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 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 protection in combination with carmakers' pricing-to-market strategies.

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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; Nellis, 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. (2018), 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. (2018) 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 EPO & 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 might have 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. Yoshioka-Kobayashi 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 not subject to 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 complements research by others that documents large price dispersions for identical goods in the highly integrated EU internal market where 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. Whether such a link exists is ex-ante unclear and therefore an empirical question. In countries where visible spare parts are design protected (i.e., where no repair clause exists) there is no competition from independent spare parts manufacturers that might "arbitrage away" cross-country price differences. Carmakers can therefore make better use of pricing-to-market strategies, for example, by conditioning spare part prices on purchasing power, fuel taxes, or climate conditions. However, the effect of design protection on price dispersion also depends on whether design protection of visible parts is predominantly permitted in countries with relatively low or high price levels.

We provide evidence that design protection indeed increases cross-country price dispersion. Our evidence is based on two empirical tests. First, 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 and 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). Second, based on a difference-in-differences estimation approach, we find that the price dispersion of identical visible spare parts is relatively larger across the set of countries that permit design protection for visible parts compared to countries that do not permit protection. Strikingly, no such difference is apparent when considering the radiator, a spare part not subject to the repair clause, regardless of the jurisdiction. Both tests suggest quantitatively important effects.

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. Reimers (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 protection

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

currently attracts substantial policy interest. Our article also differs methodologically from existing studies because we show *contemporaneous* price effects for *identical goods*.

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 (2014), 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

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[10] However, Yoshioka-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).

conclusion that small regulatory differences across markets can contribute to quantitatively important and persistent deviations from the LOOP. As noted by Goldberg and Verboven (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 van Pottelsberghe and Mejer (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 have recently been 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.

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[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.

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 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 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.[16] 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

[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).

[16] The maximal duration of design protection for spare parts is the same as for general industrial designs, that is, 25 years. Exceptions are Denmark and Sweden, where the period of protection is shorter and lasts for 15 years (Time.lex et al., 2016).

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 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 report estimates that the total automotive spare parts retail market in Europe[17] 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[18] (16.4 billion for the EU15). Further calculations based on GlobalData (2017) show that 45% of sales are attained in markets without a repair clause and that 47% of sales go through the vehicle manufacturer's 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.

[17] This 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.
[18] This figure includes sales in Switzerland and Norway but does not include sales in Cyprus, Luxembourg, and Malta.

The sale of spare parts is an important part of carmakers' business. For the year 2014, a report by Oliver Wyman (2015) finds that aftersales accounted for a modest 11% of revenues but for 38% of profits of carmakers. It is therefore not surprising that carmakers are very much aware of the importance of the repair clause for their businesses, as exemplified by an excerpt from the 2020 annual report of the Volkswagen Group: "Volkswagen may be exposed to increased competition in aftermarkets for regulatory reasons. […] In Germany, legislation entered into force on December 2, 2020 to restrict or abolish design protection for repair parts through the introduction of a repair clause. In addition, the European Commission is evaluating the market with regard to existing design protection. A possible restriction or abolition of design protection for visible replacement parts could adversely affect the Volkswagen Group's genuine parts business."

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 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.[19] 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

[19] 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).

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). In the survey, national insurance associations were asked to quote OEM spare part prices from Audatex, a software providing collision repair estimations and claims solutions in the automotive insurance industry. 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 models can be grouped into four categories according to the vehicle size: *Minicompact*, *Subcompact*, *Compact*, and *Mid-size*.[20] 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

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

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 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 that countries with and without a repair clause might systematically differ in terms of other characteristics that can affect the pricing of spare parts.[21] We propose the following cross-country estimating equation, for now only using the subsample of visible spare parts:

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

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. $Design\; protection_{c,t}$ 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.1. 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 a dummy variable that equals 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). Finally, the equation includes an indicator variable that equals 1 if model m is by a car brand that is "domestic" in country c (e.g., VW in Germany).

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

[21] In Appendix Table A.3, we report balance tests that suggest that various covariates do not significantly differ between countries with and without a repair clause.

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 $\varphi_{i,m,t}$:

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

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 dummy variables for Eurozone membership and for “domestic” manufacturers as well as adding car-model fixed effects in columns (2) and (3) decreases the coefficient estimate to about 6%. 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 $design\; protection_{c,t}$ with an array of dummy variables indicating different spare part types:

$$\log price_{i,m,c,t} = \sum_j \beta_j \; \mathbb{1}[i=j] \times design\,protection_{c,t} + \varphi_{i,m,t} + \theta' \boldsymbol{X}_{c,t} + \rho\; domestic_{m,c} + \varepsilon_{i,m,c,t} \qquad (3)$$

$\mathbb{1}[i=j]$ 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 3% for headlamps to 9% for rear wings and 11% 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 $design\,protection_{c,t}$ 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:

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

$Design\,protection_{c,t} \times visible_i$ is an interaction between the variable $design\,protection_{c,t}$ 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 $\lambda_{m,c,t}$ 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 $design\,protection_{c,t}$ and $visible_i$, the vector of control variables $\boldsymbol{X}_{c,t}$, as well as the indicator variable $domestic_{m,c}$.

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 ($design\,protection_{c,t} = 1$) compared to countries that do have a repair clause ($design\,protection_{c,t} = 0$); 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.[22] 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 almost 7%. 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.

In Appendix Table A.4, we show that our results are also robust when the analysis is constrained to the four cheapest spare parts in our sample (head lamp, front wing, rear lamp, radiator, see Table 2). Another concern is that our results might be driven by one or two countries in our sample with especially high or low prices. In Table A.5, we therefore report the estimates shown column (4) of Table 5 when one country at a time is dropped from the sample. In all cases, the estimate of interest remains positive and highly 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 $design\ protection_{c,t} \times visible_i$ with an array of dummy variables:

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

[22] In models of oligopoly supply with multiproduct firms, the price of radiators might depend on the prices of other (visible) spare parts which in turn depend on the existence of a repair clause. We believe it is reasonable to assume that any potential price effects would be of second order importance, in particular because the radiator and other spare parts are neither substitutes nor likely to be bought together.

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

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 $\sum_b \beta_b \; \mathbb{1}[size_m = j] \times design\,protection_{c,t}$ are absorbed by the country-by-model-by-year fixed effects $\lambda_{m,c,t}$.

While the estimates reported in Appendix Table A.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 column (4). The fact that we find an effect of the repair clause independent of vehicle size (in column [4]) highlights its importance.

4.3.2. Carmakers and strategic pricing

We analyze the effect of the repair clause separately for the 12 car manufacturers in our sample by estimating a modified version of equation (5):

$$\log price_{i,m,c,t} = \sum_j \beta_j \; \mathbb{1}[carmaker_m = j] \times design\,protection_{c,t} \times visible_i \tag{6}$$

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

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

[TABLE 6]

The results are shown in Table 6. 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.7, the results remain very similar when allowing estimates to differ by manufacturer *and* vehicle size.

First, there seems to be no clear distinct pattern for luxury brands. For example, we find a significant price effect for *Mercedes* but not for *BMW*. This is noteworthy, since one might have thought that buyers of luxury cars may be less price sensitive and would always prefer original parts. Under such a hypothesis, we would have expected the price effect of the repair clause to be weaker for luxury cars.

Second, our findings are interesting in the context of press reports from 2018, when 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; Gnirke, 2018a, 2018b; Bergin and Frost, 2018; and Mandrescu, 2018). Strikingly, *Peugeot* and *Renault,* for which we find large effects, are the two carmakers that are known to have used the Partneo software and that are covered in our data.[23]

Our findings suggest that the degree to which car manufactures exploit design protection in their pricing strategies varies substantially. While we can only speculate what might explain these different pricing approaches, it is unlikely that the differences stem from a lack of knowledge of some market participants of the existence of the Partneo (or similar) pricing software. For example, according to Gnirke (2018b), BMW confirmed that they were in talks with Accenture, the owner of the software, but that they were not interested in the product.

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

VW conducted a pilot test with the software in September and December 2011 but eventually decided not to use it.[24]

What seems more likely is that the different approaches regarding the pricing of spare parts might reflect contrasting business strategies or company characteristics. For example, a carmaker with a more long-term strategic view and/or with a more valuable brand might be concerned that fully exploiting its price setting power on visible spare parts might damage the company's reputation. In particular, customers that only find out about potentially very costly spare parts after having bought a car might decide to purchase a different brand next time. In this context, an interesting question, which unfortunately is beyond the scope of this article, is to what extent consumers take into account the expected future costs of spare parts when deciding on the purchase of a car.[25]

[TABLE 7]

4.3.3. Tripe differences: A case study for Poland

As mentioned above, out of the 18 countries in our data set, only Poland introduced a repair clause during the sample period in 2007, see Table A.2. In this section, we assess the robustness of our findings by exploiting the policy change in Poland in a more "traditional" difference-in-differences setting as well as in a difference-in-difference-in-differences setting. To this end, we begin by comparing the prices of visible spare parts in Poland before and after the introduction of the repair clause in 2007 with the respective prices in the Czech Republic. We chose the Czech Republic as the control because it never introduced a repair

[24] It is important to note that the use of pricing algorithms might also entail competition law risks due to "algorithmic collusion." For example, if the same pricing algorithm was used by several carmakers and this was common knowledge among carmakers, then this might eliminate the uncertainty of competition in the market and facilitate collusion. See, for example, Ezrachi and Stucke (2017) and Marx et al. (2018).

[25] This is also related to the ongoing discussion in competition policy on how to define markets in the presence of aftermarkets. A key question is whether and to what extent customers already take into account the pricing of a secondary product when buying a primary product. If they do, then it might be appropriate to define a "system market" which comprises both the primary and secondary product. Examples of primary and secondary products other than car and spare parts are printers and ink cartridges, computers and software, smartphones and apps. See, for example, (OECD, 2018) that provides an executive summary of the OECD's 2017 roundtable on *Competition Issues in Aftermarkets.*

clause and because, out of the countries in our sample, it might be considered to be culturally the "most similar" to Poland. We use the following estimating equation:

$$\log price_{i,m,c,t} = \alpha \; Poland_c + \beta \; Poland_c \times post_t \qquad (7)$$

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

$Poland_c$ is an indicator that is 1 for Poland and 0 for the Czech Republic. The variable $post_t$ is an indicator that is 1 for the post-treatment period. The coefficient of interest is β, which captures the differential change in visible spare part prices relative to the Czech Republic from 2007 on, the year when the repair clause was introduced in Poland. Note that, due to the data constraints described in Table A.2, the pre- and post-treatment periods consist of the years 2001-2003 and 2011-2013, respectively. The specification includes spare-part-by-model-by-year fixed effects. Under the assumption that without the policy change visible spare part prices would have evolved relatively similar in the two countries, the estimated coefficient β is informative about the price effect of the repair clause. The results reported in Table 7 indicate that the repair clause led to a decrease of prices for visible spare parts by about 13%, an effect that is quantitatively larger than what is suggested by our main specification reported in Table 5.

By also including non-visible spare parts (the radiator) in the sample, we can push the analysis further and estimate a difference-in-difference-in-differences regression equation:

$$\log price_{i,m,c,t} = \gamma \; Poland_c \times post_t \times visible_i + \varphi_{i,m,t} + \lambda_{m,c,t} + \omega_{i,c} + \varepsilon_{i,m,c,t} \qquad (8)$$

The coefficient of interest γ captures the price change of visible compared to non-visible (and therefore not affected) spare parts in Poland post-2007 relative to the respective price change in the Czech Republic (where no repair clause was introduced). This approach also allows to not only include country-by-model-by-year fixed effects $\lambda_{m,c,t}$ but also spare-part-by-country fixed effects $\omega_{i,c}$ that capture time-invariant spare-part-specific price differences between Poland and the Czech Republic. This should alleviate most concerns regarding potential omitted variable bias. Note that all other main and interaction effects such as $Poland_c \times post_t$ and $Poland_c \times visible_i$ are absorbed by the fixed effects. A constrained specification (that does not include fixed effects $\omega_{i,c}$) and the full specification are reported in columns (2) and (3) of Table 7, respectively. The results are quantitatively very similar to the difference-in-differences specification and corroborate our finding that the introduction of the repair clause in Poland led to a substantial reduction of prices of visible spare parts.

5. The effect of design protection on price dispersion

In the previous section, we documented that, for the case of automotive spare parts, the design right has substantial price effects. 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]

Figure A.1 in the appendix 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.

We study price convergence more formally by considering the standard deviation of pre-tax Euro-denominated log prices for spare part i for 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 A.2 in the appendix 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 Appendix Figure A.2 suggests that price dispersion only slightly decreased over our sample period. We explore this more formally using the following estimating equation:

$$\Xi_{i,m,t} = \beta_1 time_t + \beta_2 time_t^2 + \kappa_{i,m} + \varepsilon_{i,m,t} \quad (9)$$

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.[26] Results from an extended regression equation reported in columns (3) and (4) show that, while price dispersion between Eurozone members is relatively smaller, there is no evidence that Eurozone membership leads to faster price convergence.[27] In columns (5) and (6), we provide first evidence of a link between price dispersion and the design protection: We report estimates when regression equation (9) is estimated separately for countries without and with design protection for visible spare parts. While the decrease in price dispersion over time is similar in both cases, the estimated constants (16.2 vs. 21.3) indicate that there is a substantial difference in the *level* of price dispersion between the two groups.

[TABLE 8]

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 design protection of spare parts and the implied price effects demonstrated in Section 4.

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

[26] To make sure that the decline in price dispersion is not driven by a changing country composition in our sample over time, we also estimated regressions results for a subsample of eight EU member states that are present in at least 12 of the 15 years that our data spans. While quantitatively smaller, the estimates confirm a slight decline in price dispersion over our sample period. These results are available upon request.

[27] 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 European Monetary Union (EMU) were already better integrated to begin with. 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 EMU 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.

clause exists), independent spare parts manufacturers can compete with original manufacturers (carmakers), and arbitrage ensures that price differences cannot become too large. To the contrary, 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. Finally, the effect of design protection on price dispersion also depends on whether design protection of visible parts is predominantly permitted in low or high cost countries.

Under the hypothesis that design protection is 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. We provided first evidence of this in columns (5) and (6) of Table 8. A more detailed comparison is shown in Figure A.3 in the appendix. However, while suggestive, we cannot exclude the possibility that (a part of) the difference is due to unobserved heterogeneity: Countries that have a repair clause might be structurally more similar to each other than countries that do not have a repair clause.

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 regression equation:

$$\Xi_{i,m,t} = \alpha + \sum_{j \neq Mercedes} \beta_j \ \mathbb{1}[carmaker_m = j] + \kappa_{i,t} + \varepsilon_{i,m,t} \tag{10}$$

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.

[FIGURE 3]

The left panel of Figure 3 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 6). 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 (10) is estimated separately for countries without and with a repair clause. The right panel of Figure 3 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.

[TABLE 9]

We provide a final test of our hypothesis by using an estimating equation analogous to equation (4)

$$\Xi_{i,m,t}^{d} = \beta \, design\,protection_d \times visible_i + \varphi_{i,m,t} + \lambda_{m,d,t} + \varepsilon_{i,m,d,t} \qquad (11)$$

where $\Xi_{i,m,t}^{d=1}$ and $\Xi_{i,m,t}^{d=0}$ are the standard deviations of pre-tax Euro-denominated log prices for spare part i for car model m in year t across countries with and without design protection for visible spare parts, respectively. $\lambda_{m,d,t}$ are car-model-by-year fixed effects that can also vary by countries with and without design protection for visible parts ($d = 1$ or $d = 0$). Two simplified specifications as well as the full specification are reported in Table 10 in columns (1)-(2) and (3), respectively. In all cases, the estimated coefficient β implies that, relative to non-visible spare parts, the price dispersion of visible parts is about 0.7 points higher in countries that do have design protection for visible spare parts. Given that the average price dispersion of visible spare parts in countries where they are not design protected is 12.7, these results suggest that design protection increases deviations from the LOOP by about 5%. To conclude, our analysis lends support to the hypothesis that divergent rules on design protection in the EU contribute to deviations from the LOOP.

[TABLE 10]

6. Conclusions

We studied the influence of design 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[28] on the purchase of visible automotive spare parts alone.[29]

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

[28] With "savings" we refer here to the counterfactual decrease in spending of EU consumers for a given quantity of spare parts. The effect on total consumer spending on automotive spare parts of course also depends on the price elasticity of demand.

[29] Another potentially interesting aspect are the distributional consequences of the repair clause. Under the hypothesis that buyers of luxury cars are less price sensitive and always prefer original parts, we would have expected relatively larger price effects for non-luxury cars. However, as discussed in Section 4.3.2, this is not supported by our data.

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.[30] 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.[31] 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 protection also 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 launched on the national level in France and Germany. The German government decided to introduce a repair clause in German design law that came into force on 2 December 2020.[32] 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:[33] A majority (over 80%) of respondents affirmed

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[30] See Calvano et al. (2019) for a related discussion on algorithmic pricing and implications for competition policy.
[31] For media coverage of this case, we refer the reader to Philippin (2018), Gnirke (2018a, 2018b), Bergin and Frost (2018), and Mandrescu (2018).
[32] https://www.bmjv.de/SharedDocs/Pressemitteilungen/DE/2020/091020_Staerkung_fairer_Wettbewerb.html
[33] See Annex IV in European Commission (2020).

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).[34] 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,[35] 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).

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 contribute 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

[34] 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).
[35] 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.

of what factors can explain the sustained price dispersion of homogeneous products in highly integrated markets.

References

Allington, N. F. & Kattuman, P. A., & Waldmann, F. A. (2005). One market, one money, one price? *International Journal of Central Banking*, 1(3), 73-115.

Anastassacos, T. (2015) 3D printing will disrupt the spare parts market. The question is how, how soon and what to do about it, Service in Industry Briefing. Retrieved from http://serviceinindustry.com/2015/03/03/3d-printing-will-disrupt-the-spare-parts-markets/.

Arundel, A. (2001). The relative effectiveness of patents and secrecy for appropriation. *Research policy*, *30*(4), 611-624.

Chappell, L. (2019, June 24). Top Suppliers: North America, Europe and the World. *Automotive News: A supplement*.

Beldiman, D., Blanke-Roeser, C. (2015). European Design Law: Considerations Relating to Protection of Spare Parts for Restoring a Complex Product's Original Appearance. *International Review of Intellectual Property and Competition Law,* 46, 915–919.

Beldiman, D., & Blanke-Roeser, C. (2017). *An International Perspective on Design Protection of Visible Spare Parts*. Springer.

Bellan, M. (2019, March 5). Vers une libéralisation du marché des pièces détachées automobile. *Les Echos*. Retrieved from http://www.lesechos.fr/economie-france/conjoncture/vers-une-liberalisation-du-marche-des-pieces-detachees-automobile-995995.

Bergin, T. & Frost L. (2018, June 3). Software and stealth: how carmakers hike spare parts prices. *Reuters Technology News*. Retrieved from http://www.reuters.com/article/us-autos-software-pricing-insight/software-and-stealth-how-carmakers-hike-spare-parts-prices-idUSKCN1IZ07L.

Beukel, K., Alcacer, J., & Luo, H. (2017). Effects of a unified system of Industrial Designs. Working paper. *DRUID NYU Stern School of Business,* New York, June 12–14, 2017.

Bild. (2019, September 26) Autoteile werden immer teurer. *Bild*. Retrieved from http://www.bild.de/auto/mobilitaet-reisen-motorrad/mobilitaet-und-mehr/preisanstieg-um-30-prozent-in-sechs-jahren-autoteile-immer-teurer-64956186.bild.html.

Blackman, M. J. R. (1996). Designs as a searchable intellectual property right. *World Patent Information*, 18(4), 193-204.

Blind, K., Edler, J., Frietsch, R., & Schmoch, U. (2006). Motives to patent: Empirical evidence from Germany. *Research Policy,* 35(5), 655-672.

Calvano, E., Calzolari, G., Denicolò, V., & Pastorello, S. (2019). Algorithmic pricing what implications for competition policy? *Review of Industrial Organization*, 55(1), 155-171.

Castanheira, M., Ornaghi, C., & Siotis, G. (2019). The unexpected consequences of generic entry. *Journal of Health Economics*, 68.

Cavallo, A. (2017). Are online and offline prices similar? Evidence from large multi-channel retailers. *American Economic Review,* 107(1), 283-303.

Cavallo, A., Neiman, B., & Rigobon, R. (2014). Currency unions, product introductions, and the real exchange rate. *The Quarterly Journal of Economics*, 129(2), 529-595.

Ceglowski, J. (2003). The law of one price: Intranational evidence for Canada. *Canadian Journal of Economics/Revue canadienne d'économique*, 36(2), 373-400.

Chan, T. H., Mihm, J., & Sosa, M. E. (2018). On styles in product design: An analysis of US design patents. *Management Science*, 64(3), 1230-49.

Crucini, M.J., Telmer, C.I., & Zachariadis, M. (2005). "Understanding European real exchange rates." *American Economic Review,* 95(3), 724-738.

Crucini, M. J., & Shintani, M. (2008). Persistence in law of one price deviations: Evidence from micro-data. *Journal of Monetary Economics*, 55(3), 629-644.

Dan, S. M., Spaid, B. I., & Noble, C. H. (2018). Exploring the sources of design innovations: Insights from the computer, communications and audio equipment industries. *Research Policy*, 47(8), 1495-1504.

DellaVigna, S., & Gentzkow, M. (2019). Uniform pricing in U.S. retail chains, *The Quarterly Journal of Economics*, 134(4), 2011-84.

Der Spiegel. (2019, September 25). Preise für Autoersatzteile deutlich gestiegen. Retrieved from http://www.spiegel.de/auto/aktuell/auto-ersatzteile-preise-fuer-reparaturen-steigen-a-1288500.html.

Dvir, E., & Strasser, G. (2018). Does marketing widen borders? Cross-country price dispersion in the European car market. *Journal of International Economics*, 112, 134-149.

Engel, C., & Rogers, J. H. (1996). How wide is the border? *The American Economic Review*, 86(5), 1112-25.

Engel, C., & Rogers, J. H. (2004). European product market integration after the euro, *Economic Policy,* 19(39), 348-384.

EPO & EUIPO (2019). IPR-intensive industries and economic performance in the European Union, Industry-level analysis report, Third edition (September 2019).

EUIPO (2020). EUIPO Design Focus 2010 to 2019 Evolution.

European Automobile Manufacturers' Association (ACEA) (2019). Report: Vehicles in use - Europe 2019. Retrieved from https://www.acea.be/uploads/publications/ACEA_Report_Vehicles_in_use-Europe_2019.pdf.

European Commission (2019). Report from the Commission to the Council and the European Parliament – Competition Enforcement in the Pharmaceutical Sector (2009-2017). Published on 28 January 2019.

European Commission (2020). Evaluation of Directive 98/71/EC of the European Parliament and of the Council of 13 October 1998 on the legal protection of designs ('Design Directive') and of Council Regulation (EC) No 6/2002 of 12 December 2001 on the Community designs ('Community Design Regulation'). Commission Staff Working Document SWD(2020)264.

Europe Economics (2015). The economic review of industrial rights in Europe. Retrieved from https://ec.europa.eu/growth/content/economic-review-industrial-design-europe-0_en.

Ezrachi, A. & Stucke, M. E. (2017). Artificial Intelligence & Collusion: When Computers Inhibit Competition. *University of Illinois Law Review*, 2017(5), 1775-1810.

Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The next generation of the Penn World Tables. *American Economic Review*, 105(10), 3150-82.

Filitz, R. & Henkel, J. & Tether B.S. (2015). Protecting aesthetic innovations? An exploration of the use of registered community designs. *Research Policy*, 44(6), 1192-1206.

Fischer, C. (2012). Price convergence in the EMU? Evidence from micro data. *European Economic Review*, 56(4), 757-776.

Galasso, A., & Schankerman, M. (2015). Patents and cumulative innovation: Causal evidence from the courts. *The Quarterly Journal of Economics*, 130(1), 317-369.

GlobalData (2017). *The European Car Crash Repair Parts Market 2012 – 2022: Market size, market forecast and recommendations.* Published: February 2017.

Glushenkova, M., & Zachariadis, M. (2016). Understanding post-euro law-of-one-price deviations. *Journal of Money, Credit and Banking*, 48(6), 1073-1111.

Gnirke, K. (2018a, May 31). Unternehmensberatung soll Renault und Peugeot bei Preisabsprachen geholfen haben. *Der Spiegel Mobilität*. Retrieved from http://www.spiegel.de/auto/aktuell/accenture-verhalf-renault-und-psa-zu-milliardengewinn-bei-ersatzteilen-a-1210152.html.

Gnirke, K. (2018b, June 1). Die Abzock-Konzerne. *Der Spiegel Mobilität*. Retrieved from https://www.spiegel.de/auto/aktuell/renault-und-psa-skandal-fuenf-konzerne-schroepfen-kunden-bei-ersatzteilen-a-1210518.html.Goldberg, P. K., & Verboven, F. (2004). Cross-country price dispersion in the euro era: a case study of the European car market. *Economic Policy*, *19*(40), 484-521.

Goldberg, P. K., & Verboven, F. (2004). Cross-country price dispersion in the euro era: a case study of the European car market. *Economic Policy*, 19(40), 484-521.

Goldberg, P. K., & Verboven, F. (2005). Market integration and convergence to the Law of One Price: evidence from the European car market. *Journal of International Economics*, *65*(1), 49-73.

Hartwig, H. (2016). Spare parts under European design and trade mark law. *Journal of Intellectual Property Law & Practice*, 11(2), 121-129.

Haskel, J., & Wolf, H. (2001). The law of one price—a case study. *Scandinavian Journal of Economics*, *103*(4), 545-558.

Heikkilä, J. & Peltoniemi, M. (2019). Great expectations: Learning the boundaries of design rights. *Research Policy*, 48(9), 1037-95.

Herz, B., & Mejer, M. (2019). Effects of the European Union trademark: Lessons for the harmonization of intellectual property systems. *Research Policy*, 48(7), 1841-54.

Imbs, J. M., Mumtaz, H., Ravn, M. O., & Rey, H. (2010). One TV, one price? *Scandinavian Journal of Economics*, 112(4), 753-781.

Insurance Europe (2019, February). Report on European Motor Insurance Markets.

Jindal, R. P., Sarangee, K. R., Echambadi, R., & Lee, S. (2016). Designed to succeed: Dimensions of product design and their impact on market share. *Journal of Marketing*, 80(4), 72-89.

Koggersbøl, N.L., Lisberg, N.B., Belobokov, D. & Nenning, G. (2018) The Automotive Aftermarket in 2025. Trends and applications. *QVARTZ.* Retrieved from https://qvartz.com/media/2003/the-automotive-aftermarket-in-2025.pdf.

Li, X., MacGarvie, M., & Moser, P. (2018). "Dead poets' property—how does copyright influence price?" *The RAND Journal of Economics,* 49(1), 181-205.

Lim, K., O'Sullivan, D., & Falk, M. (2014). The market for designs: insights from interviews with Australian firms. *IP Australia Economic Research Paper*, 3.

Mandrescu, D. (2018, June 7). When algorithmic pricing meets concerted practices - the case of Partneo. *CoRe Blog*. Retrieved from https://coreblog.lexxion.eu/when-algorithmic-pricing-meets-concerted-practices-the-case-of-partneo/.

Moultrie, J., & Livesey, F. (2014). Measuring design investment in firms: Conceptual foundations and exploratory UK survey. *Research Policy*, *43*(3), 570-587.

Marx, L., Ritz, C. & Weller, J. (2019). Liability for outsourced algorithmic collusion – A practical approximation. *Concurrences*, 2019(2).

Nellis, S. (2018, June 27). Apple, Samsung settle U.S. patent dispute. *Reuters Technology News*. Retrieved from https://www.reuters.com/article/us-apple-samsung-elec-idUSKBN1JN2S4.

OECD (2018). Executive Summary of the Roundtable on Competition Issues in Aftermarkets Annex to the Summary Record of the 127th meeting of the Competition Committee. Retrieved from https://one.oecd.org/document/DAF/COMP/M(2017)1/ANN5/FINAL/en/pdf.

Oliver Wyman (2015). Graphics System Profit 2035 - Reinvent Sales. Retrieved from https://www.oliverwyman.com/content/dam/oliver-wyman/global/en/files/who-we-are/press-releases/OliverWyman_Graphics_System_Profit_2035-Reinvent_Sales_EN_15092015_final.pdf.

Parsley, D., & Wei, S. J. (2008). In search of a euro effect: Big lessons from a Big Mac Meal? *Journal of International Money and Finance*, 27(2), 260-276.

Philippin, Y. (2018, May 31). How Renault and PSA Peugeot Citroën secretly hiked global cost of spare parts by €1.5bn. *Mediapart*. Retrieved from https://www.mediapart.fr/en/journal/international/310518/how-renault-and-psa-peugeot-citroen-secretly-hiked-global-cost-spare-parts-15bn.

Reimers, I. (2019). Copyright and generic entry in book publishing. *American Economic Journal: Microeconomics*, *11*(3), 257-84.

Scherer, F. M. (2000). The pharmaceutical industry. In: Newhouse, J.P. (Ed.), *Handbook of Health Economics*, vol.1. Elsevier, Amsterdam, Chapter 25, pp. 1297–1336.

Schickl, L. (2013). Protection of Industrial Design in the United States and in the EU: Different Concepts or Different Labels?. *The Journal of World Intellectual Property*, 16(1-2), 15-38.

Simonovska, I. (2015). Income differences and prices of tradables: Insights from an online retailer. *The Review of Economic Studies*, 82(4), 1612-56.

Svensson, S., Richter, J. L., Maitre-Ekern, E., Pihlajarinne, T., Maigret, A., & Dalhammar, C. (2018). The emerging 'right to repair' legislation in the EU and the US. Paper presented at Going Green CAREINNOVATION 2018, Vienna, Austria.

Rahman, S. S. (2014). Industrial Design in Different Jurisdictions: A Comparison of Laws. *Journal of Intellectual Property Rights*, 19, 223-228.

Rubera, G., & Droge, C. (2013). Technology versus design innovation's effects on sales and Tobin's Q: The moderating role of branding strategy. *Journal of Product Innovation Management*, 30(3), 448-464.

Tarrain, F. (2019, March 29). Pièces de rechange : les prix ont encore flambé! *Auto Plus*. Retrieved from http://www.autoplus.fr/actualite/pieces-assurance-reparation-inflation-constructeur-1537017.html.

The Economist (2012, September 1). Apple v Samsung: iPhone, uCopy, iSue. *The Economist* Retrieved from http://www.economist.com/node/21561888.

Time.lex, Queen Mary - London, Spark Legal Network and Indiville (2016). Legal review on industrial design protection in Europe. A study carried out for the European Commission. Retrieved from https://ec.europa.eu/growth/content/legal-review-industrial-design-protection-europe-0_en.

USPTO (2016), USPTO Design patent report. Published in March 2016.

van Pottelsberghe, B., & Mejer, M. (2010). The London Agreement and the cost of patenting in Europe. *European Journal of Law and Economics*, 29(2), 211-237.

Verboven, F. (1996). International price discrimination in the European car market. *The RAND Journal of Economics*, 27(2), 240-268.

Verganti, R. (2009). *Design driven innovation: changing the rules of competition by radically innovating what things mean*. Harvard Business Press.

WIPO (2004). WIPO Intellectual Property Handbook: Policy, law and use. World Intellectual Property Organization, Geneva.

WIPO (2017). World Intellectual Property Report 2017: Intangible capital in global value chains. World Intellectual Property Organization, Geneva.

WIPO (2019). World Intellectual Property Indicators. World Intellectual Property Organization, Geneva.

Yoshioka-Kobayashi, T., Fujimoto, T., & Akiike, A. (2018). The validity of industrial design registrations and design patents as a measurement of" good" product design: A comparative empirical analysis. *World Patent Information*, 53, 14-23.

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

Spare party type	Mean	Car model			
		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 subject to design protection.

Table 3: Cross-country regression results

	(1)	(2)	(3)	(4)	(5)
Design protection$_{c.t}$	0.0793***	0.0656***	0.0642***	0.0636***	0.0635***
	(0.0108)	(0.0103)	(0.00957)	(0.00967)	(0.00997)
Real GDP per capita PPP, in logs$_{c.t}$		0.132***	0.135***	0.135***	0.135***
		(0.0211)	(0.0198)	(0.0201)	(0.0208)
Euro currency$_{c.t}$		-0.0431***	-0.0400***	-0.0412***	-0.0412***
		(0.0118)	(0.0108)	(0.0110)	(0.0113)
Domestic brand$_{m,c}$		-0.117***	-0.144***	-0.143***	-0.144***
		(0.0161)	(0.0126)	(0.0127)	(0.0131)
Observations	37,256	37,256	37,256	37,248	37,239
R-squared	0.711	0.717	0.839	0.926	0.932
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	0.0605***	0.0596***	0.0581***	0.0575***
	(0.0119)	(0.0112)	(0.0102)	(0.0104)
Boot Lid	0.0579***	0.0564***	0.0551***	0.0545***
	(0.0121)	(0.0115)	(0.0113)	(0.0114)
Flasher Lamp	0.132**	0.144**	0.104***	0.110***
	(0.0559)	(0.0571)	(0.0358)	(0.0349)
Front Bumper	0.0534***	0.0528***	0.0565***	0.0565***
	(0.0139)	(0.0135)	(0.0115)	(0.0117)
Front Door	0.0650***	0.0627***	0.0625***	0.0625***
	(0.0115)	(0.0108)	(0.0107)	(0.0109)
Front Wing	0.0713***	0.0707***	0.0659***	0.0659***
	(0.0116)	(0.0110)	(0.00944)	(0.00972)
Head Lamp	0.0307***	0.0292***	0.0310***	0.0309***
	(0.0114)	(0.0112)	(0.00977)	(0.0101)
Rear Bumper	0.0767***	0.0757***	0.0750***	0.0742***
	(0.0143)	(0.0138)	(0.0128)	(0.0131)
Rear Door	0.0701***	0.0689***	0.0669***	0.0666***
	(0.0131)	(0.0126)	(0.0117)	(0.0119)
Rear Lamp	0.0704***	0.0689***	0.0699***	0.0695***
	(0.0141)	(0.0136)	(0.0119)	(0.0121)
Rear Wing	0.0853***	0.0833***	0.0895***	0.0899***
	(0.0184)	(0.0179)	(0.0131)	(0.0130)
Windscreen	0.0707***	0.0710***	0.0694***	0.0696***
	(0.0205)	(0.0198)	(0.0199)	(0.0201)
Radiator (non-visible)	0.0203	0.0194	0.0155	0.0154
	(0.0170)	(0.0168)	(0.0101)	(0.0102)
Real GDP per capita PPP, in logs$_{c.t}$	0.130***	0.133***	0.132***	0.133***
	(0.0207)	(0.0195)	(0.0198)	(0.0205)
Euro currency$_{c.t}$	-0.0411***	-0.0383***	-0.0394***	-0.0394***
	(0.0115)	(0.0106)	(0.0107)	(0.0110)
Domestic brand$_{m,c}$	-0.108***	-0.134***	-0.133***	-0.134***
	(0.0144)	(0.0125)	(0.0126)	(0.0130)
Observations	40,944	40,944	40,936	40,927
R-squared	0.697	0.823	0.920	0.926
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$_i$	0.0631***	0.0661***	0.0473***	0.0473***
	(0.00362)	(0.00849)	(0.00779)	(0.00813)
Real GDP per capita PPP, in logs$_{c.t}$	0.133***	0.0653**		
	(0.00701)	(0.0264)		
Euro currency$_{c.t}$	-0.0395***	-0.00325		
	(0.00378)	(0.00905)		
Domestic brand$_{m,c}$	-0.134***	-0.0425***	-0.0449***	
	(0.00514)	(0.00381)	(0.00380)	
Observations	40,927	40,927	40,927	40,927
R-squared	0.926	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 equation (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 $design\ protection_{c.t} \times visible_i$ 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: Regression estimates by car manufacturer

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$ × visible$_i$				
Audi	0.0820*	0.0812*	0.0814*	0.0796**
	(0.0459)	(0.0470)	(0.0453)	(0.0325)
BMW	0.00521	0.00459	0.00492	0.00254
	(0.0212)	(0.0199)	(0.0194)	(0.0138)
Citroën	0.0616	0.0599	0.0599	0.0604
	(0.0659)	(0.0654)	(0.0602)	(0.0509)
Fiat	0.00510	0.00394	0.00456	0.00529
	(0.0220)	(0.0187)	(0.0181)	(0.0135)
Ford	-0.0209	-0.0215	-0.0207	-0.0202
	(0.0211)	(0.0207)	(0.0191)	(0.0154)
Mercedes	0.0564**	0.0556**	0.0560**	0.0559**
	(0.0273)	(0.0257)	(0.0250)	(0.0249)
Nissan	0.0678	0.0667	0.0667	0.0614*
	(0.0457)	(0.0416)	(0.0406)	(0.0358)
Opel	0.0443**	0.0433**	0.0438**	0.0422***
	(0.0201)	(0.0196)	(0.0182)	(0.0156)
Peugeot	0.121***	0.121***	0.121***	0.122***
	(0.0247)	(0.0245)	(0.0245)	(0.0242)
Renault	0.127***	0.126***	0.126***	0.124***
	(0.0317)	(0.0322)	(0.0327)	(0.0331)
Toyota	0.131***	0.129***	0.129***	0.129***
	(0.0375)	(0.0403)	(0.0399)	(0.0436)
VW	0.0613**	0.0611**	0.0614**	0.0626***
	(0.0281)	(0.0274)	(0.0260)	(0.0229)
Real GDP per capita PPP, in logs$_{c.t}$	0.132***	0.133***		
	(0.00706)	(0.0306)		
Euro currency$_{c.t}$	-0.0385***	-0.00388		
	(0.00381)	(0.00900)		
Domestic brand$_{m,c}$	-0.143***	-0.0485***	-0.0515***	
	(0.00512)	(0.00404)	(0.00404)	
Observations	40,927	40,927	40,927	40,927
R-squared	0.928	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 $design\ protection_{c.t} \times visible_i \times \mathbb{1}[carmaker_m = j]$ 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 7: Case study for Poland, regression results

	(1)	(2)	(3)
	Difference-in-differences	Triple differences	
Poland_c	0.0524***		
	(0.00918)		
$\text{Poland}_c \times \text{post}_t$	-0.131***		
	(0.0119)		
$\text{Poland}_c \times \text{visible}_i$		0.0306**	
		(0.0150)	
$\text{Poland}_c \times \text{post}_t \times \text{visible}_i$		-0.120***	-0.117***
		(0.0307)	(0.0291)
Observations	2,224	2,436	2,436
R-squared	0.975	0.983	0.984
Country × spare part FE			YES
Country × model × year FE		YES	YES
Spare part × model × year FE	YES	YES	YES

Notes: This table reports difference-in-differences and tripe differences regression estimates based on equations (7) and (8). The sample is constrained to the Czech Republic (where visible spare parts are design protected) and Poland (where a repair clause was introduced in 2007). 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 $Poland_c \times post_t$ equals 1 for observations in Poland in the year 2007 or after (when the repair clause was introduced). The variable $visible_i$ is an indicator that is 1 if spare part i is visible. For the difference-in-differences results reported in column (1), the sample only consists of visible spare parts. 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)
					Design protection for visible spare parts	
					No	Yes
Constant	19.28***	20.52***	21.11***	21.76***	16.18***	21.31***
	(0.501)	(0.633)	(0.498)	(0.691)	(0.791)	(0.605)
Time_t (years)	-0.300***	-0.683***	-0.341***	-0.564***	-0.860***	-0.773***
	(0.0553)	(0.132)	(0.0628)	(0.180)	(0.175)	(0.134)
Time_t-squared		0.0214***			0.0401***	0.0272***
		(0.00664)			(0.00911)	(0.00751)
Euro $\text{currency}_{c.2016}$			-3.692***	-4.481***		
			(0.276)	(0.617)		
Euro $\text{currency}_{c.2016} \times \text{time}_t$				0.241		
				(0.178)		
Observations	2,901	2,901	3,832	3,832	2,569	2,569
R-squared	0.587	0.589	0.505	0.506	0.500	0.594
Spare part × model FE	YES	YES	YES	YES	YES	YES

Notes: This table reports estimates of regression equation (9). 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. All specifications include a full set of interacted spare part and car model fixed effects. Columns (3) and (4), 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 did and did not adopt the euro by 2016, the end of our sample period. In this specification, the time trend in price dispersion for non-euro and euro countries is given by β_1 and $\beta_1 + \beta_3$. Columns (5) and (6) show results separately for countries without and with design protection for visible spare parts. 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***
	(0.408)	(0.425)	(0.735)
Carmaker			
Audi	1.744**	4.429***	-3.625***
	(0.728)	(0.819)	(0.853)
BMW	-3.362***	-4.716***	0.682
	(0.474)	(0.498)	(0.828)
Citroën	2.229***	2.809***	0.641
	(0.852)	(0.963)	(1.307)
Fiat	-0.360	-1.205**	0.874
	(0.489)	(0.550)	(0.810)
Ford	-2.003***	-2.934***	0.471
	(0.491)	(0.522)	(0.814)
Nissan	0.662	-0.278	4.365***
	(0.551)	(0.625)	(1.049)
Opel	-0.300	-2.558***	1.953**
	(0.458)	(0.475)	(0.810)
Peugeot	4.618***	5.778***	-1.301
	(0.593)	(0.640)	(0.893)
Renault	2.664***	2.407***	0.760
	(0.562)	(0.633)	(0.846)
Toyota	1.879***	0.535	3.205***
	(0.553)	(0.668)	(0.941)
VW	2.014***	3.199***	-0.208
	(0.561)	(0.575)	(0.961)
Observations	2,963	2,963	2,962
R-squared	0.274	0.327	0.168
Spare part × year FE	yes	yes	yes

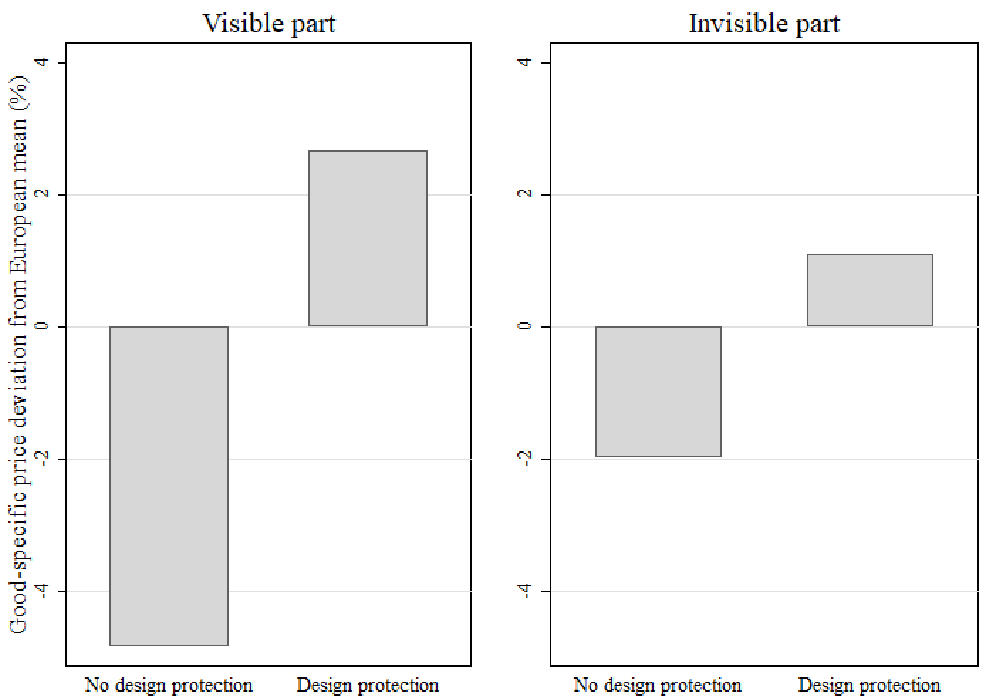
Notes: This table shows estimates of carmaker-specific price dispersion based on estimating equation (10). Estimates have to be interpreted relative to the reference category *(Mercedes)*. In column (2) and (3), price dispersion is calculated only for countries with and without design protection for 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.

Table 10: Price dispersion, difference-in-differences regression results

	(1)	(2)	(3)
Design protection$_{c.t}$ × visible$_i$	0.712**	0.744**	0.758*
	(0.297)	(0.298)	(0.434)
Observations	5,836	5,836	5,836
R-squared	0.204	0.257	0.753
Year FE	YES		
Model FE	YES	YES	
Spare Part FE	YES		
Design protection FE	YES		
Spare Part X year FE		YES	
Design protection X year FE		YES	
Spare Part X model X year FE			YES
Design Protection X model X year FE			YES

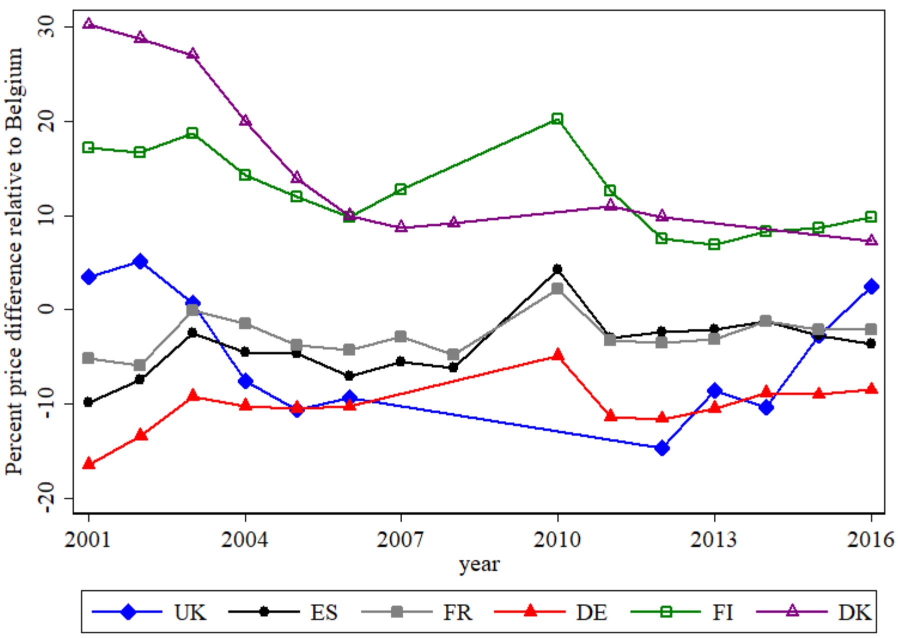
Notes: This table reports difference-in-differences regression estimates based on equation (11). The dependent variable is the standard deviation of pre-tax Euro-denominated log prices across countries for spare part i for car model m in year t across countries with and without design protection for visible spare parts. The interaction $design\ protection_{c.t} \times visible_i$ 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-design-protection level 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



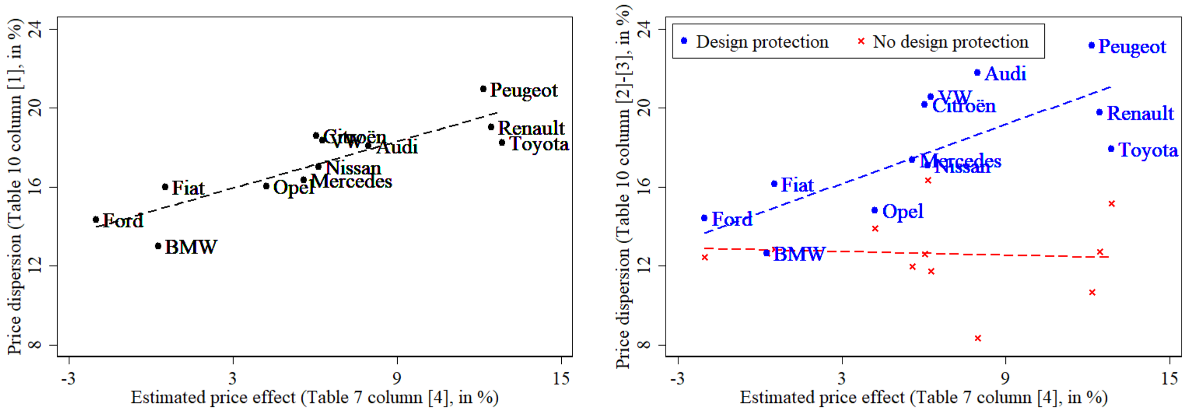
Notes: This shows a comparison of good-specific price deviations from the European mean in countries with and without a repair clause for visible (left) and non-visible spare parts (right).

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: 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 6; 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 in our sample					
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 not 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 (2 December 2020).

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 Grouן	5.871 (fe)	*Plst & Rbr*	36 Garrett Motion Inc.	1.890 (e)	*Mech, Elct*
12 BASF	5.431	*Plst & Rbr, 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
Plst & Rbr	Plastic & rubber
Trans	Transmission

Notes: The data comes from Chappell (2019).

Table A.3: Balance tests

	(1)	(2)	(3)	(4)	(5)	(6)
	Design protection for visible spare parts					
	No		Yes		T-test (equality of means)	
	Obs.	Mean (SE)	Obs.	Mean (SE)	Diff-in-mean	P-value
Real GDP PPP	6	977623.62	12	597055.83	380567.79	0.37
		(310500.57)		(244826.01)		
Population	6	32.43	12	20.27	12.15	0.35
		(9.44)		(7.55)		
Real GDP per capita PPP	6	28608.031	12	30912.824	-2304.79	0.61
		(3121.66)		(2712.50)		
Euro currency$_{2002}$	6	0.67	12	0.412	0.25	0.35
		(0.21)		(0.15)		

Notes: This table reports difference-in-means for various covariates at the beginning of the sample period (2001) between countries with and without design protection for visible spare parts. The p-value refers to a t-test on the equality of means. In all cases, we cannot reject the hypothesis that the difference-in-mean=0 (alternative hypothesis: difference-in-mean≠0).

Table A.4: Regression estimates, cheap spare parts

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$ × visible$_i$	0.0515***	0.0487***	0.0401***	0.0392***
	(0.00622)	(0.00908)	(0.00682)	(0.00783)
Real GDP per capita PPP, in logs$_{c.t}$	0.143***	0.0773*		
	(0.00971)	(0.0410)		
Euro currency$_{c.t}$	-0.0276***	-0.0196		
	(0.00576)	(0.0165)		
Domestic brand$_{c.t}$	-0.0881***	-0.0150**	-0.0171***	
	(0.00813)	(0.00621)	(0.00625)	
Observations	14,792	14,792	14,792	14,791
R-squared	0.892	0.902	0.908	0.950
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 (4) when the sample is limited to relatively cheap spare parts (head lamp, front wing, rear lamp, radiator, see Table 2). 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 $design\ protection_{c.t} \times visible_i$ 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 A.5: Regression estimates, one country left out at a time

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Design protection$_{c.t}$ × visible$_i$	0.0481***	0.0457***	0.0427***	0.0501***	0.0380***	0.0380***	0.0644***	0.0560***	0.0473***
	(0.00901)	(0.00855)	(0.00846)	(0.00870)	(0.00790)	(0.00846)	(0.00761)	(0.00856)	(0.00835)
Observations	37,682	37,761	38,279	38,394	38,615	37,931	37,701	38,088	39,461
R-squared	0.963	0.962	0.964	0.961	0.963	0.963	0.962	0.962	0.963
Country × model × year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Spare part × model × year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country dropped	Austria	Belgium	Cyprus	Czech Republic	Denmark	Finland	France	Germany	Greece

Table A.5 : *(continued)*

	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Design protection$_{c.t}$ × visible$_i$	0.0466***	0.0475***	0.0429***	0.0436***	0.0489***	0.0535***	0.0446***	0.0474***	0.0466***
	(0.00824)	(0.00843)	(0.00826)	(0.00853)	(0.00816)	(0.00845)	(0.00827)	(0.00835)	(0.00840)
Observations	40,180	39,334	38,867	38,627	38,994	37,670	39,720	39,905	38,542
R-squared	0.962	0.963	0.962	0.963	0.962	0.961	0.963	0.962	0.964
Country × model × year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Spare part × model × year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country dropped	Netherlands	Hungary	Italy	Norway	Poland	Spain	Sweden	Switzerland	United Kingdom

Notes: This table reports difference-in-differences regression estimates based on equations (4) when one country is left out of the sample at a time. The dependent variable is the log pre-tax price of spare part i for car model m in country c in year t. The interaction $design\ protection_{c.t} \times visible_i$ 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 A.6: Difference-in-differences regression results by vehicle size

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$ × visible$_i$				
Minicompact	0.0482***	0.0473***	0.0477***	0.0467***
	(0.0163)	(0.0155)	(0.0141)	(0.0130)
Subcompact	0.0624***	0.0614***	0.0618***	0.0620***
	(0.0128)	(0.0119)	(0.0107)	(0.0112)
Small family	0.0368***	0.0359***	0.0366***	0.0363***
	(0.0117)	(0.0115)	(0.00982)	(0.00972)
Mid-size	0.0276	0.0269	0.0274	0.0252*
	(0.0193)	(0.0177)	(0.0170)	(0.0140)
Real GDP per capita PPP, in logs$_{c.t}$	0.132***	0.132***		
	(0.00704)	(0.0306)		
Euro currency$_{c.t}$	-0.0398***	-0.00454		
	(0.00379)	(0.00900)		
Domestic brand$_{m,c}$	-0.132***	-0.0394***	-0.0415***	
	(0.00505)	(0.00382)	(0.00382)	
Observations	40,927	40,927	40,927	40,927
R-squared	0.927	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 $design\ protection_{c.t} \times visible_i \times \mathbb{1}[size_m = j]$ 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 A.7: Regression estimates by car manufacturer and vehicle size

	(1)	(2)	(3)	(4)
Design protection$_{c.t}$ × visible$_i$				
Minicompact				
Fiat	-0.00411	-0.00476	-0.00368	-0.00347
	(0.0269)	(0.0232)	(0.0229)	(0.0176)
Ford	-0.0232	-0.0237	-0.0236	-0.0234
	(0.0276)	(0.0280)	(0.0268)	(0.0234)
Nissan	0.0964*	0.0962**	0.0954**	0.0913**
	(0.0536)	(0.0480)	(0.0473)	(0.0409)
Opel	0.0727**	0.0715**	0.0714**	0.0692***
	(0.0309)	(0.0309)	(0.0284)	(0.0251)
Peugeot	0.117***	0.116***	0.116***	0.115***
	(0.0401)	(0.0399)	(0.0400)	(0.0393)
Renault	0.0908**	0.0892**	0.0895**	0.0883**
	(0.0357)	(0.0355)	(0.0359)	(0.0360)
VW	0.0381	0.0381	0.0381	0.0381
	(0.0775)	(0.0790)	(0.0767)	(0.0656)
Subcompact				
Citroen	0.0616	0.0599	0.0599	0.0604
	(0.0660)	(0.0654)	(0.0602)	(0.0509)
Fiat	0.0145	0.0131	0.0132	0.0139
	(0.0218)	(0.0193)	(0.0187)	(0.0161)
Ford	-0.0269	-0.0274	-0.0275	-0.0274
	(0.0233)	(0.0225)	(0.0210)	(0.0169)
Opel	0.0303	0.0287	0.0303	0.0291
	(0.0262)	(0.0257)	(0.0248)	(0.0213)
Peugeot	0.126***	0.125***	0.125***	0.126***
	(0.0244)	(0.0233)	(0.0233)	(0.0234)
Renault	0.160***	0.159***	0.159***	0.157***
	(0.0358)	(0.0369)	(0.0373)	(0.0374)
VW	0.0669***	0.0664***	0.0669***	0.0687***
	(0.0239)	(0.0220)	(0.0209)	(0.0197)
Compact				
Audi	0.0820*	0.0812*	0.0814*	0.0796**
	(0.0459)	(0.0470)	(0.0453)	(0.0325)
BMW	0.0146	0.0140	0.0144	0.0145
	(0.0284)	(0.0270)	(0.0268)	(0.0226)
Ford	-0.0124	-0.0129	-0.0109	-0.0103
	(0.0244)	(0.0235)	(0.0220)	(0.0196)
Nissan	0.0375	0.0353	0.0362	0.0314
	(0.0439)	(0.0411)	(0.0399)	(0.0402)
Opel	0.0294	0.0289	0.0288	0.0281
	(0.0235)	(0.0227)	(0.0225)	(0.0190)
Toyota	0.131***	0.129***	0.129***	0.129***
	(0.0375)	(0.0403)	(0.0400)	(0.0436)

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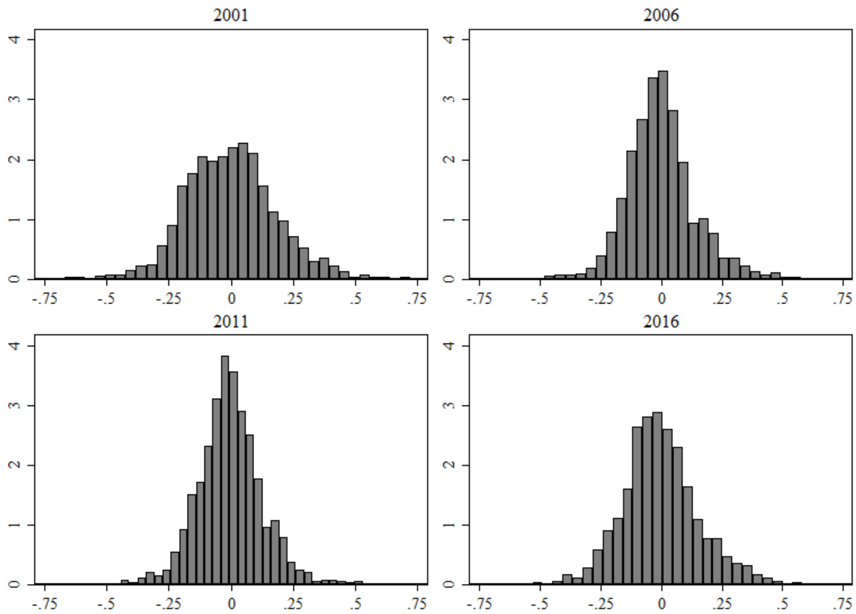
Mid-Size				
BMW	-0.00110	-0.00172	-0.00157	-0.00547
	(0.0217)	(0.0209)	(0.0204)	(0.0145)
Mercedes	0.0564**	0.0555**	0.0560**	0.0559**
	(0.0273)	(0.0257)	(0.0250)	(0.0249)
Real GDP per capita PPP, in $\text{logs}_{c.t}$	0.132***	0.133***		
	(0.00708)	(0.0306)		
Euro $\text{currency}_{c.t}$	-0.0383***	-0.00356		
	(0.00381)	(0.00899)		
Domestic $\text{brand}_{m,c}$	-0.143***	-0.0485***	-0.0515***	
	(0.00511)	(0.00403)	(0.00403)	
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

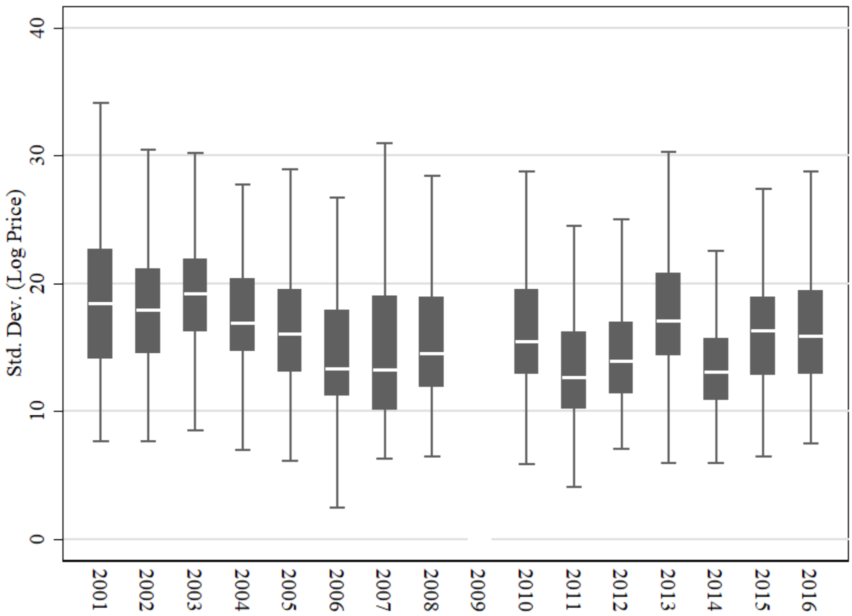
Notes: This table reports difference-in-differences regression estimates based on an extended version of equation (5) that allows effects to vary by car manufacturer and vehicle size. The dependent variables is the log pre-tax price of spare part i for car model m in country c in year t. The interaction $design\ protection_{c.t} \times visible_i \times \mathbb{1}[carmaker_m = j] \times \mathbb{1}[size_m = k]$ 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.

Figure A.1: Cross-country price differences



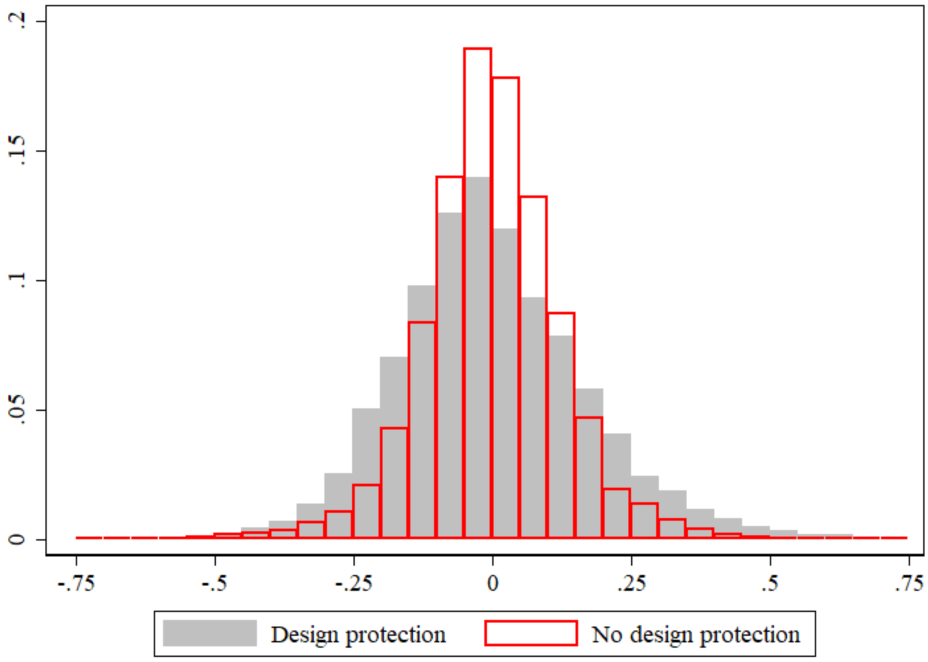
Notes: This shows the good-by-good price dispersion of twelve types of visible spare parts for 60 different car models sold in 18 European countries between 2001 and 2016. Price dispersion is measured as log deviations from the geometric-average European price for spare part i for car model m in year 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 A.2: 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 A.3: LOOP deviations for countries without and with repair clause



Notes: This shows histograms of $q_{i,m,c,t}^{d=1}$ and $q_{i,m,c,t}^{d=0}$ 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%.