built and the year of launch of the model. Subc=subcompact, Comp=compact, Interm=intermediate, Stand=standard, Lux=Luxury, SUV=Sport Utility Vehicle. The model families that are removed in our simulation are reported in italic.

**The Opel case** Restructuring of Opel consists in dropping the following model families, which are listed in Table A.9:

1. Opel Agila: this vehicle is co-developed between Opel and Daewoo. It is commercially unsuccessful both in Europe and in Asia;
2. Opel Captiva: vehicles belonging to this model family are co-developed between Opel and Daewoo. They are commercially unsuccessful both in Europe and in Asia;
3. Opel Vectra: this model family is constituted by Opel Vectra and its successor Opel Insignia. This is a popular model for Opel. In a situation of crisis, firms may tend to postpone the launch of new models because of the development costs. Since we are interested in understanding the impact of the crisis on Opel, we use the example of Opel Insignia to simulate the impact of postponing the launch of a new model due to the crisis, where at the same time the obsolete predecessor Opel Vectra, dating back to 2002, remains unsold. Opel Insignia was developed on a new platform and the production started at the end of 2008. The example is mainly illustrative, since Opel Insignia was mostly developed before the crisis.

Table A.9: Models marketed by Opel in 2009

Model family	Model variants	Segment	% firm sales	Quartile segm. sales	Platform	Model year	Platform year
<i>Opel Agila</i>	<i>Agila</i>	<i>Subc</i>	<i>6.4</i>	<i>1</i>	<i>Suzuki YP/YN platform</i>	<i>2008</i>	<i>2003</i>
Opel Astra	Astra/Zafira	Comp/ Sports	28.1	4	3000/3300(old) Global Delta platform (new)	2009	2002/ 2008
<i>Opel Vectra</i>	<i>Vectra</i>	<i>Interm</i>	<i>14.1</i>	<i>4</i>	<i>Epsilon platform</i>	<i>2002</i>	<i>2001</i>
	<i>Insigna</i>				<i>Global Epsilon</i>	<i>2009</i>	<i>2008</i>
<i>GM Captiva</i>	<i>Antara/Captiva</i>	<i>SUV</i>	<i>2.6</i>	<i>2</i>	<i>Theta platform</i>	<i>2006</i>	<i>2001</i>
Opel Corsa	Corsa/Meriva/ Tigra	Subc/ Sports	36.4	4	FIAT/GM 199/4400	2005	2005
GM Cruze	Cruze	Comp	1.2	1	Global Delta platform	2008	2009
GM Epica	Epica/Evanda	Interm	0.3	1	Daewoo V200	2006	1999
GM Kalos	Aveo/Kalos/ Lanos	Subc	3.7	1	Daewoo T200	2002	2002
GM Lacetti	Aranos/Lacetti/ Nubira	Comp	0.7	1	Global Delta platform	2008	2009
GM Matiz	Matiz/Spark	Subc	4.7	1	GM Global Gamma	2009	2009
GM Solstice	GT	Sports	0.2	1	GM Kappa platform	2005	2003
Saab 9-3	9-3, 9-3X, 900	Std/ Sports	1.5	1	GM Epsilon platform	1998	1995
Saab 9-5	9-5, 9000	Lux	0.1	1	GM2900 platform	1997	1988

This table reports all the model families marketed by Opel in 2009 with their share with respect to the total firm's sales and the share of sales within the marketing segment to which each model belongs to. The table also reports information the automobile platform on which the model is built and the year of launch of the model. Subc=subcompact, Comp=compact, Interm=intermediate, Stand=standard, Lux=Luxury, SUV=Sport Utility Vehicle. The model families that are removed in our simulation are reported in italic.





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