The effect of design protection on price and price dispersion: Evidence from automotive spare parts

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Abstract. The design right is a widely used but poorly understood intellectual property right that allows the protection of products' aesthetics and outer appearances. We study the influence of design right protection on price by exploiting cross-country differences in the scope of protection in the European automotive spare parts market: In some countries, repair parts are exempted from design protection, while in others they are not. Based on detailed price data, our difference-in-differences estimates imply that design protection increases prices by about 5–8%, with large differences between carmakers. We then link our findings to the literature on deviations from the law of one price. We document large cross-country price deviations for identical spare parts and provide evidence that a part of these price deviations can be explained by the lack of harmonization of design right protection in combination with carmakers' pricing-to-market strategies.

JEL Classification: L11; L62; F15; O34; K21

Keywords: design right, design patent, repair clause, law of one price, price dispersion, European car market, automotive aftermarket, spare parts

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1. Introduction

In 2018, Apple and Samsung finally decided to settle their seven-year dispute over Apple's allegations that Samsung "slavishly" copied designs related to the iPhone and iPad (*The Economist*, 2012; Nelson, 2018). This and other high-stakes court cases show that product form and design have become increasingly important for the development of new products and that companies are willing to invest substantial resources into defending related intellectual property (IP).[1] It is therefore surprising that – while patents, copyrights, and trademarks have been extensively studied in the economic literature – the industrial design right has for the most part escaped the attention of economists.[2]

The industrial design right (hereafter, "design right") is an IP right that protects the appearance of a product with the aim of promoting aesthetic innovation and product differentiation. The owner can prevent third parties from making, selling, or importing articles bearing the protected design for commercial purposes.[3] Many industries ranging from automotive through clothing, footwear, and sports goods to furniture rely on design protection.[4] Such protection is especially important for electronic devices, including smartphones, with Samsung, Apple, LG, and Philips ranking among the top ten applicants in Europe and the United States.[5] The number of design right applications is on the rise, reaching over 1.02 million filings globally in 2018 (WIPO, 2019).

Despite its ubiquity, the design right is not harmonized across jurisdictions: While WTO members agreed on some minimum requirements under the TRIPS agreement, there is no

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[1] See also, for example, Verganti (2009). There is a small but growing literature that studies design innovations (as opposed to technological innovations), including Rubera and Droge (2013), Jindal et al. (2016), Chan et al. (2017), and Dan et al. (2018).

[2] Recent exceptions are Filitz et al. (2015), Beukel et al. (2017), and Heikkilä and Peltoniemi (2019). In the management literature, Chan et al. (2017) use data on US design patents to study the role of product form in new product development. Dan et al. (2018) combines COMPUSTAT data and design patent registrations to study the sources of design innovations.

[3] We refer the reader to Chapter 2 of WIPO (2004) and Article 25 and 26 of the TRIPS agreement.

[4] See Figure C22 in WIPO (2019). For an overview of especially "design-intensive" industries in the EU, we refer the reader to Table 40 in EUIPO (2019).

[5] See WIPO (2017, p. 116), USPTO (2016), and EUIPO (2020).

consensus on the scope of protection.[6] Because of its implications for the economically important automotive spare parts market, an especially contentious question is whether protecting the design of a component part separately from the product into which it is embedded should be possible.

To inform the debate, it is important to understand the effect of design protection on price. In defining the optimal scope of protection, policy makers are facing a trade-off: The broader the scope, the more right owners can increase the prices of protected goods, which might increase profits and therefore incentivize innovation. However, higher prices might also reduce consumer surplus and prevent the creation of follow-on products and innovation.

A strong price effect would also imply that the lack of harmonization has broader implications. Variation in the scope of design protection might translate into cross-country price dispersion for identical goods and might therefore offer (a partial) explanation for deviations from the law of one price (LOOP) for identical products, a phenomenon that has been widely documented in the economic literature.

Despite the centrality of the question, no empirical evidence exists on the influence of design protection on price. One potential reason for this lack of evidence is that the identification of causal effects is complicated because ownership of the respective right is endogenous to pricing decisions.[7] For example, products with greater commercial appeal are more likely to be protected by a design title, but are also likely to be offered at a higher price. In addition, to control for unobservable factors, in an ideal setting one would like to compare prices of identical goods with and without design protection. However, this is difficult given the lack of experimental variation.

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[6] Schickl (2013) and Rahman (2014) compare the intellectual property laws protecting designs in the EU, the US, Japan, and Australia. Yokshioka-Kobayahsi et al. (2018) present a more quantitative analysis of differences in the registration systems in the EU, US, Japan, China, and South Korea. We also refer the reader to Blackman (1996).

[7] These challenges in identifying causal effects are not specific to the design right, but also apply to other IP rights. See, for example, Galasso and Schankerman (2015), Li et al. (2018), and Reimers (2019).

In this article, we address these challenges to identification by taking advantage of cross-country differences in the scope of design protection in Europe. We focus on the European market for (visible) automotive spare parts. As of 2018, in 18 European Union (EU) member states, car manufacturers can protect *visible* spare parts using design rights and therefore prohibit the production and import of identical parts by independent manufacturers. In these countries, customers must therefore purchase visible repair parts exclusively from original manufacturers or their suppliers. In the remaining ten EU member states, national design law specifically excludes visible spare parts from this protection via a so-called "repair clause," enabling competition from independent manufacturers. We use a regression model to compare the prices of identical spare parts between countries with and without a repair clause.

Our research is based on a novel data set that contains the pre-tax prices of 12 types of spare parts for 60 car models from 2001 to 2016 in 16 EU member states plus Norway and Switzerland. While the last two are not EU members, they nevertheless participate in the EU internal market.[8] A key feature of our data is that spare part prices are listed by car model. This allows us to make cross-country price comparisons between exactly defined products. We can, for example, compare the price of a windscreen for a *BMW 5 Series 530d 2993 cc 2011* between Germany and the UK in 2016. To address the potential concerns of omitted variable bias, we also provide difference-in-differences estimates exploiting the fact that the radiator, a component part inside the vehicle, is not a *visible* spare part and therefore is not affected by the repair clause, regardless of the jurisdiction.

We show that design protection increases the prices of visible spare parts on average by about 5–8%, depending on the empirical specification. Based on these estimates, a back-of-the-

[8] Norway is part of the European Economic Area (EEA), which ensures that it can take part in the EU single market. Switzerland has agreed to accept certain aspects of EU legislation in exchange for accessing the EU's single market. In particular, since 1999, the EU and Switzerland mutually accept conformity assessment results carried out for specified industrial products.

envelope calculation suggests that an EU-wide repair clause would save EU consumers between 450 and 720 million euros annually on the purchase of visible automotive spare parts alone. While we find no differences across vehicle sizes, we find that estimated price effects vary substantially between carmakers, suggesting differences in the degree to which manufacturers exploit design protection in their pricing strategies. We discuss this finding in particular in the context of the 2018 press reports that revealed that several major carmakers used an algorithmic pricing software (Partneo) to identify the maximum price that consumers would be willing to pay for a spare part. Strikingly, we find the strongest effect of design protection on pricing for the car manufacturers in our sample that are known to have used the pricing software.

Our findings have important implications for the literature that studies deviations from the LOOP. We show that prices of automotive spare parts differ very substantially within the EU internal market. In 2016, the headlamp for a *Ford Focus III* was 30% more expensive in France than in the UK. The windscreen for a *BMW 5 Series 530d* was 42% more expensive in Germany compared to Spain. This finding and the extent of this price dispersion is surprising, because the EU internal market is highly integrated, formal trade barriers were abolished a long time ago, and many countries share the same currency.

We argue that design protection contributes to cross-country price dispersion. In countries where visible spare parts are not design protected (i.e., where a repair clause exists), arbitrage due to competition by independent spare parts manufacturers implies that cross-country price differences are bounded by trade costs. To the contrary, in countries where visible spare parts are design protected, carmakers are free to use pricing-to-market strategies and, for example, can condition spare part prices on purchasing power, fuel taxes, or climate conditions. Design protection can therefore result in cross-country price differences for identical spare parts (i) between countries with and without repair clause and (ii) among countries without a repair clause.

As described above, our findings suggest that carmakers take into account design protection in their pricing strategies to varying degrees. A testable implication is therefore that price dispersion should be largest for those carmakers that make most use of such strategies. We show that this in indeed the case in our data. In further support of our argument, we find that this relation only holds when price dispersion is calculated in the sample of countries where visible spare parts can be design protected (i.e., where independent spare part manufacturers cannot compete). Our results suggest quantitatively important effects: For the manufacturers that make most use of strategic pricing, cross-country price dispersion between countries where visible spare parts can be design protected is almost double the dispersion between countries with a repair clause.

This article makes several important contributions to the economic literature. A large literature in economics studies IP rights and their implications on market structure and price. The effects of patent protection are well understood, especially in the context of generic entry after patent expiry in the pharmaceutical industry. A consistent finding is that the loss of exclusivity leads prices drop by 40–50% (e.g., Scherer, 2010; Castanheira et al., 2019; European Commission, 2019). For copyright, Li et al. (2018) exploit a differential increase in the copyright length of books by dead authors in Britain in 1814. They find a substantial effect on price, probably because of publishers' improved ability to perform intertemporal price discrimination. Reimer (2019) identifies a positive effect of copyright on prices by exploiting an abrupt change in copyright protection in the year 1923.[9] We complement this literature by documenting a substantial price effect for the design right. As we argue in more detail below, our finding is especially important since the optimal scope of design right protection currently attracts substantial policy interest. Our article also differs methodologically from existing studies because we show *contemporaneous* price effects for *identical goods*.

[9] To the best of our knowledge, there is no direct evidence on the effect of trademark protection on price.

Second, we complement a small literature that, based on survey evidence, finds that design rights only play a minor role in appropriating returns from innovations. For example, Blind (2006) documents that patenting German firms regard design rights as the least important protection instrument. Arundel (2001), Moultrie and Livesey (2011), and Lim et al. (2014) report similar findings.[10] By contrast, the price effects that we find indicate that – at least in the automotive industry – design rights can play a substantial role in appropriating returns from innovations.

Third, we contribute to the large literature on deviations from the LOOP. It has been shown that international borders and even regional borders have a surprisingly strong effect on price dispersion (Engel and Rogers, 1996; Ceglowski, 2003). Price differentials have been attributed to differences in distribution costs (Crucini and Shintani, 2008), differences in currencies (Cavallo et al. 2014), and to strategic pricing and varying mark-ups (Haskel and Wolf, 2001; Simonovska, 2015).[11] Price differentials in the European car market are especially well documented: Large price differences persist despite the EU heavily promoting the integration of the market (Verboven, 1996; Goldberg and Verboven, 2004, 2005). In recent research, Dvir and Strasser (2018) find that active pricing-to-market strategies (e.g., based on differences in climate or fuel taxes) might explain some of the differences.

We provide further empirical evidence of large and persistent price differences for homogenous, narrowly defined products in the highly integrated EU market. Unlike the existing literature, we identify a specific regulatory difference that affects competition in markets and therefore causes price dispersion. Our results therefore lead to the general conclusion that small regulatory differences across markets can lead to quantitatively important and persistent deviations from the LOOP. As noted by Goldberg and Verboven

[10] However, Yoshioka and Kobayashi et al. (2018) find that companies often use design rights to protect their design award-winning designs.

[11] Some research finds only negligible deviations from the LOOP for online retail stores (e.g., Cavallo et al., 2014) and for prices of identical goods sold by the same retail chains (Cavallo, 2017; DellaVigna and Gentzkow, 2019).

(2005), in-depth analyses of particular markets can therefore greatly help – and might even be indispensable – to improve our understanding of what factors can explain the sustained price dispersion of homogeneous products in integrated markets.

Fourth, we are the first to show clear empirical evidence of a link between the price dispersion of homogeneous products and the scope of IP right protection. Our article thus connects the literature on price differences for homogenous products with a literature that studies the fragmentation of IP rights systems in Europe. Examples are Mejer and van Pottelsberghe (2010), who document the costs of the fragmented European patent system, as well as Herz and Mejer (2019) and Beukel et al. (2017), who study the effects of the partial harmonization of the EU system for trademarks and designs, respectively. While the existing literature mostly focuses on the effect of fragmentation on the administrative costs for applicants, we provide evidence of the effect of the fragmentation of IP rights systems on product market outcomes.

Finally, this article has important policy implications, because it contributes to the contentious debate on whether to exempt spare parts from design protection.[12] In the EU, during the last three decades, the European Commission made three legislative attempts to harmonize this issue, but without success.[13] On the national level, France and Germany are currently working on legislative proposals to introduce a repair clause for visible spare parts into their national design laws. Similar initiatives are underway outside of the EU, for example, in the United States and Brazil.

The remainder of this article is structured as follows. Section 2 briefly describes the institutional background of design protection and the repair clause in the EU with a special

[12] The debate received prominent media coverage in some EU countries. For examples from the German and French press, we refer the reader to *Der Spiegel* (2019), *Bild* (2019), Bellan (2019) in *Les Echos*, and Tarrain (2019) in *Auto Plus*.

[13] In the initial 1993 proposal for harmonizing industrial design legislation in Europe, the Commission suggested a repair clause that would limit to three years the design protection for spare parts used for the purpose of repair to restore the original appearance of a complex product.

emphasis on the automotive aftermarket. In Section 3, we present the data. In Section 4, we show that design protection leads to higher prices for visible spare parts and that car manufacturers differ in their pricing strategies. In Section 5, we document that substantial deviations from the LOOP exist for identical spare parts and provide evidence that part of these deviations are driven by the lack of harmonization of design protection in combination with manufacturers' strategic pricing. In Section 6, we conclude and discuss policy implications.

2. Design protection in the EU automotive aftermarket

In the EU, a substantial harmonization of design right protection has been achieved since the 1990s.[14] Nevertheless, important national differences remain, in particular regarding the ability to separately protect component parts that are used to repair a complex product so as to restore the product to its original appearance (hereafter, "spare parts"). While spare parts are not protectable under the EU Community Design right, on the national level member states are free to choose whether to exempt spare parts from design protection for the purpose of repair.[15] As of 2018, in 18 of the 28 EU member states, spare parts are recognized as individual protectable entities. The other ten member states provide a so-called repair clause under which spare parts are exempted from design protection when utilized for repair purposes. We refer the reader to Table A.1 in the appendix for an overview of national protection regimes in the 28 countries that were EU members as of 2016 plus Switzerland and Norway.

An important qualification is that protection is limited to spare parts that are *visible* in the course of normal use of the product in which they are embedded. For the case of a car, this

[14] First, in 1998 the EU Directive 98/71/EC on the legal protection of designs led to an approximation of national design protection laws across EU member states. Second, in 2001 the Community Design Right that offers unitary protection across the EU through a single procedure, was introduced. Since then, there exist a dual system in the EU whereby applicants can seek protection at the national and/or the EU level.

[15] For a detailed discussion on the repair clause in European Design Law, we refer the reader to Beldiman and Blanke-Roeser (2015, 2017).

means that, while the design of a front door can be protected in jurisdictions in which no repair clause exists, the design of a component part inside of the vehicle that is not visible under normal use (e.g., a radiator) is not protectable in the EU.

While design protection is important for many products such as electronic devices, furniture, clothing, and footwear, the protection of components parts is most relevant for the automotive industry. With more than 300 million vehicles in circulation on EU roads (83% of which are passenger cars) and the cost of repair compared to the price of a new car being relatively low, the demand for damage repair is significant. According to the European Automobile Manufacturers' Association (2019) and Insurance Europe (2019), more than 12 million motor third-party liability claims are made annually. A recent QVARTZ Report estimates that the total automotive spare parts retail market in Europe[16] has a value of 123 billion euros (85 billion for the EU15), with 39% of sales taking place via original equipment supplies channels (Koggersbøl et al., 2018). According to GlobalData (2017), in 2017 annual sales of *visible* automotive spare parts – encompassing body parts, integrated lighting, and automotive glass – in the EU internal market amounted to about 20 billion euros[17] (16.4 billion for the EU15). Further calculations based on GlobalData (2017) shows that 45% of sales are attained in markets without a repair clause and that 47% of sales go through the Vehicle Manufacturer's (VMNs) channel. Table A.2 in the appendix shows the top 50 original equipment suppliers of spare parts in the EU; 11 of them produce body and interior components.

It is also important to note that the European automotive market is well integrated, which makes it especially accessible for our analysis. Under the EU Whole Vehicle Type-Approval System, manufacturers can obtain certification for a vehicle type in one EU country and then

[16] The QUARTZ report only reports data separately for Western Europe (EU15) and Eastern Europe, which consists of the EU12 as well as Russia, Ukraine, Belarus, and the Balkans.
[17] This figure includes sales in Switzerland and Norway but does not include sales in Cyprus, Luxembourg, and Malta.

market it in the EU internal market (including Norway and Switzerland) without the need for further testing. The type approval regulation also covers safety critical spare parts such as glass and lighting. Furthermore, the 2003 Block Exemption Regulation promotes the right of vehicle owners to choose workshops for service and repair, as well as policy initiatives that established the EU-wide validity of car warranties and registration documents.[18] This level of harmonization greatly facilitates cross-country price comparisons and the identification of potential effects of design protection.

3. Data

We use data from annual surveys conducted by the Centro Zaragoza - Instituto de Investigación de Vehículos. The surveys were initiated by Insurance Europe to gather price information on insurance-sensitive automotive spare parts across European countries. They cover 12 types of visible spare parts in three segments – body parts, lighting, and automotive glass – as well as one non-visible spare part (radiator). Pre-tax euro-denominated prices are reported by country and separately for vehicle models that were widely available in Europe in the year of the survey.

We collected all annual surveys over the period 2001–2016 (data for year 2009 is missing) and converted the data into a large four-dimensional panel, which contains a single price quote $price_{i,m,c,t}$ for each spare part i for car model m in country c in year t. After dropping 24 records with obviously misreported prices, we are left with 40,946 observations. The panel is unbalanced. Depending on the year, it provides price information for about 20 different car models in up to 18 countries (16 countries that were EU members by the end of the sample period in 2016 plus Norway and Switzerland; see Table A.1 in the appendix). On average, each car model is covered for about five consecutive years. Over the period 2001–2016, a total of 64 car models by 12 manufacturers (e.g., Mercedes, Toyota, Audi) are covered. Car

[18] For a detailed overview of recent changes in the regulation of the EU car market, we refer the reader to the Online Appendix C of Dvir and Strasser (2018).

models can be grouped into four categories according to the vehicle size: *Minicompact*, *Subcompact*, *Compact*, and *Mid-size*.[19] Table 1 below shows a sample of records from the data.

[TABLE 1]

[TABLE 2]

Table 2 reports average prices for different spare part types for the year 2016, with boot lids and rear doors being the most and rear lamps the least expensive. From the last four columns, it is apparent that these average prices mask substantial differences across car models: for example, a rear bumper costs 140 euros for a *Renault Clio IV Authentique* but 633 euros for a *BMW 5 Series 530d*. This highlights a key advantage of our data: Our price information on car-model-specific spare parts allows us to make cross-country price comparisons for very narrowly defined product categories.

[FIGURE 1]

4. The effect of design protection on price

In this section, we study the effect of design protection on price, taking advantage of the differences in the scope of protection described in Section 2. We first present descriptive evidence as well as results from cross-country regressions. To address potential omitted variable bias, we then propose a difference-in-differences approach that uses non-visible spare parts as a control group.

4.1. Descriptive evidence

Under the hypothesis that design protection affects price, prices for identical spare parts should be relatively higher in countries without a repair clause. To explore this, we follow Crucini et al. (2005) and others and calculate log deviations from the geometric-average

[19] The US EPA size classes for cars are based on interior passenger and cargo volumes, see https://www.fueleconomy.gov/feg/info.shtml#sizeclasses.

European price for spare part i for car model m in country c in year t as $q_{i,m,c,t} = \log price_{i,m,c,t} - \frac{1}{N}\sum_{j=1}^{N} \log price_{i,m,j,t}$, where N is the number of countries. The left panel of Figure 1 compares the mean of $q_{i,m,c,t}$ for visible spare parts between countries without and with a repair clause. We see a large difference of about 7%.

The right panel makes the same comparison for the radiator spare part. Unlike the other spare parts in our data set, the radiator is a component part located inside the vehicle. Because it is therefore not visible in the course of normal use, it is not subject to design protection, independent of whether country c adopted a repair clause, see Section 2. The figure shows that the price difference is indeed much smaller.

4.2. Cross-country regression analysis

While suggestive, the descriptive evidence only offers limited insights, in particular because we cannot exclude the fact that countries with and without a repair clause systematically differ in terms of other characteristics that might affect the pricing of spare parts. We propose the following cross-country estimating equation, for now only using the subsample of visible spare parts:

$$\log price_{i,m,c,t} = \beta \; design\_prot_{c,t} + \sigma_i + \mu_m + \tau_t + \theta' \boldsymbol{X}_{c,t} + \varepsilon_{i,m,c,t} \qquad (1)$$

As before, $\log price_{i,m,c,t}$ is the pre-tax euro-denominated log price for spare part i for car model m in country c in year t. $design\_prot_{c,t}$ is an indicator variable that equals 1 if country c in year t offers design protection for visible spare parts (i.e., has no repair clause) and 0 otherwise; see Table A.2. The spare part and year fixed effects σ_i and τ_t capture differences in prices between spare parts and years. The car model fixed effects μ_m allow spare part prices to systematically vary by car model. The estimating equation also includes a vector of control variables $\boldsymbol{X}_{c,t}$ to alleviate concerns regarding omitted variable bias: It includes dummy variables that equal 1 if country c is a member of the Eurozone as well as real GDP per capita in PPPs (in logs) from the Penn World Tables 9.1 (Feenstra et al., 2015).

Estimating equation (1) has several potential weaknesses. First, the spare part prices differ by car model. As we saw in Table 2, a new windscreen for a *Renault Clio IV* is cheaper than for a *BMW 5 Series*. The car model fixed effects μ_m only fully capture this in the special case in which *all* spare parts of a given model are priced proportionally higher. Second, the specification only captures year-specific effects that uniformly affect the prices of spare parts of all models in all countries. We address both of these points by estimating a more flexible regression equation that includes a full set of interacted spare-part-by-model-by-year fixed effects $\varphi_{i,m,t}$:

$$\log price_{i,m,c,t} = \beta\ design\_prot_{c,t} + \varphi_{i,m,t} + \theta'\, \boldsymbol{X}_{c,t} + \varepsilon_{i,m,c,t} \qquad (2)$$

Identification comes from differences in the pricing of the same spare part for the same car model in the same year between countries in which spare parts are covered by design protection and countries in which an exemption via a repair clause exists.

[TABLE 3]

The results based on estimating equations (1) and (2) are reported in Table 3. In column (1), we find that design protection of visible spare parts increases prices on average by about 8%. The coefficient estimate is statistically highly significant. Controlling for real GDP per capita and including a dummy variable for Eurozone membership as well as adding car-model fixed effects in columns (2) and (3) decreases the coefficient estimate to about 5%. Coefficient estimates remain very similar when adding spare-part-by-model and spare-part-by-model-by-year fixed effects in columns (4) and (5).

[TABLE 4]

4.2.1. Spare part types

We now estimate the effect separately for the 13 spare part types, of which 12 are visible and one is non-visible (the radiator). To do so, we extend regression equations (1) and (2) by interacting the variable $design\_prot_{c,t}$ with an array of dummy variables indicating different spare part types:

$$\log price_{i,m,c,t} = \sum_{j} \beta_j \ \mathbb{1}[i = j] \times design\_prot_{c,t} + \varphi_{i,m,t} + \theta' \boldsymbol{X}_{c,t} + \varepsilon_{i,m,c,t} \tag{3}$$

$\mathbb{1}[i = j]$ is an indicator function. The estimates are shown in Table 4. We find positive and significant effects for all visible spare parts in all specifications. In the most restrictive specification reported in columns (4), estimates range from 2.3% for headlamps to 8.3% for rear wings and 10% for flasher lamps.

The most important finding for Table 4 is that we cannot reject the null hypothesis that the repair clause has no effect on the price of the radiator. This finding lends support to our difference-in-differences estimation approach that uses the radiator as a control group for our estimates.

4.3. Difference-in-differences regression analysis

A drawback of estimating equations (1) to (3) is that they do not allow for the inclusion of country fixed effects. Although our estimates account for a limited number of control variables, without allowing for country fixed effects, we cannot exclude the possibility that our results might be driven by omitted variable bias. Countries without a repair clause might share common and unobserved characteristics that also affect the pricing of spare parts. Because our sample spans the time period 2001–2016, one option would be to base our estimates on within-country policy changes. Unfortunately, out of the 18 countries in our data set, only Poland introduced a repair clause during the sample period (in 2007; see Table A.1

in the appendix). That is, despite carrying a t subscript, the variation in $design\_prot_{c,t}$ is almost completely cross-sectional.

We therefore follow an alternative approach. As discussed above, unlike the other spare parts in our data set, the radiator is a component part located inside the vehicle. Because it is therefore not a visible in the course of normal use, it is not subject to design protection, independent of whether country c adopted a repair clause. We propose the following estimating equation that uses the radiator as a control group:

$$\log price_{i,m,c,t} = \beta \; design\_prot_{c,t} \times visible_i + \varphi_{i,m,t} + \lambda_{c,m,t} + \varepsilon_{i,m,c,t} \qquad (4)$$

$design\_prot_{c,t} \times visible_i$ is an interaction between the variable $design\_prot_{c,t}$ and an indicator variable that equals 1 if a spare part i is visible and 0 otherwise (the radiator). The estimating equation includes a full set of interacted country, car model, and year fixed effects $\lambda_{c,m,t}$ and therefore allows for country-specific price differences to also vary by year and car model. These fixed effects therefore not only pick up cross-country variation due to factors such as purchasing power or local costs at the retail level, but also account for possible cross-country price differentials of specific car models or brands that might be driven, for example, by factors such as fuel taxes or weather conditions, even when changing over time. Under the assumption that the radiator is a good control group, it is highly unlikely that our results are subject to omitted variable bias. Note that the fixed effects absorb the mean effects $design\_prot_{c,t}$ and $visible_i$ as well as the vector of control variables $\boldsymbol{X}_{c,t}$.

Estimating equation (4) can be interpreted as a difference-in-differences estimator that implements the following test: Consider the price difference between visible and non-visible spare parts for the same car model, year, and country. Under the hypothesis that the design protection of visible spare parts increases prices, we would expect this difference to be larger for countries that do not have a repair clause ($design\_prot_{c,t} = 1$) compared to countries that do have a repair clause ($design\_prot_{c,t} = 0$); it should therefore hold $\beta > 0$. A critical assumption for this test to be meaningful is that the price of the non-visible spare part (the radiator) is indeed not affected by the repair clause and therefore serves as a valid control group. We showed evidence of this in Table 4, in Section 4.2.1, above.

[TABLE 5]

The results are shown in Table 5. Column (1) reports a constrained specification in which country fixed effects are not included. The resulting estimate is very similar to the estimates reported in Table 3. When including country fixed effects in column (2), this estimate increases slightly, to more than 6%. In columns (3) and (4), we also allow spare part prices to vary by country-by-year as well as by country-by-car-model-by-year. The resulting estimate is about 4.7% and is highly statistically significant.

4.3.1. Vehicle size

The effect of design protection for spare parts might differ by vehicle size. We therefore estimate the effect separately for four size classes: *Minicompact*, *Subcompact*, *Compact*, and *Mid-size*. To do this, we extend regression equation (4) by further interacting the interaction $design\_prot_{c,t} \times visible_i$ with an array of dummy variables:

$$\log price_{i,m,c,t} = \sum_j \beta_j \, \mathbb{1}[size_m = j] \times design\_prot_{c,t} \times visible_i \tag{5}$$

$$+\varphi_{i,m,t} + \lambda_{c,m,t} + \varepsilon_{i,m,c,t}$$

The indicator function $\mathbb{1}[size_m = j]$ equals 1 if car model m is of size j and 0 otherwise. Note that the mean effects $\sum_b \beta_b \, \mathbb{1}[size_m = j] \times design\_prot_{c,t}$ are absorbed by the country-by-model-by-time fixed effects $\lambda_{c,m,t}$.

[TABLE 6]

While the estimates reported in Table 6 are very stable across specifications, there seems to be no clear pattern related to vehicle size: We find large and statistically highly significant effects for *minicompact*, *subcompact*, and *small family* cars. For *mid-size* cars, we find a slightly smaller effect that only becomes significantly different from zero when including the full battery of fixed effects in specification (4). The fact that we find an effect of the repair clause independent of vehicle size (in specification [4]) highlights its importance.

4.3.2. Carmakers and strategic pricing

In 2018, it became known that five major carmakers used an algorithmic pricing software (Partneo) to identify the maximum price that consumers would be willing to pay for a spare part. Thanks to this software, between 2008 to 2013, these major carmakers increased prices on average by 15%, boosting their total revenues by more than 1 billion US dollars (e.g., Philippin, 2018). This suggests that carmakers differ in the degree of sophistication of their pricing strategies and that the extent to which they exploit pricing power due to design protection might vary.

To explore this, we analyze the effect of the repair clause separately for the 12 car manufacturers in our sample and estimate a modified version of equation (5):

$$\log price_{i,m,c,t} = \sum_{j} \beta_j \; \mathbb{1}[carmaker_m = j] \times design\_prot_{c,t} \times visible_i \qquad (6)$$

$$+\varphi_{i,m,t} + \lambda_{c,m,t} + \varepsilon_{i,m,c,t}$$

$\mathbb{1}[carmaker_m = j]$ is an indicator function that equals 1 if car model m is by carmaker j and 0 otherwise.

[TABLE 7]

The results are shown in Table 7. We find that the coefficient estimates vary considerably across manufacturers: We estimate coefficients that are not statistically different from zero for *BMW*, *Citroen*, *Fiat*, and *Ford*. Meanwhile, we find large effects for *Toyota*, *Peugeot*, and *Renault* with coefficients of up to 13%. As can be seen in Table A.3, the results remain very similar when allowing estimates to differ by manufacturer *and* vehicle size. Strikingly, *Peugeot* and *Renault* are the two carmakers that are known to have used the Partneo software and that are covered in our data.[20]

In conclusion, our findings suggest that the degree to which car manufactures exploit design protection in their pricing strategies varies substantially.

5. The effect of design protection on price dispersion

In the previous section, we documented that the design right has substantial price effects, at least in the case of automotive spare parts. In this section, we link our findings to the literature on deviations from the LOOP. We begin by documenting the large extent of price dispersion of automotive spare parts in Europe and show that only modest price convergence took place over our sample period. We then provide empirical evidence that price dispersion is to a large part driven by the lack of harmonization in the scope of design protection in combination with pricing-to-market strategies by car manufacturers.

5.1. Price dispersion and convergence

Following Goldberg and Verboven (2005), we begin by calculating aggregate price indices for the 18 countries in our sample using a hedonic price regression. Figure 2 plots these indices for some selected countries. Systematic cross-country price differences of spare parts exist: for example, in 2001, Denmark was 30% more expensive than Belgium (the reference country) while Germany was about 15% cheaper. Price differences are very large but remain relatively stable over time, at least over the last ten years of our sample period.

[FIGURE 2]

[20] It is also reported that *Nissan* used the software, however, our data only covers *Nissan* for the years 2001-2004.

Figure 3 provides a more comprehensive overview of price dispersion: It shows histograms of log deviations from the geometric-average European price for spare part i for car model m in year t, $q_{i,m,c,t} = \log price_{i,m,c,t} - \frac{1}{N}\sum_{j=1}^{N} \log price_{i,m,j,t}$, where N is the number of countries. It is apparent that deviation from the LOOP can be very large: Across all years, the standard deviation is about 17%. While a decrease is apparent compared to 2001, deviations remain large as of 2016.

[FIGURE 3][FIGURE 4]

We study price convergence more formally by considering the standard deviation of pre-tax euro-denominated log prices for given spare part i for a car model m in year t across countries c, $\Xi_{i,m,t} = 100 \times Std(\log price_{i,m,c,t} \mid i, m, t)$ (e.g., Crucini et al., 2005; Dvir and Strasser, 2018). Figure 4 visualizes the distribution of $\Xi_{i,m,t}$ using a box plot. Boxes represent the 25th–75th percentile range, and the horizontal line denotes the median. The results remain robust when using the price range instead of the standard deviation.

A visual inspection of Figure 4 suggests that price dispersion only slightly decreased over our sample period. We explore this more formally using the following estimating equation:

$$\Xi_{i,m,t} = \beta_1 time_t + \beta_2 time_t^{\ 2} + \kappa_{i,m} + \varepsilon_{i,m,t} \tag{8}$$

The coefficients β_1 and β_2 capture a (potentially quadratic) time trend. Because the regression includes spare-part-by-car-model fixed effects $\kappa_{i,m}$, any potential time trend is identified from within spare part price dispersion over time and our results are unlikely to be affected by composition bias. Results are shown in Table 8. In column (1), we impose the restriction $\beta_2 = 0$ and find evidence of a linear decline in price dispersion between 2001 and 2016. When estimating the full model in column (2), we find evidence of a slight decrease in the pace of decline in more recent years. To make sure that the decline in price dispersion is not driven by a changing country composition in our sample over time, we report regression results for a subsample of eight EU member states that are present in at least 12 of the 15 years that our data spans in column (3) and (4). While quantitatively smaller, the estimates confirm a slight decline in price dispersion over our sample period. Results from an extended regression equation reported in columns (5) and (6) show that, while price dispersion between Eurozone members is relatively smaller, there is no evidence that Eurozone membership leads faster price convergence.[21]

[TABLE 8]

To conclude, while we find evidence that price dispersion in automotive spare parts slightly decreased in our sample period from 2001 to 2016, very large price differences remain. We find that price dispersion is lower within the European Monetary Union (EMU). However, our findings are not conclusive regarding whether it was the common currency that led to a decrease in price dispersion or whether countries that joined the EMU were already better integrated to begin with.

5.2. Strategic pricing and price dispersion

The analysis above leaves little doubt that, despite modest price convergence in recent years, the pricing of spare parts in the EU internal market is fragmented across national lines and that large and sustained deviation from the LOOP exist. A crucial question is to what extent these deviations can be explained by the divergent rules on the protection of spare parts and the implied price effects demonstrated in Section 4.

[21] A large literature that studies the effect of the Euro on the LOOP and price converge and finds mixed results. Allington et al. (2005) finds price convergence due to the adoption of the Euro. Goldberg and Verboven (2004) document that the Euro decreases price dispersion for the automotive sector. To the contrary, Engel and Rogers (2004), Parsley and Wei (2008), and Fischer (2012) find no evidence that the Euro causes price convergence. Imbs et al. (2010) and Glushkenkova and Zachariadis (2016) find lower price dispersion for European Monetary Union members, but they cannot directly link this to the single currency. For the case of online retail stores, Cavallo et al. (2014), using price data from online retail stores, find that the LOOP holds well within currency unions but less so among credible and strong pegs.

Carmakers use pricing-to-market strategies that condition prices on country-specific characteristics such as purchasing power, fuel taxes, or climate conditions (e.g., Dvir and Strasser, 2018). In countries where spare parts are not design protected (i.e., where a repair clause exists), independent spare parts manufacturers can compete with original manufacturers (carmakers), and arbitrage ensures that price differences are bounded by trade costs. However, in countries without a repair clause, where the production and importation of design-protected spare parts by independent manufacturers is prohibited, such strategies might lead to large and sustained deviations from the LOOP.

Under the hypothesis that this mechanism contributes to price dispersion, a first testable implication is that the general level of cross-country price dispersion for countries without a repair clause should be relatively higher. As can be seen in Figure 5, this is indeed the case. However, while suggestive, we cannot exclude the possibility that (a part of) the difference is due to unobserved heterogeneity: Countries that implemented the repair clause might be structurally more similar than countries that do not have a repair clause.

[FIGURE 5]

We therefore consider a second testable implication: In Section 4.3.2, we documented that the price effect of design protection differs substantially between car manufacturers, potentially because the degree to which they exploit design protection for strategic pricing varies. Under the hypothesis that divergent rules on the protection of spare parts contribute to price dispersion, we would therefore expect to see more pronounced price dispersion for carmakers for which we also find larger price effects. We explore this by estimating the following estimating equation:

$$\Xi_{i,m,t} = \alpha + \sum_{j \neq Mercedes} \beta_j \; \mathbb{1}[carmaker_m = j] + \kappa_{i,t} + \varepsilon_{i,m,t} \tag{9}$$

The coefficients β_j capture the carmaker-specific price dispersion relative to *Mercedes*, the reference category. $\kappa_{i,t}$ are spare-part-by-year fixed effects. The estimates are shown in column (1) of Table 9. The estimate of the constant α implies an average standard deviation of 16.3 points for *Mercedes*. Our estimates of β_j suggest substantial differences in price dispersion between different brands: Only for three out of eleven manufacturers, we cannot reject the hypothesis that price dispersion is equal to the reference category.

The left panel of Figure 6 shows a plot of the manufacturer-specific price dispersion (column (1) of Table 9) against the estimated manufacturer-specific price effect from equation (6) (reported in column [4] of Table 7). A strong positive relationship is apparent: Cross-country price dispersion is indeed highest for the carmakers for which we found the strongest price effects in Section 4, indicating a link between price dispersion and strategic pricing based on design protection.

We conduct a placebo test to make sure that this result is not spurious: By definition, car manufacturers can only use strategic pricing based on design protection in countries that did not implement a repair clause. Therefore, if price dispersion is indeed driven by strategic pricing based on design protection, the positive relationship should disappear once price dispersion is calculated for the set of countries that have a repair clause. Columns (2) and (3) of Table 9 report results when regression equation (9) is estimated separately for countries without and with a repair clause. The right panel of Figure 6 indeed shows that, while there is a strong positive relationship for the sample of countries without a repair clause, *no* such link is apparent for the sample of countries that have a repair clause. Our data suggests that the effects are quantitatively important: For the carmakers that make most use of strategic pricing, price dispersion almost doubles.

To conclude, our analysis lends strong support to the hypothesis that divergent rules on design protection in the EU contribute to deviations from the LOOP.

[TABLE 9]

[FIGURE 6]

6. Conclusions

We studied the influence of design right protection on price by exploiting cross-country differences in the scope of protection in the EU. Using detailed price information on automotive spare parts, we found that design protection increases prices for identical spare parts by 5–8%. We found large differences between car manufacturers, suggesting that their pricing strategies vary in the degree to which they take design protection legislation into account. We then linked this evidence to the literature on the LOOP: We documented that, in the highly integrated EU market, large and persistent price deviations exist for identical spare parts (e.g., the front door of a *BMW 5 Series 530d*) and provided evidence that differences in the scope of design protection in combination with carmakers' pricing-to-market strategies can explain some of these deviations.

Our findings have important policy implications. Although WTO members agree on minimum standards for their protection under the TRIPS agreement, there is no common definition of industrial design or regarding what kind of object is eligible for protection. Given that design protection is widely used in many industries, ranging from consumer electronics (such as smartphones) to textiles, furniture, and the automotive sector, economic evidence on the optimal scope of protection is needed to inform the debate.

The strong price effects that we documented in this article imply that – contrary to survey evidence (e.g., Blind, 2006) – design rights can play a role in appropriating returns from innovations. A back-of-the-envelope calculation based on our estimates suggests that this results in high costs for consumers in the EU. We documented that the annual value of the market for visible automotive spare parts in the EU amounts to about 20 billion euros, with

45% of sales occurring in countries without a repair clause. Our estimates of a price effect of 5–8% imply that, if there was an EU-wide repair clause, EU consumers would save between 450 and 720 million euros annually on the purchase of visible automotive spare parts alone.

An important insight from our study is that car manufactures seem to vary in the degree to which they strategically exploit their pricing power due to design protection. While we estimated non-significant effects for some manufacturers, for others, we found price effects of up to 13%. This finding is especially interesting when seen in the context of reports from 2018, at which point it became known that five major carmakers used an algorithmic pricing software (Partneo) to identify the maximum price consumers would be willing to pay for automotive spare parts.[22] Thanks to this software, between 2008 to 2013 these major carmakers increased prices of visible spare parts by 15% on average, boosting their total revenues by more than 1 billion US dollars.[23] Strikingly, we find especially strong price effects for the two carmakers that are known to have used the Partneo software and that are covered in our data.

A limitation of our study is that our empirical setting is not suited to discern whether design right protection actually leads to more innovation. More empirical research is needed to better understand the trade-off between reduced consumer surplus due to higher prices of design-protected goods and increased incentives for creation.

Our findings are especially valuable for informing the contentious debate on exempting visible repair parts from design protection in the EU and beyond. In 2004, the European Commission proposed the introduction of an EU-wide repair clause in the EU design legislation. Due to a lack of progress in the negotiations, the proposal was eventually withdrawn in 2014, but since then, initiatives aiming to introduce repair clauses have been

[22] See Calvano et al. (2019) for a related discussion on algorithmic pricing and implications for competition policy.
[23] For media coverage of this case, we refer the reader to Philippin (2018), Gnirke (2018), Bergin & Frost (2018), and Mandrescu (2018).

launched on the national level in France and Germany. The German Government decided to introduce a repair clause in German design law on 10 September 2020.[24] Outside the EU, the United States and Brazil have recently made attempts to introduce repair clauses (Beldiman and Blanke-Roeser, 2017).

A recently concluded public consultation by the European Commission highlights that the lack of harmonization remains a problem:[25] A majority (55.6%) of respondents affirmed that the fragmentation of the scope of design protection was problematic for their cross-border operations, as it creates legal uncertainty and unpredictability. It is seen as creating unequal and unfair conditions of competition in the EU, for example, because it hinders the creation of European supply chains and leads to "repair tourism" across member states. However, despite their recognition of the problem and the need for harmonization, stakeholders are divided in their views on how to achieve it.

The relevance of the repair clause is not limited to the automotive spare parts market. Design protection of spare parts is important for other industries, including watches, smartphones, and electronics and household appliances (Europe Economics, 2015; Hartwig, 2016).[26] The importance of the repair clause is likely to increase in coming years, as technologies such as 3D printing increasingly facilitate the on-site and on-demand fabrication of spare parts and therefore lower the barriers to entry for independent manufacturers (Anastassacos, 2015; Beldiman and Blanke-Roeser, 2017, Chapter 7). Another important factor is that in the context of the political commitment to promote a more circular and sustainable economy,[27] there is a growing concern that design protection of spare parts is in conflict with the aim to increase the durability and reparability of products (e.g., Svensson et al., 2018).

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[24] https://www.bmjv.de/SharedDocs/Pressemitteilungen/DE/2020/091020_Staerkung_fairer_Wettbewerb.html

[25] See Annex IV in European Commission (2020).

[26] For example, Dyson sued Qualtex for manufacturing and selling spare parts for Dyson vacuum cleaners that were virtually identical to the Dyson originals (see also Hartwig, 2016, page 128).

[27] For the case of the EU, we refer the reader to the 2020 "Circular Economy Action Plan" (European Commission, 2020) that, amongst others, sets out a plan to move towards a "right to repair" for electronic devices.

Finally, the evidence presented in this article might contribute to a better understanding of cross-country price dispersion. Our findings suggest the more general conclusion that small regulatory differences across markets can lead to quantitatively important and persistent deviations from the LOOP. As illustrated by the case of the Partneo software discussed above, advances in strategic pricing might further amplify this development. In line with Goldberg and Verboven (2005), we therefore conclude that in-depth analyses of particular markets can greatly help – and might even be indispensable – in improving our understanding of what factors can explain the sustained price dispersion of homogeneous products in highly integrated markets.

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Table 1: Sample of records from our dataset

Year	Spare part	Car model	AT	BE	CH	CY	CZ	DE	DK	ES	FI	FR	GR	HU	IT	NL	NO	PL	SE	UK
2011	Radiator	Opel Insignia Essentia 1796 cc 2009	210,5	200		253,33	195,32	177,5	228,07	169,5	173	194,5			187			168,41		
2004	Bonnet	Nissan Primera Acenta 1998 cc 2002	260,1	253,87	298,55	304,79	250,1	169	261,35	257,75	315,6	259,35	232,11	341,22	226,26		278,65		326,88	248,31
2001	Front Door	Renault Megane RT 1598 cc 1996	290,11	238,55	320,02		249,28	219,34	362,55	210,13	302,91	217,54	248,86	183,33	228,16	215,38	493,59	277,53	348,78	269,2
2007	Rear Wing	Toyota Avensis Sol 1794 cc 2003	303,96	318,26		421,7	289,67		314,16	240,61	359,01	257,97	275,7	356,94	236,9		308,57		223,14	
2003	Rear Lamp	Fiat Brava SX 1370 cc 1995	83,5	79,38	109,39	98,07	77,27	79,42	93,13	75,56	143,37	78	72,05	89,89	78,08	83,38	134,71	71,4	90,95	92,12
2013	Front Bumper	Ford Fiesta Ambiente 1242 cc 2008	323,09	330,66		277,5	274,68	420,95		324,23	312,99	283,04					343,44	269,79		249,19
2008	Front Bumper	Fiat Bravo Dynamic 1368 cc 2007	220	219,3		177,15	239,32		238,01	223,73		221,88	247,2	253,23	215				213,17	
2006	Rear Door	Opel Astra H Enjoy 1598 cc 2004	358,44	370		365,37	356,79	285,9	442,35	324,83	383	361			342,51					183
2012	Front Door	Ford Fiesta Ambiente 1242 cc 2008	367,44	395,7		513,25	396,67	384,41	368,44	346,35	367,44	371,08						351,22		346,46
2001	Rear Door	Renault Megane RT 1598 cc 1996	241,13	241,2	287,82		239,7	425	314,3	210,13	302,91	221,97	239,18	183,33	232,69	234,2	459,88	291,49	348,78	291,37
2016	Boot Lid	Fiat Bravo Dynamic 1368 cc 2007	540	572,23		558		592,85	554,15	561,61	592,95	492,06	410,2				836,37	448,46		728,3
2003	Front Bumper	Nissan Primera Acenta 1998 cc 2002	212,95	185,05	200,58		155,76	163,15	206,98	163,21	200	160,16	133,07	395,2	141,5	184,72			212,58	133,37
2002	Radiator	Mercedes E Series Elegance 2295 cc 1995	164	242,55	274,55	227,84	249,29	164,08	205,7	265,69	239,83	246	242,76	300,2	249,96	167,04	507,03	266,18	191,67	308,49
2013	Front Wing	BMW 3 Series 320 d 1995 cc 2012	141	216,56		206	167,86	183,4		182,11	173,39	168,82					204,33	204,79		206,12
2015	Bonnet	Opel Corsa D Essentia 1229 cc 2007	233,5	288,5				220		257	260	285					355,87	216,69		221,92
2004	Front Door	VW Golf IV S 1390 cc 1998	291	329,5	318,41	557,93	337,6	267	329,27	304,2	410,66	314,54	320,39	319,67	313,61		438,7		355,04	289,34
2010	Front Wing	Peugeot 207 Xline 1360 cc 2006	89,71	83		126,3	69,7	89,74		90,16	90,98	89,71		81,15	80		160,9			
2007	Rear Lamp	Ford Focus II Trend 1596 cc 2005	41,37	74,96		62,97	65,41		74,95	76,81	71,25	85,68	85,59	60,64	64,92		60,91		31,04	
2014	Front Door	Opel Insignia Essentia 1796 cc 2009	498	576		724,01		471		521	625	565						491,95		457,8
2010	Head Lamp	Ford Mondeo Ambiente 1596 cc 2007	170,5	169,74		131,73	125,94	136,34		146,72	167,33	155,9		128,97	154,45		145,97			
2004	Front Wing	Mercedes E Series Elegance 2597 cc 2002	230,9	255,75	281,89	330,89	251,95	219,3	252,36	270,63	309,83	228,5	212,97	179,3	248,78		302,71		286,68	166,42
2001	Rear Lamp	Ford Mondeo LX 1796 cc 1996	149,34	144,27	150,48	123,77	83,32	85,9	128,67	91,41	111,51	100,62	126,54	85,65	99,68	122,31	112,44	101,83	148,06	71,46
2010	Rear Lamp	VW Golf VI Advance 1595 cc 2008	61	68,2			55,85	56,4		69,37	71,15	53,15		68,07	63,34		102,01			
2010	Head Lamp	Ford Fiesta Ambiente 1297 cc 2002	154,73	129,53		126,69	123,59	131,12		142,49	155,89	145,44		113,61	150,02		128,02			
2003	Rear Door	Peugeot 307 XN 1587 cc 2001	234,41		445,93		444,15	344,1	503,32	231,47	376,23	243,31	210,45	261,18	238,96	250	724	333,58	437,21	257,79

Notes: Selected variables for 25 out of 40,946 records from our data set are shown. Prices are pre-tax and Euro-denominated. Blank entries denote missing data.

Table 2: Cross-country automotive spare part mean prices, 2016

		Car model			
Spare party type	Mean	Renault Clio IV Authentique 1149 cc 2014	Ford Focus III Trend 1596 cc 2012	Audi A4 Basic 1798 cc 2009	BMW 5 Series 530d 2993 cc 2011
Boot Lid	549.6	513.3	360.8	495.2	605.2
Rear Door	505.6	591.7	321.7	473.4	694.3
Front Door	500.7	483.6	369.4	490.0	713.9
Rear Wing	474.8	480.0	440.1	450.8	651.4
Bonnet	393.2	364.1	273.7	445.4	887.5
Front Bumper	359.3	244.6	333.2	428.7	597.3
Rear Bumper	337.8	140.2	315.3	390.4	633.3
Windscreen	285.8	187.9	334.2	314.7	344.1
Radiator*	253.1	256.7	216.5	139.8	449.7
Head Lamp	253.0	197.8	195.8	308.6	513.1
Front Wing	174.5	168.4	109.3	236.0	357.6
Rear Lamp	144.9	97.1	205.0	108.2	248.4

Notes: This table shows pre-tax Euro-denominated cross-country mean prices by spare part and for four selected car models in 2016. * The radiator is a non-visible spare part and therefore not affected by the repair clause.

Table 3: Cross-country regression results

	(1)	(2)	(3)	(4)	(5)
Design protection$_{c.t}$	0.0793***	0.0594***	0.0565***	0.0559***	0.0557***
	(0.0108)	(0.0107)	(0.0103)	(0.0104)	(0.0108)
Real GDP per capita PPP, in logs$_{c.t}$		0.127***	0.129***	0.129***	0.129***
		(0.0218)	(0.0208)	(0.0211)	(0.0218)
Euro currency$_{c.t}$		-0.0532***	-0.0525***	-0.0536***	-0.0537***
		(0.0120)	(0.0117)	(0.0118)	(0.0122)
Observations	37,256	37,256	37,256	37,248	37,239
R-squared	0.711	0.715	0.837	0.924	0.930
Year FE	YES	YES	YES	YES	
Model FE			YES		
Spare part FE	YES	YES	YES		
Spare part × model FE				YES	
Spare part × model × year FE					YES

Notes: This table reports cross-country regression estimates based on equations (1) and (2). The sample only consists of visible spare parts, that is, the radiator is excluded. The dependent variable is the log pre-tax price of spare part i for car model m in country c in year t. $Design\ protection_{c.t}$ is an indicator variable that equals 1 if country c provides design protection for visible spare parts (i.e., does not have a repair clause); otherwise it is 0. Standard errors clustered at the country-by-year level are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 4: Regression estimates by spare part type

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$				
Bonnet	0.0549***	0.0526***	0.0512***	0.0504***
	(0.0122)	(0.0118)	(0.0109)	(0.0112)
Boot Lid	0.0523***	0.0494***	0.0481***	0.0475***
	(0.0123)	(0.0120)	(0.0119)	(0.0120)
Flasher Lamp	0.126**	0.137**	0.0958***	0.102***
	(0.0563)	(0.0577)	(0.0364)	(0.0356)
Front Bumper	0.0479***	0.0459***	0.0496***	0.0495***
	(0.0143)	(0.0140)	(0.0120)	(0.0123)
Front Door	0.0593***	0.0557***	0.0555***	0.0554***
	(0.0118)	(0.0115)	(0.0113)	(0.0116)
Front Wing	0.0657***	0.0637***	0.0590***	0.0589***
	(0.0118)	(0.0114)	(0.0101)	(0.0104)
Head Lamp	0.0251**	0.0222*	0.0241**	0.0239**
	(0.0117)	(0.0116)	(0.0102)	(0.0105)
Rear Bumper	0.0711***	0.0687***	0.0681***	0.0672***
	(0.0147)	(0.0144)	(0.0133)	(0.0137)
Rear Door	0.0635***	0.0606***	0.0587***	0.0583***
	(0.0133)	(0.0131)	(0.0123)	(0.0125)
Rear Lamp	0.0648***	0.0619***	0.0629***	0.0624***
	(0.0146)	(0.0143)	(0.0127)	(0.0129)
Rear Wing	0.0797***	0.0763***	0.0826***	0.0829***
	(0.0188)	(0.0186)	(0.0139)	(0.0138)
Windscreen	0.0623***	0.0605***	0.0589***	0.0591***
	(0.0212)	(0.0207)	(0.0208)	(0.0210)
Radiator (non-visible)	0.0147	0.0124	0.00849	0.00833
	(0.0168)	(0.0167)	(0.0102)	(0.0103)
Real GDP per capita PPP, in logs$_{c.t}$	0.125***	0.127***	0.127***	0.127***
	(0.0214)	(0.0204)	(0.0207)	(0.0214)
Euro currency$_{c.t}$	-0.0504***	-0.0498***	-0.0509***	-0.0510***
	(0.0117)	(0.0114)	(0.0115)	(0.0118)
Observations	40,944	40,944	40,936	40,927
R-squared	0.695	0.821	0.918	0.924
Year FE	YES	YES	YES	
Model FE		YES		
Spare part FE	YES	YES		
Spare part × model FE			YES	
Spare part × model × year FE				YES

Notes: This table reports estimates of regression equation (3) that allow estimates to vary by spare part type. The dependent variables is the log pre-tax price of spare part i for car model m in country c in year t. $Design\ protection_{c.t}$ is an indicator variable that equals 1 if country c offers industrial design protection for visible spare parts and 0 otherwise. The radiator is a spare part that is non-visible and therefore not affected by the repair clause. Standard errors clustered at the country-by-year level are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 5: Difference-in-differences regression results

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$ × visible part$_i$	0.0560***	0.0659***	0.0473***	0.0473***
	(0.00381)	(0.00848)	(0.00779)	(0.00813)
Real GDP per capita PPP, in logs$_{c.t}$	0.128***	0.0650**		
	(0.00723)	(0.0264)		
Euro currency$_{c.t}$	-0.0511***	-0.00327		
	(0.00398)	(0.00904)		
Observations	40,927	40,927	40,927	40,927
R-squared	0.924	0.936	0.939	0.962
Country FE		YES		
Country × year FE			YES	
Country × model × year FE				YES
Spare part × model × year FE	YES	YES	YES	YES

Notes: This table reports difference-in-differences regression estimates based on equations (4). The dependent variables is the log pre-tax price of spare part i for car model m in country c in year t. The interaction $design\ protection_{c.t} \times visible\ part_i$ equals 1 if country c provides design protection for visible spare parts (i.e., does not have a repair clause) and spare part i is visible; otherwise it is 0. Standard errors clustered at the spare-part-by-country-by-year level are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 6: Difference-in-differences regression results by vehicle size

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$ × visible part$_i$				
Minicompact	0.0480***	0.0472***	0.0477***	0.0467***
	(0.0159)	(0.0154)	(0.0141)	(0.0130)
Subcompact	0.0623***	0.0614***	0.0618***	0.0620***
	(0.0125)	(0.0119)	(0.0106)	(0.0112)
Small family	0.0368***	0.0359***	0.0366***	0.0363***
	(0.0124)	(0.0115)	(0.00992)	(0.00972)
Mid-size	0.0277	0.0270	0.0274	0.0252*
	(0.0200)	(0.0178)	(0.0170)	(0.0140)
Real GDP per capita PPP, in logs$_{c.t}$	0.127***	0.131***		
	(0.00726)	(0.0306)		
Euro currency$_{c.t}$	-0.0512***	-0.00459		
	(0.00398)	(0.00899)		
Observations	40,927	40,927	40,927	40,927
R-squared	0.924	0.936	0.940	0.962
Country FE		YES		
Country × year FE			YES	
Country × model × year FE				YES
Spare part × model × year FE	YES	YES	YES	YES

Notes: This table reports difference-in-differences regression estimates based on equation (5) that allow effects to vary by four car categories. The dependent variables is the log pre-tax price of spare part i for car model m in country c in year t. The interaction $design\ protection_{c.t} \times visible\ part_i \times \mathbb{1}[size_m = j]$ equals 1 if country c provides design protection for visible spare parts (i.e., does not have a repair clause) and spare part i is visible and car model m is of size category j; otherwise it is 0. Standard errors clustered at the spare-part-by-country-by-year level are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 7: Regression estimates by car manufacturer

	(1)	(2)	(3)	(4)
Design $\text{protection}_{c.t}$ × visible part_i				
Audi	0.0820*	0.0812*	0.0814*	0.0796**
	(0.0464)	(0.0470)	(0.0453)	(0.0325)
BMW	0.00533	0.00459	0.00491	0.00254
	(0.0220)	(0.0200)	(0.0195)	(0.0138)
Citroën	0.0618	0.0599	0.0599	0.0604
	(0.0642)	(0.0650)	(0.0599)	(0.0509)
Fiat	0.00432	0.00373	0.00434	0.00529
	(0.0214)	(0.0189)	(0.0183)	(0.0135)
Ford	-0.0209	-0.0215	-0.0206	-0.0202
	(0.0215)	(0.0209)	(0.0193)	(0.0154)
Mercedes	0.0562**	0.0556**	0.0560**	0.0559**
	(0.0279)	(0.0257)	(0.0250)	(0.0249)
Nissan	0.0677	0.0666	0.0667	0.0614*
	(0.0452)	(0.0416)	(0.0406)	(0.0358)
Opel	0.0442**	0.0433**	0.0438**	0.0422***
	(0.0205)	(0.0195)	(0.0181)	(0.0156)
Peugeot	0.121***	0.121***	0.121***	0.122***
	(0.0237)	(0.0245)	(0.0244)	(0.0242)
Renault	0.127***	0.126***	0.126***	0.124***
	(0.0299)	(0.0319)	(0.0324)	(0.0331)
Toyota	0.131***	0.129***	0.129***	0.129***
	(0.0370)	(0.0403)	(0.0399)	(0.0436)
VW	0.0613**	0.0611**	0.0614**	0.0626***
	(0.0282)	(0.0273)	(0.0260)	(0.0229)
Real GDP per capita PPP, in $\text{logs}_{c.t}$	0.127***	0.132***		
	(0.00731)	(0.0306)		
Euro $\text{currency}_{c.t}$	-0.0506***	-0.00375		
	(0.00402)	(0.00899)		
Observations	40,927	40,927	40,927	40,927
R-squared	0.925	0.937	0.941	0.962
Country FE		YES		
Country × year FE			YES	
Country × model × year FE				YES
Spare part × model × year FE	YES	YES	YES	YES

Notes: This table reports difference-in-differences regression estimates based on equation (6) that allow effects to vary by car manufacturer. The dependent variables is the log pre-tax price of spare part i for car model m in country c in year t. The interaction $design\ protection_{c.t} \times visible\ part_i \times \mathbb{1}[manufacturer_m = j]$ equals 1 if country c provides design protection for visible spare parts (i.e., does not have a repair clause) and spare part i is visible and car model m is by manufacturer j; otherwise it is 0. Standard errors clustered at the spare-part-by-country-by-year level are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 8: Time trends in price dispersion of automotive spare parts, regression estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample (16 EU MS + NO,CH)		8 EU MS (AT, BE, CY, CZ, DE, ES, FI, FR)		Full sample (16 EU MS + NO,CH)	
Time_t (years)	-0.300***	-0.683***	-0.214***	-0.307**	-0.341***	-0.564***
	(0.0553)	(0.132)	(0.0594)	(0.131)	(0.0628)	(0.180)
Time_t-squared		0.0214***		0.00518		
		(0.00664)		(0.00677)		
Euro $\text{currency}_{c.2016}$					-3.692***	-4.481***
					(0.276)	(0.617)
Euro $\text{currency}_{c.2016}$ × time_t						0.241
						(0.178)
Observations	2,901	2,901	2,881	2,881	3,832	3,832
R-squared	0.587	0.589	0.576	0.576	0.505	0.506
Spare part × car model FE	YES	YES	YES	YES	YES	YES

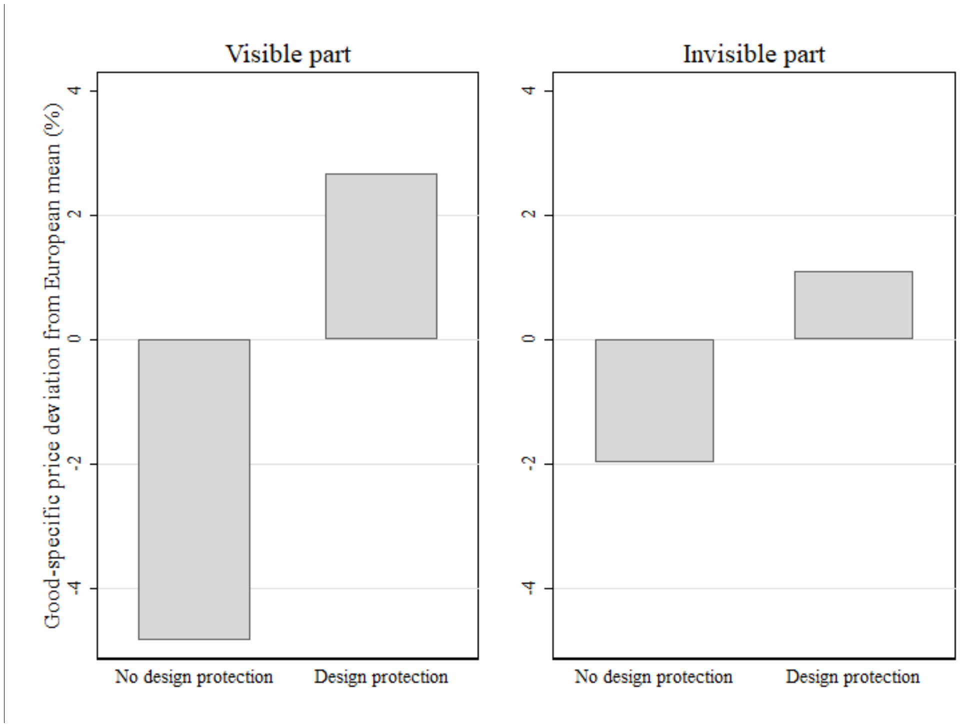
Notes: This table reports estimates of regression equation (8). The dependent variable is the standard deviation of pre-tax Euro-denominated log prices across countries for spare part i for car model m in year t. $Time_t$ is the number of years since 2000. $Euro\ currency_{c.2016}$ is an indicator that equals 1 if country c is member of the Eurozone by year 2016, the end of our sample period. All specifications include a full set of interacted spare part and car model fixed effects. In columns (3) and (4) the sample is constrained to eight EU member states. Columns (5) and (6), report results from an extended regression equation $\Xi_{i,m,t}^{euro} = \beta_1 time_t + \beta_2 \mathbb{1}[euro = 1] + \beta_3 \mathbb{1}[euro = 1] \times time_t + \kappa_{i,m} + \varepsilon_{i,m,t}$, where $\Xi_{i,m,t}^{euro=1}$ and $\Xi_{i,m,t}^{euro=0}$ are the standard deviations of spare part prices for the countries in our sample that, by 2016, adopted and did not adopt the euro. In this specification, the time trend in price dispersion for non-euro and euro countries is given by β_1 and $\beta_1 + \beta_3$. The sample only contains visible spare parts. Robust standard errors are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 9: Price dispersion by carmaker

	(1)	(2)	(3)
	All countries	Countries with design protection	Countries without design protection
Constant (Mercedes)	16.35***	17.37***	11.97***
	(0.430)	(0.489)	(0.587)
Carmaker			
Audi	1.744**	4.429***	-3.625***
	(0.777)	(0.882)	(1.060)
BMW	-3.362***	-4.716***	0.682
	(0.539)	(0.613)	(0.736)
Citroën	2.229**	2.809***	0.641
	(0.871)	(0.990)	(1.189)
Fiat	-0.360	-1.205**	0.874
	(0.523)	(0.594)	(0.714)
Ford	-2.003***	-2.934***	0.471
	(0.498)	(0.566)	(0.680)
Nissan	0.662	-0.278	4.365***
	(0.726)	(0.825)	(0.992)
Opel	-0.300	-2.558***	1.953***
	(0.496)	(0.563)	(0.677)
Peugeot	4.618***	5.778***	-1.301*
	(0.544)	(0.618)	(0.742)
Renault	2.664***	2.407***	0.760
	(0.527)	(0.599)	(0.719)
Toyota	1.879***	0.535	3.205***
	(0.674)	(0.766)	(0.920)
VW	2.014***	3.199***	-0.208
	(0.567)	(0.644)	(0.774)
Observations	2,963	2,963	2,962
R-squared	0.274	0.327	0.168
Spare part × year FE	yes	yes	yes

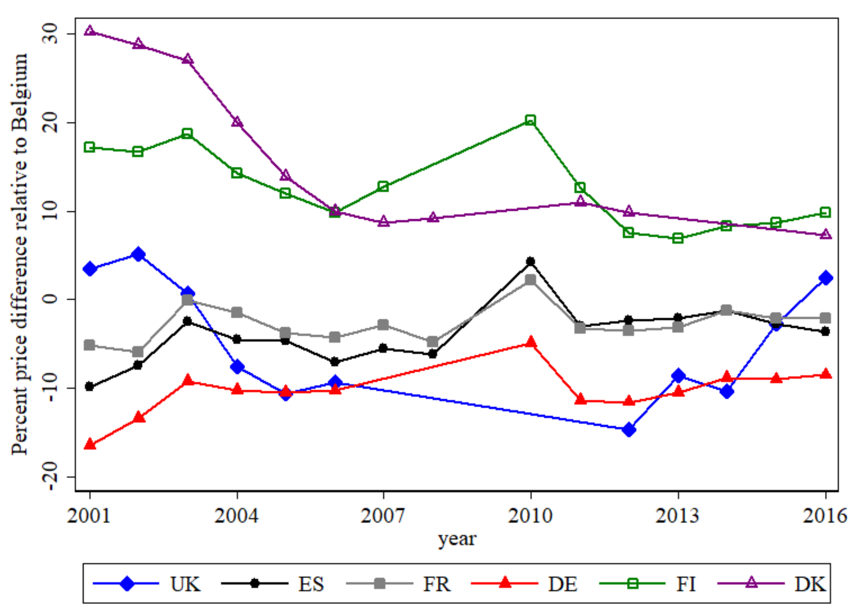
Notes: This table shows estimates of carmaker-specific price dispersion based on estimating equation (9). Estimates have to be interpreted relative to the reference category *(Mercedes)*. In column (2) and (3), price dispersion is calculated only for countries with and without design protection for visible spare parts (i.e., countries without and with a repair clause). The sample only contains visible spare parts. Robust standard errors are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Figure 1: Spare part prices in countries with and without repair clause



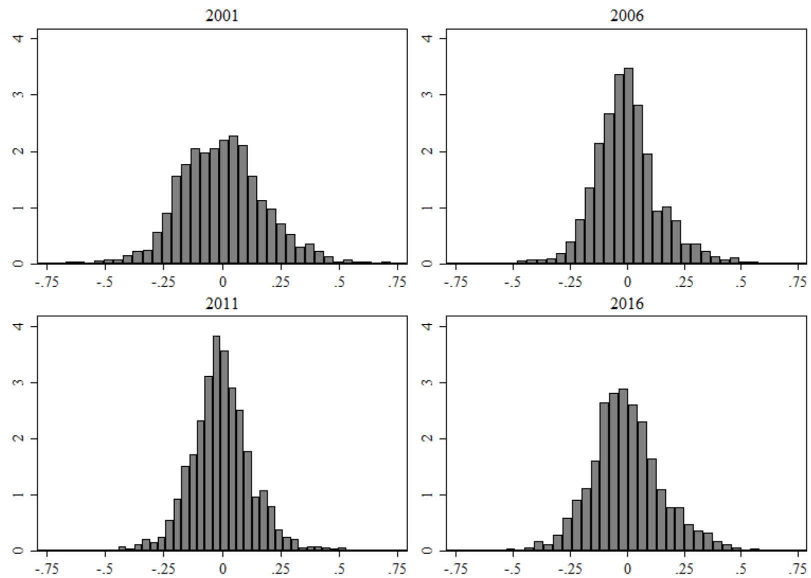
Notes: This shows a comparison of good-specific price deviations from the European mean in countries with and without a repair clause for visible (left) and non-visible spare parts (right).

Figure 2: Aggregate country price indices for selected countries, 2001-2016



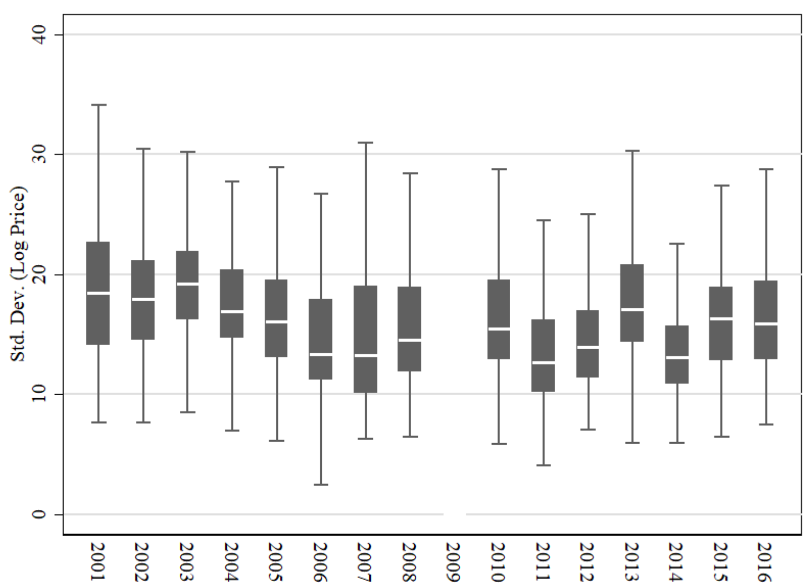
Notes: This shows aggregate price indices for spare parts for selected countries from 2001 to 2016. Indices represent estimated country-by-year effects based the hedonic price regression $\log price_{i,m,c,t} = \mu_{c,t} + \varphi_{i,m,t} + \varepsilon_{i,m,c,t}$. The spare-part-by-model-by-year fixed effects $\varphi_{i,m,t}$ account for variation in spare part prices that is uniform across countries. The residual country-by-time price differences are captured by the estimated price indices $\mu_{c,t}$. The y-axis shows the percentage price-difference relative to Belgium.

Figure 3: Cross-country price differences



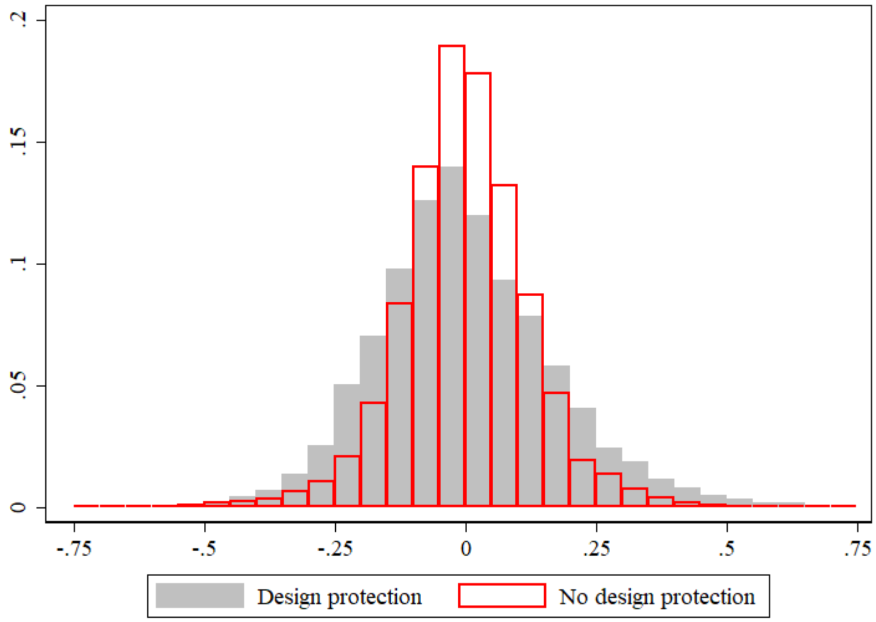
Notes: This shows the good-by-good price dispersion of twelve types of visible spare parts for 60 different car models sold in 18 European countries between 2001 and 2016. Price dispersion is measured as log deviations from the geometric-average European price for spare part i for car model m in year t, $q_{i,m,c,t} = \log price_{i,m,c,t} - \frac{1}{N}\sum_{j=1}^{N} \log price_{i,m,j,t}$, where N is the number of countries. We exclude the small number of observations where $|q_{i,m,c,t}| > 0.75$.

Figure 4: Price dispersion over time in the EU



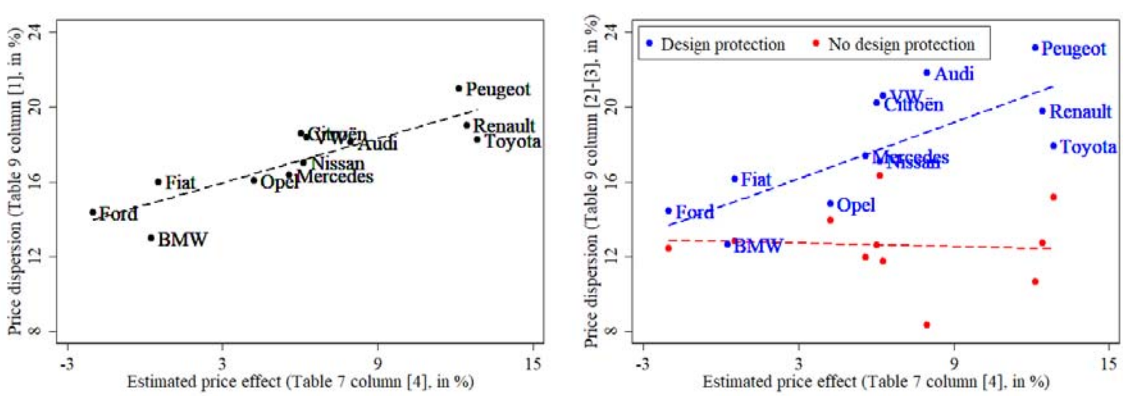
Notes: This shows the distribution of the standard deviation of pre-tax Euro-denominated log prices for visible spare part i for a car model m in year t across countries c, $\Xi_{i,m,t} = 100 \times Std(\log price_{i,m,c,t} | \, i, m, t)$. Boxes represent the 25th–75th percentile range, with the horizontal line denoting the median. The lower whisker ends at the largest observed value below the 25th percentile minus 1.5 interquartile ranges threshold, and the upper whisker ends at the smallest observed value above the 75th percentile plus 1.5 interquartile ranges threshold. There is no data for year 2009.

Figure 5: LOOP deviations for countries without and with repair clause



Notes: This shows histograms of $q_{i,m,c,t}^{design\_prot=1}$ and $q_{i,m,c,t}^{design\_prot=0}$ for visible spare parts, the good-specific price deviations from the mean for the sample of countries with design protection for visible spare parts (no repair clause, gray) and without (repair clause, red). Price dispersion for the latter group is substantially smaller: the ratio of the standard deviations is about 75%.

Figure 6: The relation between price dispersion and estimated price effect



Notes: This plots the manufacturer-specific price dispersion on the y-axis against the estimated price effect on the x-axis. In the left panel, price dispersion is calculated for all countries in our sample. In the right panel, price dispersion is calculated separately for countries with and without design protection for visible spare parts (i.e., countries without and with a repair clause). The estimated price effects are reported in column (4) of Table 7; for price dispersion see columns (1)-(3) of Table 9. Note that for price dispersion the full effect is shown $(\hat{\alpha} + \hat{\beta}_j)$.

Appendix

Table A.1: Country coverage of the sample

	Repair clause	Coverage in our sample	# years covered	EU accession	Euro accession
Countries <u>in our sample</u>					
Austria (AT)	no	2001-2008,2010-2016	15	1995	1999
Belgium (BE)	yes	2001-2008,2010-2016	15	1957	1999
Cyprus (CY)	no	2001-2008,2010-2016	15	2004	2008
Czech Republic (CZ)	no	2001-2008,2010-2013	12	2004	-
Denmark (DK)	no	2001-2008,2011-2012,2016	11	1973	-
Finland (FI)	no	2001-2007, 2010-2016	14	1995	1999
France (FR)	no	2001-2008,2010-2013	15	1957	1999
Germany (DE)	no*	2001-2006,2010-2016	13	1957	1999
Greece (GR)	no	2001-2005,2007-2008	8	1981	2002
Hungary (HU)	yes	2001-2005,2007-2010	8	2004	-
Italy (IT)	yes (2001)	2001-2008,2010-2011	10	1957	1999
Netherlands (NL)	yes	2001-2008,2010-2011	4	1957	1999
Norway (NO)	no	2001-2005,2007-2008, 2010,2013,2015-2016	11	-	-
Poland (PL)	yes (2007)	2001-2003,2011-2016	9	2004	-
Spain (ES)	yes	2001-2008,2010-2016	15	1986	1999
Sweden (SE)	no	2001-2004,2007-2008	6	1995	-
Switzerland (CH)	no	2001-2005	5	-	-
United Kingdom (UK)	yes	2001-2006,2012-2016	11	1973	-
EU member countries <u>not</u> in our sample					
Bulgaria	no	-	-	2007	-
Croatia	no	-	-	2013	-
Estonia	no	-	-	2004	2011
Ireland	yes	-	-	1973	1999
Latvia	yes	-	-	2004	2014
Lithuania	yes	-	-	2004	2015
Luxembourg	yes	-	-	1957	1999
Malta	no	-	-	2004	2008
Portugal	no	-	-	1986	2008
Romania	no	-	-	2007	-
Slovakia	no	-	-	2004	2009
Slovenia	no	-	-	2004	2007

Notes: This shows the county coverage of our sample. Information on the repair clause is from Europe Economics (2015) and Beldiman and Blanke-Roeser (2017). *The German Government decided to introduce a repair clause in German design law on 10 September 2020. The repair clause applies to all designs registered from the time the implementation enters into force (expected January 2021).

Table A.2: Revenues of the top 50 suppliers in Europe in 2018 (in million US Dollars)

Company name	Revenue	Product	Company name	Revenue	Product
1 Robert Bosch	22.286	*Elc, Elct*	26 Grupo Antolin	3.230	*Int*
2 Continental	18.901	*Brk, Tyres*	27 Yazaki Corp.	3.010 (fe)	*Elc*
3 ZF Friedrichshafen	17.357	*Brk*	28 Panasonic Automotive Systems Co.	2.795 (f)	*Elct*
4 Magna International Inc.	17.147	*Engr*	29 Autoliv Inc.	2.690	*Safety*
5 Faurecia	10.540	*Exht*	30 Dana Inc.	2.524 (f)	*Mech*
6 Thyssenkrupp	9.374	*Mech*	31 Hyundai Mobis	2.383	*Int, Elct*
7 Valeo	9.054 (f)	*Trans, Elct*	32 Freudenberg Group	2.355	*Int*
8 Lear Corp.	8.671	*Seats*	33 GKN Automotive	2.322	*Engr*
9 Mahle	6.914 (f)	*Mech*	34 JTEKT Corp.	2.092	*Trans*
10 Gestamp	6.260	*Mech*	35 IAC Group	2.020	*Int*
11 Samvardhana Motherson Grou	5.871 (fe)	*Plst*	36 Garrett Motion Inc.	1.890 (e)	*Mech, Elct*
12 BASF	5.431	*Plst, Exst*	37 Yanfeng	1.791	*Int, Safety*
13 Plastic Omnium Co.	5.357	*Plst*	38 Hanon Systems	1.781	*Clng*
14 Denso Corp.	5.052 (fe)	*Elc, Elct*	39 Delphi Technologies	1.673 (e)	*Engr*
15 Magneti Marelli	5.030 (f)	*Elc, Elct,Mech*	40 Webasto	1.660 (fe)	*Body*
16 Schaeffler	5.026 (e)	*Trans, Mech*	41 CIE Automotive	1.657	*Engr*
17 Benteler Automotive	4.917	*Exst, Mech*	42 Infineon Technologies	1.642	*Engr*
18 Adient	4.698	*Int, Elct*	43 Nemak	1.642	*Engr*
19 HELLA GmbH & Co.	4.489 (fe)	*Elct*	44 TI Fluid Systems	1.605 (e)	*Engr*
20 BorgWarner Inc.	4.001 (f)	*Trans, Mech*	45 Flex-N-Gate Corp.	1.502	*Body, Int*
21 Aptiv	3.989	*Int, Elct*	46 Leopold Kostal	1.500	*Elc, Elct*
22 Tenneco Inc.*	3.700	*Exht, Mech*	47 Federal-Mogul	1.401 (fe)	*Exht*
23 Brose Fahrzeugteile	3.670	*Body, Brk*	48 Linamar Corp.	1.334	*Engr*
24 Eberspaecher Gruppe	3.594 (f)	*Elc, Elct, Clng*	49 Constellium	1.228	*Body*
25 Aisin Seiki Co.	3.290 (f)	*Trans, Elct*	50 Preh	1.152	*Clng*

(e) estimate; (f) fiscal year; (fe) fiscal year estimate

Product:

Body	Body components
Brk	Mechanical brake
Clng	A/C, airbags, seat belts, or security systems
Elc	Electric components
Elct	Electronic
Engr	Engineering and powertrain application
Exht	Manifolds and exhaust lines
Int	Interior components, door & instr. panels,
Mech	Mechanical comp. of engines and chassis
Mtrs	Advanced composite materials
Plst & Rbr	Plastic & rubber: e.g. paints and coatings
Trans	Transmission

Notes: The data comes from Automotive Supply (2019).

Table A.3: Regression estimates by car manufacturer and vehicle size

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$ × visible part$_i$				
Minicompact				
Fiat	-0.00482	-0.00494	-0.00386	-0.00347
	(0.0263)	(0.0233)	(0.0231)	(0.0176)
Ford	-0.0231	-0.0236	-0.0235	-0.0234
	(0.0280)	(0.0282)	(0.0270)	(0.0234)
Nissan	0.0962*	0.0961**	0.0953**	0.0913**
	(0.0531)	(0.0480)	(0.0473)	(0.0409)
Opel	0.0725**	0.0715**	0.0714**	0.0692***
	(0.0311)	(0.0309)	(0.0283)	(0.0251)
Peugeot	0.117***	0.116***	0.116***	0.115***
	(0.0389)	(0.0398)	(0.0399)	(0.0393)
Renault	0.0909***	0.0892**	0.0895**	0.0883**
	(0.0342)	(0.0352)	(0.0356)	(0.0360)
VW	0.0381	0.0381	0.0381	0.0381
	(0.0773)	(0.0790)	(0.0767)	(0.0656)
Subcompact				
Citroen	0.0618	0.0599	0.0599	0.0604
	(0.0642)	(0.0651)	(0.0599)	(0.0509)
Fiat	0.0138	0.0129	0.0130	0.0139
	(0.0212)	(0.0194)	(0.0187)	(0.0161)
Ford	-0.0269	-0.0274	-0.0275	-0.0274
	(0.0237)	(0.0227)	(0.0212)	(0.0169)
Opel	0.0302	0.0288	0.0303	0.0291
	(0.0265)	(0.0257)	(0.0248)	(0.0213)
Peugeot	0.126***	0.125***	0.125***	0.126***
	(0.0239)	(0.0233)	(0.0233)	(0.0234)
Renault	0.160***	0.159***	0.159***	0.157***
	(0.0342)	(0.0366)	(0.0370)	(0.0374)
VW	0.0668***	0.0664***	0.0669***	0.0687***
	(0.0242)	(0.0219)	(0.0208)	(0.0197)
Compact				
Audi	0.0820*	0.0812*	0.0814*	0.0796**
	(0.0464)	(0.0470)	(0.0453)	(0.0325)
BMW	0.0145	0.0140	0.0144	0.0145
	(0.0292)	(0.0271)	(0.0269)	(0.0226)
Ford	-0.0124	-0.0129	-0.0109	-0.0103
	(0.0247)	(0.0236)	(0.0221)	(0.0196)
Nissan	0.0376	0.0352	0.0361	0.0314
	(0.0433)	(0.0411)	(0.0400)	(0.0402)
Opel	0.0293	0.0289	0.0288	0.0281
	(0.0241)	(0.0226)	(0.0225)	(0.0190)
Toyota	0.131***	0.129***	0.129***	0.129***
	(0.0370)	(0.0404)	(0.0400)	(0.0436)

(continues on the next page)

	(1)	(2)	(3)	(4)
Mid-Size				
BMW	-0.000860	-0.00170	-0.00156	-0.00547
	(0.0224)	(0.0210)	(0.0204)	(0.0145)
Mercedes	0.0562**	0.0556**	0.0560**	0.0559**
	(0.0279)	(0.0257)	(0.0250)	(0.0249)
Real GDP per capita PPP, in $\text{logs}_{c.t}$	0.127***	0.132***		
	(0.00732)	(0.0306)		
Euro $\text{currency}_{c.t}$	-0.0505***	-0.00343		
	(0.00403)	(0.00897)		
Observations	40,927	40,927	40,927	40,927
R-squared	0.926	0.937	0.941	0.962
Country FE		YES		
Country × year FE			YES	
Country × model × year FE				YES
Spare part × model × year FE	YES	YES	YES	YES

Notes: This table reports difference-in-differences regression estimates based on an extended version of equation (5) that allows effects to vary by car manufacturer and vehicle size. The dependent variables is the log pre-tax price of spare part i for car model m in country c in year t. The interaction $design\,protection_{c.t} \times visible\,part_i \times \mathbb{1}[manufacturer_m = j] \times \mathbb{1}[size_m = k]$ equals 1 if country c provides design protection for visible spare parts (i.e., does not have a repair clause) and spare part i is visible and car model m is by manufacturer j and of vehicle size k; otherwise it is 0. Standard errors clustered at the spare-part-by-country-by-year level are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.