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# Causal evidence of antitrust damages in the car manufacturers' cartel in Spain☆

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ABSTRACT

This paper estimates the causal impact on vehicle prices of an automobile manufacturers' cartel that operated in Spain from 2006 to 2013. To do so, we construct a novel dataset containing manufacturers' recommended retail prices for Spain and several unaffected European Union countries over the period 2000–2011. Exploiting variation in the timing of cartel entry across brands, we apply a difference-in-differences approach controlling for sales volume, scrappage schemes, and fixed effects. Our estimates show that the cartel increased prices in Spain by approximately 9.3% on average during the infringement period. Robustness checks confirm the consistency of the findings: the parallel trends assumption holds, results remain stable with alternative control groups, and placebo tests yield no significant effects. These findings contribute to the limited empirical literature on causal estimation of cartel overcharges and provide policy-relevant insights on the transmission of upstream collusion to final consumer prices.

## 1. Introduction

The vertical dimension of horizontal cartels remains an important yet underexplored feature of how collusion operates. Theoretical literature has shown that upstream collusion is easier to sustain under particular organisational structures of retail distribution (Nocke and White, 2007; Reisinger and Thomes, 2017), when certain vertical restraints are introduced (Piccolo and Reisinger, 2011; Hunold and Muthers, 2024), or when complementary payment schemes align incentives along the supply chain (Schinkel et al., 2008; Gu et al., 2019). Information-sharing agreements among upstream firms on wholesale contracts further facilitate coordination (Piccolo and Reisinger, 2011; Reisinger and Thomes, 2017), consistent with earlier work highlighting the anticompetitive role of information exchange (Kühn and Vives, 1995; Kühn, 2001; Ivaldi et al., 2003). Despite this extensive theoretical work, however, empirical

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evidence quantifying the effects of upstream collusion on consumer welfare remains limited (Laitenberger and Smuda, 2015; Clark et al., 2022; Holler and Rickert, 2022).

We provide causal evidence on the retail price effects of upstream collusion by analysing an automobile manufacturers' cartel that operated in Spain between 2006 and 2013. The Spanish Competition Authority (CNMC) found that 21 automobile wholesale distributors engaged in a single and continuous infringement of Spanish and European Union (EU) competition law by exchanging confidential commercial information, both current and future, to reduce uncertainty and coordinate their conduct. The cartel affected the entire Spanish market for new and used vehicles, spare parts, and after-sales services, with participants accounting for approximately 91% of national car distribution and covering nearly all mainstream as well as some premium brands.

According to the CNMC (2015, p. 93), the information exchange increased transparency and the likelihood of anticompetitive effects, ultimately affecting final consumers "in the form of lower discounts, less aggressive commercial policies by the brands, and a reduced effort to differentiate themselves from other firms by offering higher-quality services."[1]

To understand the price effects of this conduct, it is useful to consider the vertical structure of vehicle distribution in Spain. Most car manufacturers rely on selective distribution systems imposing quantitative and qualitative requirements to ensure dealer quality and solvency. These vertically integrated relationships are governed by contracts covering sales targets, inventory, warranties, promotional activities, and reporting obligations. The CNMC noted that "[w]hile the setting of the final sale price of the automobile is the responsibility of the dealer, it is closely linked to the remuneration policy established by the brand for its dealer network".

Dealer remuneration combines a fixed margin, effectively a discount on the manufacturer's publicly announced recommended resale price or list price, and a variable component tied to performance objectives, such as sales volume and customer satisfaction, typically paid periodically and on a deferred basis. The recommended resale price serves as the reference for both dealer compensation and consumer search and comparison, influencing how buyers evaluate prices across models and brands (Degryse and Verboven, 2000).

The market exhibited a low degree of transparency, making it difficult for firms to know competitors' commercial conditions. The cartel exploited this vertical structure by aligning incentives across dealer networks through coordinated information exchanges, thereby transmitting upstream collusion to final retail prices.

Our analysis of the Spanish automobile manufacturers' cartel is motivated by features with both analytical and policy relevance. First, the case involves a novel form of cartel infringement, in which firms did not fix prices or quantities but periodically exchanged detailed, sensitive, and brand-specific information. The anticompetitive role of information sharing has recently attracted renewed attention in policy and academic debates (Harrington, 2022; Klein and Neurohr, 2023; Andreu et al., 2023; Cussen and Montero, 2024; Janssen and Karamychev, 2025), making this setting particularly valuable for empirical investigation. Second, the automotive sector plays a key role in developed economies, contributing substantially to GDP, employment, and innovation (Haugh et al., 2010; Saberi, 2018), and has long been subject to regulatory and antitrust scrutiny in the EU, including sector-specific block exemption regulations and recurrent policy interventions aimed at stimulating demand and renewing the vehicle fleet. Furthermore, vehicle purchases represent one of the largest financial commitments for most households (Klein and Smart, 2017; Pierce and Connolly, 2023), providing a strong motivation to evaluate the consumer-level price effects of car manufacturers' collusion.

Two key elements underpin our empirical analysis. The first is the construction of a comprehensive dataset covering vehicle prices and relevant market variables. We compile a dataset that combines manufacturers' recommended retail prices (list prices) for Spain (the treated group) and for 26 other European countries (the control group) with additional market-level variables for the period 2000–2011. The database includes brand-, model-, and version-level prices, as well as variables commonly used in the literature to explain car prices, such as total sales by brand, GDP per capita, petrol prices, and the timing of replacement and scrappage schemes in Spain.

The second element concerns model specification and estimation. We use a difference-in-differences (DiD) approach that compares the observed price evolution in Spain with the counterfactual evolution in unaffected EU countries. This approach combines before-during-after and cross-sectional comparisons, providing a robust estimate of the harm caused by the cartel (European Commission, 2019). We also validate our estimates through several robustness checks, including pre-treatment trend analyses, alternative control groups, and placebo tests using other EU countries as hypothetical treated markets. These exercises support the accuracy of the causal inference by confirming that observed price dynamics are not driven by external shocks or unobserved heterogeneity.

We find that the prices of vehicles from cartelized brands increased significantly more in Spain than in the rest of the EU during the infringement period, with causal estimates ranging from 7.7% to 11.5% and our preferred model indicating an average increase of 9.3%. Robustness analyses confirm the stability and validity of the estimates. Pre-treatment dynamics show no significant differences between Spain and comparable EU markets, and placebo estimations yield null effects. These results support a causal interpretation of the price increase as the outcome of the cartel's conduct.

Our study contributes to the empirical assessment of cartel overcharges along the supply chain by providing causal evidence on how upstream information-sharing arrangements translate into higher retail prices in a vertically structured market. By documenting the magnitude and transmission of collusive effects in the automotive sector, the paper advances our understanding of cartel damages and price formation.

These findings also have important policy and applied implications. For competition authorities, they highlight the consumer harm that can arise from information-sharing cartels and underscore the value of detailed information obtained through detection and

[1] CNMC, Resolución del expediente S/DC/0502/13. Fabricantes de automóviles (2015), p. 19. All translations from Spanish by the authors.

leniency mechanisms for processing and sanctioning cartels in complex vertical structures. For courts and potential claimants, the results provide a benchmark for quantifying damages and for understanding how coordinated upstream conduct can affect final consumer prices.

Despite the scope of our empirical strategy, the effects we identify are necessarily partial. In particular, due to lack of data, we do not account for potential non-price outcomes of the cartel, such as reductions in product variety or quality noted in the CNMC decision. We also lack data on final transaction prices and individual discounts, which result from private negotiations between buyers and dealers and are not systematically recorded. Still, by relying on manufacturers' recommended retail prices—the benchmark guiding both dealer compensation and consumer price comparisons—our estimates provide a consistent measure of the price effects transmitted through the vertical chain.

The rest of the paper is organised as follows. Section 2 reviews economic theories and models for estimating cartel damages, providing the analytical foundation. Section 3 examines the structure and functioning of the affected markets and presents an overview of the cartel case. Section 4 describes the data collected for this study and their main descriptive statistics. Section 5 presents the estimation methodology and the results of the price overcharge analysis, including parallel trends and robustness checks, and discusses the magnitude of the cartel's impact on automobile prices. Finally, Section 6 concludes.

## 2. Conceptual framework and literature review

This section examines the economic theories on cartel-induced harm, the key factors influencing its magnitude, and the models used to estimate damages in the related literature. These elements provide a conceptual basis for the subsequent analysis.

### 2.1. Economic theories on the damage caused by cartels

Economic theory plays a crucial role in understanding the effects of cartels and in quantifying the harm they cause under different market conditions. By providing analytical tools to identify and assess distortions, economic analysis helps uncover how anticompetitive practices reduce consumer welfare and create inefficiencies.

The primary way cartels harm direct customers is through price overcharges, artificially increasing prices and extracting supracompetitive profits at their expense —an effect known as price overcharge or cost effect. This leads to a loss of customer welfare, as purchasers are forced to pay higher prices than they would in the absence of a cartel agreement, referred to as the counterfactual or "but-for" price. As a result, customers incur an actual loss, also legally termed *damnum emergens*.

Additionally, the pass-through effect occurs when part of the overcharge is transferred to indirect customers through higher prices (see Kosicki and Cahill, 2006; Verboven and van Dijk, 2009; Basso and Ross, 2010; Brander and Ross, 2017; or European Commission, 2013, 2019). This effect is particularly significant in vertically related markets, where price increases cascade along the supply chain. Finally, the output or volume effect refers to the loss of potential benefits for both direct and indirect customers, whether existing or potential (see Kosicki and Cahill, 2006; Verboven and van Dijk, 2009; European Commission, 2019; Weber, 2021). This loss, which can take the form of reduced consumer utility or forgone profit, arises from lower sales at cartel prices compared to the higher sales that would have occurred at the counterfactual price —a concept also legally known as *lucrum cessans*.[2]

Regarding the effects on competitors not involved in the cartel, they may indirectly benefit from artificially high prices, as they can adjust their own pricing strategies accordingly —an effect known as the umbrella effect (Friederiszick and Röller, 2010; OECD, 2011; Hansberry et al. 2014; Inderst et al., 2014; Maier-Rigaud, 2014; European Commission, 2019; Caoui, 2022). However, these same existing or potential competitors may face exclusionary practices by cartel members, such as restricting access to key inputs or leveraging market power to distort competition, ultimately deterring their entry or expansion in the same or related markets.

Several factors determine the extent of cartel-induced harm (OECD, 2011; European Commission, 2013, 2023; CNMC, 2023). Demand elasticity plays a key role, as more inelastic demand allows cartels to sustain higher prices. The cartel's duration and the combined market share of participating firms also amplify the harm, with longer-lasting and larger market share cartels causing greater damage. Industry characteristics such as market concentration, barriers to entry, and product differentiation influence both cartel stability and the damage caused (OECD, 2010; European Commission, 2013). Additionally, the pass-through rate, or the extent to which upstream price increases are transmitted downstream, affects the total consumer burden in final markets.

### 2.2. Literature review on cartel overcharge estimation

The empirical literature on cartel overcharges has expanded substantially, applying diverse methods to estimate price effects and damages (Oxera, 2009; OECD, 2011; European Commission, 2013, 2019; CNMC, 2023). Early work focused on direct purchasers, but these studies provide essential guidance for identifying counterfactual prices and understanding how overcharges may be passed on to indirect purchasers.

Meta-analyses summarize broad evidence on cartel overcharges (Connor and Bolotova, 2006; Bolotova, 2009; Bolotova et al., 2009; Smuda, 2014; Connor, 2014), though their reliance on heterogeneous methods and contexts limits comparability (Boyer and Kotchoni, 2015).

[2] Beyond the price and output effects, cartels also generate allocative and productive inefficiencies, leading to deadweight loss and reducing incentives for innovation and efficiency in the long term.

In addition to these meta-analytic syntheses, a number of studies have examined individual cartels using alternative empirical strategies. Studies using reduced-form models include Connor's (2001) seminal analysis of the lysine cartel based on before-and-after methods, while later research applied regression-based dummy-variable approaches to cases such as the South African wheat flour cartel (Mncube, 2014). Other contributions examine the performance of the dummy-variable method under different conditions, comparing it with forecasting techniques using simulated data (Nieberding, 2006; McCrary and Rubinfeld, 2014) or with dynamic treatment effect models in the context of the Italian pasta cartel (Notaro, 2014).

Structural approaches offer a complementary perspective, enabling estimation with limited data while embedding market fundamentals (Mariuzzo et al., 2009; Zona, 2010; Boyer et al., 2019; Bonnet and Bouamra-Mechemache, 2020). For instance, Mariuzzo et al. (2009) simulate price coordination among Irish car dealers, while Bonnet and Bouamra-Mechemache (2020) estimate wholesale overcharges in the French yogurt cartel and identify umbrella effects on non-cartelized products. However, these models often rely on internal accounting data, which may not always be accessible (Boyer et al., 2019).

Recent research emphasizes causal identification, particularly through difference-in-differences (DiD) designs. These studies estimate the price impact of collusion by comparing treated and untreated markets, thereby improving the validity of overcharge estimates. Applications include the Quebec retail gasoline cartel (Erutku and Hildebrand, 2010; Boyer, 2022), the German cement cartel (Hüschelrath et al., 2013; Frank and Schliffke, 2013), and South African markets for concrete and bitumen (Khumalo et al., 2014; Boshoff, 2015). More recent studies extend DiD analysis to consumer harm from upstream cartels, such as the European detergent cartel (Laitenberger and Smuda, 2015), collusion in the U.S. generic drug industry (Clark et al., 2022), and the German coffee cartel (Holler and Rickert, 2022). These contributions highlight heterogeneity in cartel impacts, the importance of market structure, and the potential amplification of effects through vertical restraints such as resale price maintenance.

This paper contributes to that literature by examining how upstream collusion among automobile manufacturers in Spain affected retail prices. Using DiD estimation and extensive robustness checks, it provides causal evidence on how confidential information exchange among competitors transmitted anticompetitive effects downstream. The analysis thereby contributes to the empirical literature on how upstream cartels can translate into consumer harm.

## 3. Market context and cartel conduct

This section examines the structure and functioning of the affected markets and discusses the relevant market regulations, offering a comprehensive framework for understanding the legal and economic context of the case. It also provides an overview of the case, outlining the cartel's operations, its impact on the affected markets, and the resulting effects.

### *3.1. Functioning and structure of affected markets*

According to the CNMC (2015, p. 15), the market affected by the cartel is the distribution and sale of motor vehicles in Spain by the main automobile brands operating in the country. This includes the sale of new and used vehicles, spare parts, and accessories, as well as the provision of after-sales services carried out by these brands through their official dealer networks in Spain.

In this context, understanding the structure of distribution and supply chains, as well as the contractual arrangements between vertically related firms, is crucial. Below, we illustrate the different players and relationships along the value chain for automobile distribution and after-sales services.

Automobile manufacturers, primarily multinational corporations, dominate the automotive value chain in an oligopolistic market, focusing on car design, engine production, and final assembly. Most parts and components are supplied by specialized equipment manufacturers, with only 20–25% produced in-house (Moyano and Martínez, 2014). Despite this, car manufacturers historically control sales via authorized networks (Verboven and van Dijk, 2009).

The sector has seen significant concentration, from over fifty manufacturers in the 1960s to just ten global groups by 2010 (Montoro et al., 2010), a trend that continues today. Wholesale distributors (brands) sell cars through either exclusive or selective distribution systems, typically via dealership contracts (Vázquez, 2000). Many car manufacturers operating in Spain use selective distribution, setting both quantitative and qualitative requirements to ensure distributor quality and solvency.

These manufacturers maintain vertically integrated relationships with authorized dealers, creating a structure where cars are sold to retailers and ultimately to consumers. As noted by the CNMC (2015, p. 22), in 2013, 77 different car brands operated in Spain, with individual market shares not exceeding 10% and a combined market share of around 91% among the implicated brands, including most mainstream car brands and some premium brands.

Manufacturers impose commercial conditions and sales terms on retailers, including setting sales targets and minimum purchase obligations, often influencing the prices and availability of vehicles (Vázquez, 2000; Arruñada, Garicano et al., 2005; Arruñada, Vázquez et al., 2009). The manufacturer's price lists, which include base model prices and extra equipment costs, serve as reference points, with the final sale prices also affected by discounts, promotions, and the dealer's own strategy (González et al., 2015).

Retail distribution of automobiles occurs either through authorized independent dealers or through manufacturer's subsidiaries, with both channels integrated into each brand's official dealer network.[3] The retail automobile distribution market is mature, with many dealerships competing on brand-specific and interbrand levels. Dealers typically face low-profit margins, which limits their

[3] These dealers also engage in the used-car market, offering vehicles from all brands, with pricing influenced by trade-ins and the market's competitive landscape (Autopolis, 2000).

ability to offer discounts (Autopolis, 2000). Price setting is highly influenced by the manufacturer's policies; dealers negotiate sales targets and receive rebates contingent on achieving them (Zanarone, 2009).

As noted in the CNMC (2015, p. 19) sanctioning decision, "[a]lthough the final sale price of the automobile is the responsibility of the dealer, it is closely linked to the remuneration policy established by the brand for its dealer network. This remuneration consists of a fixed compensation or base margin, independent of the number of vehicles sold by the dealer and perceived as a reduction (discount) on the price paid by the dealer to the brand, and a variable compensation dependent on the achievement of sales volume targets as well as customer satisfaction and loyalty, which is received by the dealer on a deferred and periodic basis."

In after-sales services, the competition is not directly between brands but between authorized service centers and independent workshops. Authorized workshops generally offer more expensive, high-quality services, typically servicing new cars or those under warranty. Independent workshops, however, offer lower-priced alternatives, often using non-original parts (Rastrollo and Martínez, 2004). Additionally, quick-service chains and auto-centers have emerged, offering specialized, lower-cost services (Moyano and Martínez, 2014).

The CNMC states that "the automobile distribution market is a **market with very low transparency** (in bold in the original) […] As a consequence, brands are not in a position to know or even estimate, based on publicly available sources, the wholesale or retail market for new or used automobiles in terms of units sold (volume) or total or disaggregated sales values for new vehicles, used vehicles, or spare parts." (CNMC, 2015, p. 20)

In terms of demand, car sales in Spain are influenced by multiple sectors, including private fleets, individuals, and car rental companies. The individual segment, which accounts for nearly 50% of sales, is driven by factors such as household income and the utility of the vehicle, with economic factors significantly affecting purchasing decisions (Christidis et al., 2003). Buying a car constitutes a major financial decision, particularly for low- and middle-income households, which often face obstacles to both acquiring and retaining ownership (Klein and Smart, 2017; Pierce and Connolly, 2023). According to Andersen (2001), car purchases are typically the second-largest household expense after housing, including not only the purchase price but also financing, insurance, taxes, and maintenance. Given the relatively high value of automobiles, consumers actively search for price differences across brands and models (Punj and Staelin, 1983).

### 3.2. Applicable market regulations

The Spanish automotive sector is considered strategic due to its economic impact, employment generation, and technological spillovers. This has justified various government incentive programs aimed at stimulating demand and renewing the vehicle fleet. During the infringement period, Spanish government incentive plans for combustion vehicles included the PREVER (1997–2007), VIVE (2008–2009), and 2000E (2009–2010) programs, as well as the first two editions of the PIVE program (2012–2014).[4]

The sector has also received special regulatory treatment within the EU, benefiting from category exemption regulations since 1985. Regulation (EC) No 1400/2002 governed vertical agreements in the primary market until 2013 and in the after-sales market until 2010, promoting greater competition in car distribution and services. It was later replaced by Regulation (EU) No 461/2010 for after-sales agreements, while the primary market fell under the general vertical agreements framework of Regulation (EU) No 330/2010.[5]

Block exemptions define agreements and, in some cases, market share thresholds within a safe harbour where efficiency gains outweigh anticompetitive effects. They also identify "black clauses," for which benefits never offset costs, including agreements between manufacturers, resale price maintenance, and vertical price fixing. Recommended resale prices remain exempt if market shares do not exceed 30% and recommendations do not amount to fixed or minimum prices.

### 3.3. Cartel conduct and economic effects

In 2015, following a leniency application by the firm Seat, the CNMC found that 21 competing wholesale car distributors in Spain engaged in a single and continuous infringement, violating Article 1 of the Spanish Competition Law (Law 15/2007) and Article 101 of the Treaty on the Functioning of the European Union (TFEU). According to the CNMC (2015, p. 83) sanctioning decision, "[t]he infringement consisted of the exchange of commercially sensitive, current, and future confidential information, highly disaggregated. The information exchanges were part of a complex agreement, encompassing multiple information-exchange agreements, executed according to a preconceived plan, taking advantage of the same opportunity generated by specific marketing and after-sales forums, and using methods and monitoring systems for the same purpose (…)."

[4] For a study on the effects of such programs in the automotive market, see Jiménez et al. (2016), Grigolon et al. (2016) or Cantos-Sánchez et al. (2018).

[5] For a broader analysis of the various EU regulations that have governed the automotive sector, and more specifically, the vertical agreements between European car manufacturers and their distributors, see, among others, Verboven (2008), Marco Colino (2007, 2010), and Šmejkal (2021).

The anti-competitive conduct occurred from February 2006 to August 2013,[7] although not all brands participated throughout the entire period.[8] Based on the CNMC sanctioning decision, Table 1 reports the dates on which different brands joined the cartel, which we assume represent each brand's cartelization period and the associated potential effects. The left column groups brands that began participation in February 2006, the first recorded date, some of which remained until August 2013, the last recorded date. The right column shows brands joining subsequently.

As we explained before, the combined market shares of participating brands accounted for around 91% of the Spanish car distribution market, covering almost all mainstream brands and some premium brands. Consequently, competitive pressure from non-cartelized brands was insufficient to counteract the cartel's effects (OECD, 2010; European Commission, 2023).

The cartel operated through a complex and closed system of three information-exchange forums, restricted to participating firms. It originated in 2006 with the "Brand Club,"[9] where confidential information was shared under a "*quid pro quo*" principle. From 2009, a consultancy firm organized and facilitated exchanges at the Brand Club, while in 2010 a second consultancy firm supported the expansion of exchanges through the "After-Sales Directors Forum." The subsequent "Manufacturers' Meetings" further reinforced coordination. Fig. 1 shows the main cartel events, including the timeline of brand participation and forum creation.

The information exchanged was highly disaggregated, covering sales units, revenues, profit margins, and percentages related to new and used cars, spare parts, and after-sales services. This level of detail allowed each firm to assess the gains and losses from its anti-competitive behavior, thereby sustaining cartel stability (Kühn and Vives, 1995; Kühn, 2001; OECD, 2010; European Commission, 2023).

This information was transmitted confidentially and periodically, with reporting frequency ranging from annual to monthly and prepared by external consultants, further minimizing potential gains from deviation by enabling faster detection and response (Ivaldi et al., 2003).

The CNMC stated that "[s]uch exchanges are harmful to competition insofar as they are able to undermine uncertainty about the market behavior of the brands regarding strategic parameters, reduce the independence of conduct among the participating brands, and weaken the incentives to compete" (CNMC, 2015, p. 49). The car distribution market exhibited a low degree of transparency, preventing firms from accurately assessing—let alone knowing—the commercial conditions of their competitors in both wholesale and retail markets. According to the CNMC (2015, p. 71), "what is relevant to conclude the anti-competitive nature of the information exchange is the concurrence of three cumulative elements: the finding that such conduct creates an artificial market transparency, that the information is confined to the parties, and, finally, that it is suitable to affect their competitive behavior".[10]

This logic is consistent with economic theory, which emphasizes the role of information sharing in facilitating coordination and sustaining collusion when monitoring is difficult and enforcement imperfect (Genesove and Mullin, 2001; Clark and Houde, 2014; Byrne and De Roos, 2019). Even non-binding, cheap-talk communications can support collusion where private and noisy supervision is the only monitoring mechanism (Awaya and Krishna, 2016, 2020; Spector, 2022).

The CNMC concluded that "[t]he reduction of competition generated by such information exchanges during the periods in which they occurred has been passed on to the final consumer in the form of lower discounts, less aggressive commercial policies by the brands, and a lower effort to distinguish themselves from other firms with higher-quality services" (CNMC, 2015, p. 92). Fig. 2 illustrates the vertical structure of vehicle distribution in Spain, highlighting the stages of the supply chain and the channels through which cartel members coordinated their conduct.

In the car manufacturers' cartel, the primary victims were both direct and indirect purchasers. Direct purchasers include dealers and authorized workshops, who faced additional costs in vehicle prices and spare parts due to the anti-competitive conduct. Although these direct purchasers initially absorbed the additional costs, it stands to reason that they almost entirely passed them on to final consumers (indirect purchasers) through higher retail prices and lower discounts.[11]

This theory of price pass-through is supported by several key arguments: (i) High intra- and inter-brand competition in the car retail market, combined with the substantial market share of participating dealers, meant that the cartel-induced price increase was almost fully passed on to final consumers. This aligns with economic theory (Kosicki and Cahill, 2006; Verboven and van Dijk, 2009; Basso and Ross, 2010; Brander and Ross, 2017) and the European Commission (2019) guidelines on overcharge pass-through; (ii) The low margins at which dealers operate in the retail market (Autopolis, 2000; Rodríguez, 2006; Moyano and Martínez, 2014), together with the long-running conduct, make it unlikely that dealers would have absorbed the price increases or adjusted discounts through their own sales strategies; (iii) Since manufacturers aimed to protect their dealer networks from significant losses during the economic crisis, it is unreasonable to assume they would have agreed to a price increase that could not be fully passed on to final consumers.

[6] This brand (Saab) is not included in the dataset due to the lack of available data during the cartel period.

[7] Although the CNMC acknowledged evidence suggesting that information exchanges may have started as early as 2004, the official start date was set as February 2006.

[8] The sanctioning decision also considered each company's involvement in the various forums, determining their specific responsibility for the duration of the cartel, while maintaining the view that it was a single and continuous infringement.

[9] The "Brand Club" or "Partners' Club" was composed of the "traditional partners" or *Family Capos*, as they referred to themselves, namely Chevrolet, Citroën, Fiat, Ford, Opel, Peugeot, Renault, and Toyota, with Seat joining in June 2005. The admission of new firms to the club required the support or invitation of one of the traditional partners of the "Brand Club."

[10] As the European Commission (2023) highlights, the lower the pre-existing level of market transparency, the greater the potential for an information exchange to facilitate collusive outcomes.

[11] Additionally, the dealers and workshops experienced reduced sales due to the price increase, leading to a loss of profit or volume effect.

**Table 1**
Periods of participation in the cartel by brand.

| First brands in the cartel | Period | Second brands in the cartel | Period |
|---|---|---|---|
| Chevrolet, Fiat, Alfa Romeo, Lancia, Lexus, Toyota | February 2006-August 2013 | Kia | March 2007-November 2012 |
| Citroën, Ford, Opel, Peugeot, Renault | February 2006-July 2013 | Chrysler, Jeep, Dodge | April 2008-August 2013 |
| Seat | February 2006-January 2013 | BMW, Nissan | June 2008-August 2013 |
| | | Volkswagen | October 2008-June 2013 |
| | | Audi | March 2010-June 2013 |
| | | Skoda | April 2009-June 2013 |
| | | Honda | April 2009-August 2013 |
| | | Mitsubishi, Hyundai, Volvo | March 2010-August 2013 |
| | | Mazda | March 2010-February 2012 |
| | | Mercedes-Benz | March 2010-February 2011 |
| | | Saab[6] | September 2010-February 2011 |
| | | Porsche | June 2010-August 2013 |

Source: CNMC.

Ultimately, indirect purchasers, i.e., final consumers of vehicles and after-sales services, paid higher prices for vehicles and services than they would have in the absence of the cartel. The harm to final consumers is measured by the difference between the observed prices and the prices they would have faced in a counterfactual scenario without the cartel, for both vehicle purchases and maintenance services.[12]

Although our analysis focuses on the effects of the cartel on new vehicle retail prices, in cases where consumers purchased both vehicles and maintenance services, the harm was even greater, particularly for new or under-warranty vehicles. Therefore, in such cases, our results likely underestimate the total damages incurred by these final consumers. Finally, the pass-through effects could also have affected final buyers (indirect purchasers) of vehicles from authorized dealers of non-cartelized brands through the impact of "umbrella pricing" on the Spanish retail distribution of those brands.

## 4. Data and descriptives

We set up a database that contains information about the manufacturers' recommended retail prices (list prices) for Spain and the European Union, by brand, model and version, for the period 2000–2011.[13] Although it does not cover the entire cartelization period, it allows us to analyse the effects on prices for all the brands involved, as we have data preceding the cartel and for approximately 75% of its duration (2006–2013). While this constitutes a limitation, the dataset still provides a representative sample of the cartel's effects.[14]

With this baseline information, an unbalanced panel has been set up containing the variables described in the following table (Table 2).

We therefore have vehicle prices by brand, model and exact version in Spain and 26 other European countries.[21] In addition, we have most of the variables used in the academic literature as explanatory of car prices. In our case, we have total sales by brand, an

[12] The CNMC highlights the interdependence between the primary market (vehicle distribution) and the secondary market (after-sales services), as competitive dynamics in one influence the other. This strategic integration is evident in how manufacturers plan and manage both sales and after-sales services as a unified business model.

[13] The Annex to the European Commission's 'Car Price Report' states the following: "The report is factual and based on list prices –before any discount– both including and excluding taxes, provided by car manufacturers in co-operation with their associations (ACEA and JAMA)." According to the year of the report, the number of manufacturers (European and foreign) that have provided information to the European Commission on their recommended retail prices, and the number of best-selling models for which such information is provided, are indicated. See European Commission (2000 to 2011).

[14] The final two years of the cartel (2012–2013), corresponding to the early post-crisis recovery phase, are not observed in the dataset. While pricing effects could in principle differ in this later period, their direction is not clear *ex ante*. Economic recovery and easing credit constraints in durable-goods markets may allow manufacturers to sustain high list prices (see Gavazza and Lanteri, 2021), while weakening coordination among cartel participants could exert downward pressure on prices. Taken together, these opposing mechanisms imply no clear directional bias arising from the absence of post-2011 data. The observed sample nonetheless covers the core and most intense phase of the cartel.

[15] Please see: https://competition-policy.ec.europa.eu/sectors/motor-vehicles/documents_en

[16] Countries included: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom.

[17] European Automobile Manufacturers' Association (ACEA). See: https://www.acea.auto/reliable-data-statistics

[18] See: https://datos.bancomundial.org/indicator/NY.GDP.PCAP.CD?locations=EU

[19] See: https://energy.ec.europa.eu/data-and-analysis/weekly-oil-bulletin_en

[20] Spanish Official State Bulletin (BOE, Spanish acronym).

[21] These data were collected using web scraping and programming from the website included in footnote 15, although some years required manual transcription due to the data configuration. The database was also reviewed to detect potential errors and standardize them. The code in the STATA statistical package is available for review.

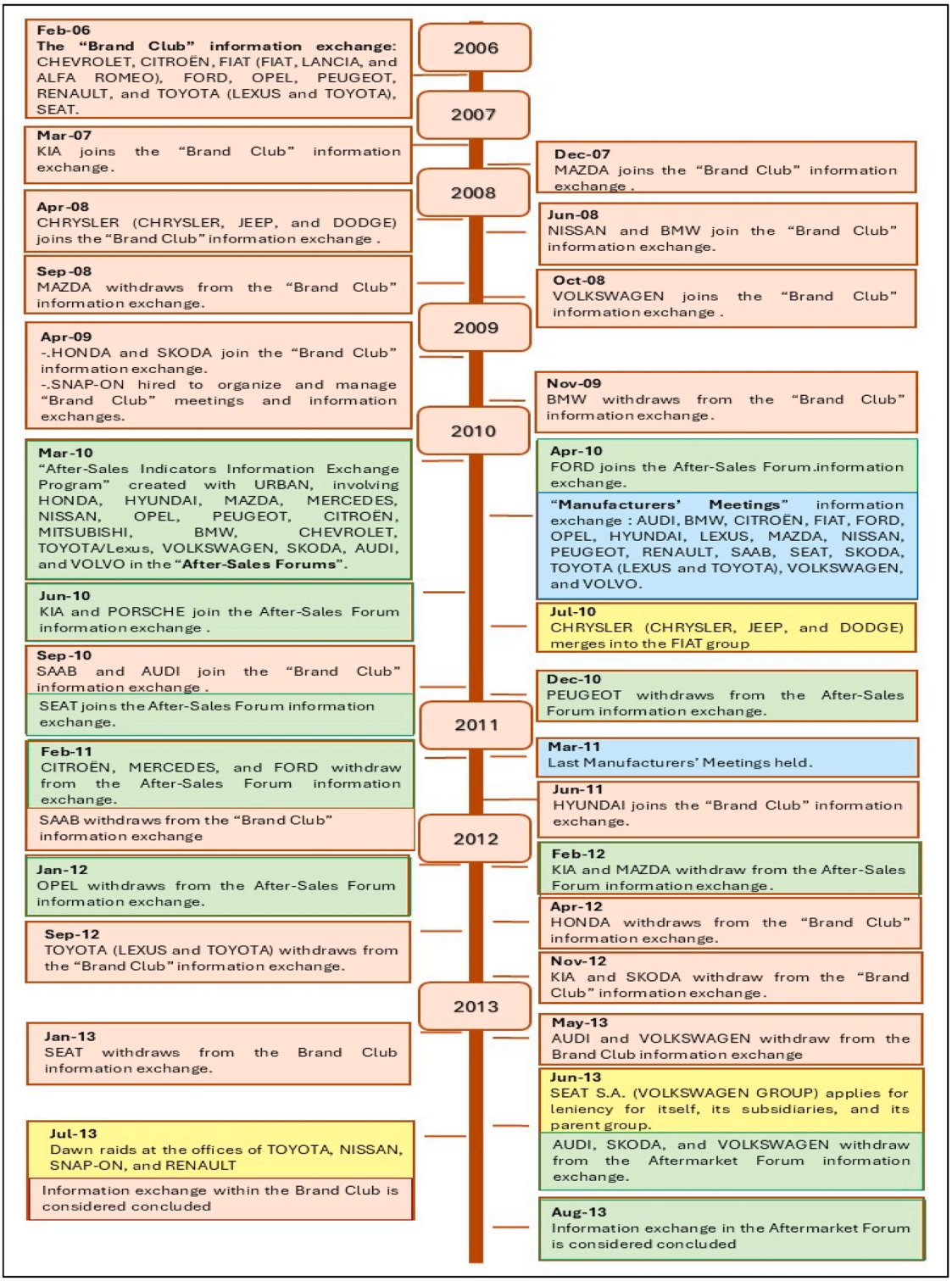


**Fig. 1.** Cartel timeline.

Source: Own elaboration based on CNMC (2015). Brand Club; After-Sales Forum; Manufacturers' Meetings; Other key events affecting the cartel. Note: SNAP-ON and URBAN are consultancy firms.

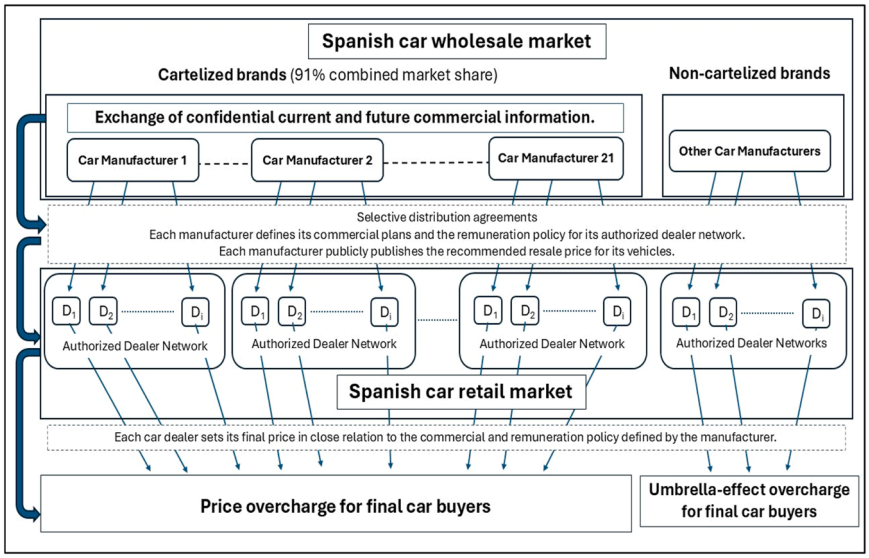


**Fig. 2.** Vertical supply chains of vehicle distribution and cartel conduct.
Source: Own elaboration. Note: i denotes any number of distributors within the retail network.

**Table 2**
Covariates. Spain and EU. 2000–2011.

| Covariate | Source | Region | Periodicity | Comments |
|---|---|---|---|---|
| Manufacturers' recommended vehicle prices (before and after tax) | European Commision[15] | EU-27 (UK included)[16] | Semmi-annual or annual | It includes brand, model and version. |
| Cartelization period by brand | CNMC | Spain | - | Binary variables describing the period in which the brand participated in the cartel. |
| Annual sales | ACEA[17] | EU-27 (UK included) | Annual | Annual total sales by brand and country. |
| GDP pc | World Bank[18] | EU-27 (UK included) | Annual | Gross Domestic Product per capita, real prices. |
| Petrol prices | European Commision[19] | EU-27 (UK included) | Monthly | Retailer petrol prices (€ per liter), applied exchange rate. |
| Scrappage schemes | BOE[20] | Spain | - | Binary variables that include the period in which there were vehicle replacement plans in Spain (VIVE and Plan 2000E). |

Source: Own elaboration.

income indicator by country (GDP per capita), the price of 95 petrol (as an indicator of the evolution of the oil market and its potential long-term impact on vehicle sales) and the replacement and scrappage plans implemented in Spain in that period.

The last variable is included because, as Jiménez et al. (2016) point out, they have an impact on final vehicles' prices, as producers appropriate part of the subsidy. Similarly, it should be noted that it has been impossible to locate dates about all vehicle substitution schemes in other European countries. However, this limitation implies that the results we obtain would be biased downwards, as we will describe later.

How did vehicle prices in Spain behave relative to other EU countries before and during the cartel? Although a formal answer will be provided by the causal inference analysis discussed later, the descriptive analysis reveals not only the variability within the dataset, but also helps to identify potential patterns (see Appendix B for a time serie analysis).

The next figures (Fig. 3 and Fig. 4) show the average prices, before and during the cartel, according to the implication of each brand in the cartel and the country to which the data belong. Thus, we differentiate between *cartelized* and *non-cartelized* brands, both in Spain and in the rest of the European countries (see footnote 22). It should be noted that the term "*cartelized brand*" refers to the brands that participated in the cartel case in Spain (treatment group), and also to the same brand for which we do also have information at EU level, i.e., member States other than Spain (which will be used as control group, as will be explained later).[22] The term "*non-cartelized*"

[22] In our sample, the cartelized brands are Alfa Romeo, Audi, BMW, Citroën, Fiat, Ford, Honda, Lancia, Mazda, Mercedes-Benz, Nissan, Opel, Peugeot, Renault, SEAT, Skoda, Toyota, Volkswagen and Volvo. The brands KIA, Mitsubishi, Hyundai and Saab are excluded from the sample because the information is only available either for the period before the cartel takes place or for the cartel period, but not for both periods.

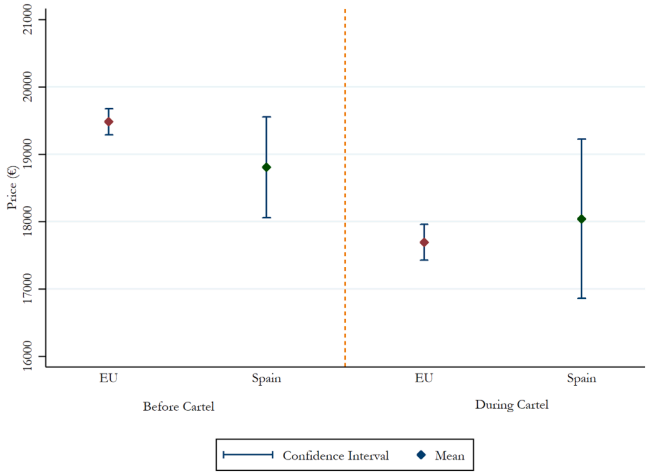


**Fig. 3.** Average prices (before taxes) of cartelized brands, before and during the cartel. 2000–2011.
Source: Own elaboration.

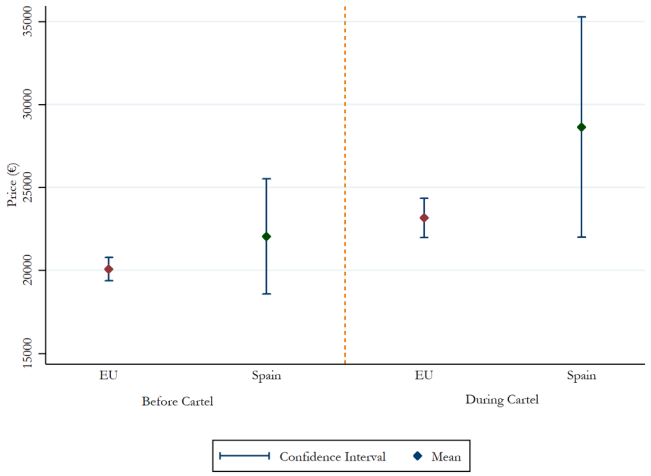


**Fig. 4.** Average prices (before taxes) of non-cartelized brands, before and during the cartel. 2000–2011.
Source: Own elaboration.

refers to the brands that did not participate in the cartel agreement in Spain, and for which we have information both at the EU level and Spain.[23] In addition, we perform a *t*-test comparing means between Spain and the European Union, for each case (cartelized before the cartel, cartelized during the cartel, non-cartelized before the cartel and non-cartelized during the cartel).

Several results can be highlighted from the figures. Considering whether confidence intervals do (fully) overlap or not, the reader can visually understand whether the differences in mean prices are statistically significant or not.

Firstly, Fig. 3 shows that the average prices of the cartelized brands fell in the cartel period compared to the pre-cartel period both at the EU level (from 19,482.82€ to 17,693.51€, a decrease of approximately 9.2%) and in Spain (from 18,807.40€ to 18,041.64€, a decrease of approximately 4.1%). This may be due to a composition effect in the sample we are analysing, both because of the different models of each brand, and because each brand was not in the cartel for the same period of time.[24] This is why, as we have already pointed out, these descriptive indicators do not show any causal behaviour, given that we must control for the factors affecting prices in each period, as will be discussed in the next section.

Secondly, average prices behave differently for cartelized and non-cartelized brands (Fig. 4). In fact, non-cartelized brands increase their prices more than cartelized brands during the cartelization period (an increase of 15.3% in EU member states, from 20,088.87€ to

[23] In our sample, the non-cartelized brands are Daihatsu, Land Rover, Mini, Subaru and Suzuki. We have excluded Jaguar and MG Rover from the sample because the information is only available either for the period before the cartel takes place or for the cartel period, but not for both periods.
[24] For example, Mercedes-Benz is one of the brands with the highest prices among the cartelized brands, but it was in the cartel since March 2010, which means that only one year for this brand in our sample (2011 data) has been affected by the cartel.

23,171.14; and an increase of 29.9% in Spain, from 22,055.99€ to 28,646.76€). Again, this may be due to composition effect on the sample we are analysing, because of the different models and vehicle versions of each brand. Alternatively, prices of non-cartelized brands may have increased as a consequence of the cartel, producing an umbrella effect.

Regarding the comparison of average prices of the same vehicles in Spain and in Europe for the cartelized brands, they decrease less during the cartel period (or even increase more) than in the European Union, which may be indicating a different behaviour between both levels of analysis (Spain versus the European Union). Thus, the change in average prices in Europe is 5.1 percentage points lower than in Spain.

Finally, the mean difference tests comparing average prices in Spain with the same vehicle in other countries belonging to the EU are significant only in the case of cartelized brands before the cartel (at the 10% significance level) and for non-cartelized brands during the cartelization period (at the 5% significance level). The former implies that the sample has different average prices before the cartel (they are lower in Spain than in the EU), but during the cartel such differences are eliminated. Second, those brands that did not participate in the cartel increased prices more in Spain than in the rest of the EU countries.[25] In other words, both types of brands become relatively more expensive in Spain during the cartelization period compared to the EU. But, as with the other descriptives, these results should be viewed with caution as they do not point to causality.

Given the potential differences between cartelized and non-cartelized brands, we focus our analysis on the behaviour of vehicles' prices of cartelized brands in Spain and the EU, therefore, we are able to work with a homogenous and comparable control group with respect to the treatment group (cartelized brands in Spain). Specifically, we can compare the performance of the cartelized brands in Spain with the performance of the same brands in the EU (which were not affected by the cartel and therefore constitute the control group), before and after the entry into the cartel.

However, given the different points in time at which each brand joined the cartel, and in order to homogenise the analysis and eliminate these temporal differences, we have created the following event study (Fig. 5). This approach takes advantage of changes in the market over time (the different entries of each firm into the cartel) to estimate the effects of the cartel. The coefficients shown in the figure below are obtained as the difference in average prices for these cartelized brands in Spain compared to those same brands in the rest of the EU countries, for each year before or during the cartel.

It can be seen that the price differences are negative on the left (years 5, 4 and 3 before cartel) and positive on the right (years 1 to 5 during carte, excepting year 2). This would indicate that average brand prices in Spain were generally lower than in the EU before the cartel, while the difference became positive as the cartel took effect. However, these results are only statistically valid for the periods well before (5 and 4 years before) and during the cartel (year 4 and 5 during the cartel), and are equally descriptive, like all those shown so far. It would be necessary to control for the different covariates that may be affecting prices to determine price effects, something we discuss in the next section, specifically in the DiD modelling.

## 5. Methodology and results

The estimation of the causal effects of the cartel follows the usual structure of DiD models. This method estimates the harm by comparing the observed situation where the infringement took place, with a hypothetical counterfactual scenario in which it did not. From an economic perspective, the DiD approach is considered the most accurate among comparator-based methods, as it combines both the before-during-after and cross-sectional approaches. Specifically, the method analyses how the relevant economic variable evolves over time in the passing-on market and compares this evolution with that of the same variable in an unaffected comparator market during the same period (European Commission, 2019).

Therefore, the estimates of the DiD model will be carried out by means of the following equation [1]:

$$P_{ict} = \beta_0 + \beta_1 \text{Cartelized Brand Spain}_{ic} + \beta_2 \text{Cartel Period}_{it} + \beta_3 \text{DiD}_{ict} + \beta_4 \text{Sales}_{ct} + \sum_{i=j}^{2} \beta_i \text{Scrappage}_{ct} + \sum_{i=j}^{n} \beta_i \text{Brand}_i + \sum_{i=j}^{m} \beta_i \text{Model}_i + \sum_{i=j}^{z} \beta_i \text{Version}_i + \sum_{i=j}^{k} \beta_i \text{Country}_c + u_{ict} \quad (1)$$

where:

$P_{ict}$: is the net price (i.e. excluding taxes) of the vehicle corresponding to version *i* (corresponding to a brand) in year *t* and in country *c*. Taxes should not be included in the price to avoid that different taxation and changes in taxation, which we cannot control, over time for each country affect the results. This is the variable to be explained by the model, which will be expressed in natural logarithms.

Cartelized Brand $\text{Spain}_{ic}$: binary variable that takes value 1 when the price of the vehicle corresponds to a cartelized brand *i* in Spain, and 0 otherwise.

[25] It should be taken into account not only the differences regarding vehicles' characteriscts between cartelized and non-cartelized brands, but also that the brands participating in the cartel case accounted for around 91% of the car distribution market in Spain, which have benefited the non-cartelized brands too.

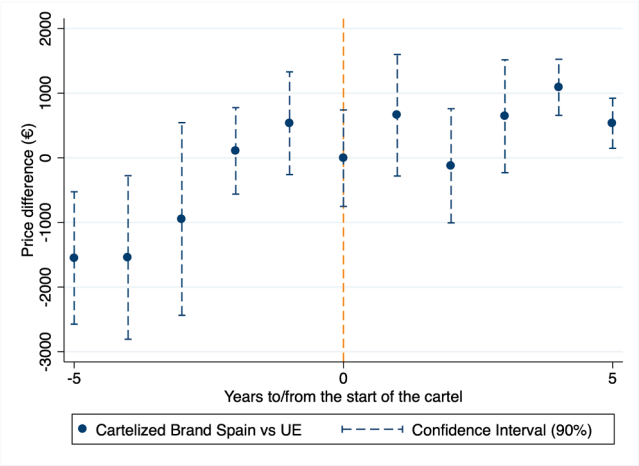


**Fig. 5.** Average prices differences (before taxes) for cartelized brands. Spains vs. EU. Descriptive analysis.
Source: Own elaboration from EU database.

Cartel Period$_{it}$: binary variable that takes value 1 when the price of the vehicle corresponding to a brand *i* is given in the cartel period, and 0 otherwise.

DiD$_{ict}$: it is the product of the two previous variables and the variable of interest. It takes a value of 1 for those brands that participate in the cartel in Spain after the start of the cartelization period, and 0 otherwise. This is the DiD estimator and, therefore, the coefficient resulting from this estimation indicates the behaviour of the prices of vehicles that have participated in the cartel in Spain with respect to the behaviour of these same brands in other countries of the European Union (where no cartelization has been discovered and, therefore, it is the control group).

Sales$_{ct}$: Total vehicle sales in country *c* in year *t*. This variable allows for controlling the effects that total market demand may have on prices. There are two key points to highlight about this variable. The first is a limitation, as we do not have sales data by brand, country, and year. This means that we are controlling for the overall vehicle demand in each country market every year, but not for the specific demand of each brand in each country and year. The second point is the endogenous relationship with the variable to be explained (prices), which may bias the estimates. To address this issue, the model is analysed using an instrumental variables

**Table 3**
Difference-in-differences estimations. Prices before taxes (in natural logarithms). Instrumental variables (sales). 2000–2011.

| | Model (1) | Model (2) | Model (3) | Model (4) |
|---|---|---|---|---|
| DiD (Spain) | 0.0775** | 0.0797*** | 0.1155*** | 0.0929*** |
| | (0.04) | (0.02) | (0.04) | (0.01) |
| Cartelized Brand Spain | Included | Included | Included | Included |
| Cartel period | Included | Included | Included | Included |
| Sales | Not Included | Not Included | Included | Included |
| Scrappage schemes | Not Included | Not Included | Included | Included |
| Brand effect | Not Included | Included | Not Included | Included |
| Model effect | Not Included | Not Included | Not Included | Included |
| Version effect | Not Included | Not Included | Not Included | Included |
| Country effect | Not Included | Included | Not Included | Included |
| Control group | Cartelized brands in EU member states other than Spain | Cartelized brands in EU member states other than Spain | Cartelized brands in EU member states other than Spain | Cartelized brands in EU member states other than Spain |
| Observations | 22,800 | 22,800 | 21,269 | 21,244 |
| $R^2$ | 0.001 | 0.55 | 0.0003 | 0.95 |
| Durbin Chi2 | - | - | 1.291 | 740.12 |
| Wu-Hausman F | - | - | 1.290 | 741.82 |
| F-statistic | - | - | 1806.56 | 478.954 |
| Critical value (10%) | - | - | 19.93 | 19.93 |

Note 1: Standard error in brackets
*p < 0.10, **p < 0.05, ***p < 0.01 significance test.
Note 2: Durbin Chi2 and Wu-Hausman F are used for the endogeneity test of the variable *sales*, where the null hypothesis is that the variable is exogenous. In all cases the null hypothesis is rejected. The F-statistic - or minimum eigenvalue statistic of Cragg and Donald (1993) - and the critical value representing the highest rejection rate of a nominal Wald test of 5% that we are willing to tolerate, are used to test the null hypothesis of Stock and Yogo (2005) that the instrument is weak. If the statistic is greater than the critical value, we can conclude that our instruments are not weak.

regression, where total sales for each country are explained based on the *GDP* per capita in country *c* at time *t*, in current prices; and the average price of gasoline over the last three months in country *c* at time *t*. This way, we control for variations in the country's average wealth and long-term vehicle purchase decisions (in case the evolution of petrol prices could affect vehicle purchase decisions). This variable is also expressed in natural logarithms.

$Scrappage_{ct}$: binary variables that take value 1 when a scrappage scheme was in force in Spain. Concretely it refers to *Plan VIVE* (2008–2009) and *Plan 2000E* (2009–2010). These two covariates are included due to the potential effects on prices, as Jiménez et al. (2016) found in this market.

*Brand, model and version effects:* these three binary variables control for the effects that each of them may have on price, namely whether the brand is premium or not, the model of the particular vehicle being analysed, and the features that a specific version of a particular model entails. Version fixed effects are included as a proxy for the absence of information on vehicle characteristics.

*Country effect:* binary variable that takes value 1 for each country, in order to control for potential country effects on prices.

$u_{ict}$: error term.

The following table (Table 3) includes the estimates of equation [1]. We have developed four models, varying the fixed effects and the control explanatory variables as a method to verify the robustness of our results.[26]

In all the estimations, the DiD coefficients are statistically significant and positive.[27] This implies that the prices of vehicles from cartelized brands in Spain increased more than the prices of those same vehicles in the rest of European Union countries. Concretely, these models point out a causal price increase between 7.97% in model (2) to 11.5% from model (3).[28] Our preferred model is the one that controls for sales, scrappage schemes and fixed effects [model (4)], corresponding with a causal effect of approximately 9.3% (Fig. 6).

The previous figure allows for a better visualization of the estimation results of this DiD model. It includes, for five years before and during the cartel, the difference between the average prices of cartelized brands in Spain and those same brands in Europe (the base group is the year immediately preceding the start of the cartel). This analysis is similar to the previous descriptive analysis (see Fig. 4), but with an important difference: in this case, we are controlling for other factors that may affect price behavior, as described in equation [1], by using the estimated coefficients from that model [model (4)], so it represents conditional mean differences.

Three key results can be highlighted. On one hand, the average prices in Spain were lower than in the European Union before each brand joined the Spanish cartel, although we cannot statistically rule out at the 10% level that the price difference is zero. Secondly, the figure illustrates that trends are similar for the treatment and the control group in the pre-treatment period (the differences are not statistically significant at the 10% significance level in each pre-cartel period).[29] On the other hand, after each brand joined the cartel, the prices for vehicles in Spain increased more than those same vehicles in the European Union, turning this Spain vs. EU vehicle price difference positive; however, it is more noticeable and statistically significant from the second year in the cartel onwards.

But data limitations mean that these results cover the period 2006–2011. Given the continued increase in the Spain-EU price differential after the start of the cartel obtained from the above graphical analysis, it is reasonable to claim that the 9.3% average effect on vehicle prices is a lower bound effect value for the period, which would be even higher if the European Commission had data for 2012 and 2013.

Additionally, our estimates are based on manufacturers' recommended retail prices rather than transaction-level prices. While this implies that the estimated coefficients capture changes in posted prices, discounts are unlikely to be independent of the cartel conduct. Consistent with the CNMC decision, the information exchanges among manufacturers likely constrained manufacturer-led discounts during the cartel period. Because margins at the dealer level are limited,[30] retailers' ability to offset these constraints through independent discounting would have been reduced. As a result, transaction prices for cartelized brands may have been closer to posted prices, while non-cartelized brands may have continued to offer discounts. Under this interpretation, the use of posted prices may lead to a conservative estimate of the cartel overprice faced by final consumers.

[26] We are aware that the staggered structure would potentially suggest the use of the staggered DiD method (CSDiD). However, this is not feasible with our data for two main reasons. First, the unit of observation is at the vehicle version level, and applying CSDiD would require aggregating the data at the brand level, which would lead to the loss of valuable statistical information and sample size. Second, to the best of our knowledge, CSDiD cannot be applied in combination with instrumental variables, which would significantly reduce the explanatory power of our model. Nonetheless, we have estimated the previous table using only the brands that were present throughout the entire cartel period, and three estimations considered only treated brands at each moment (excluding treated observations as control group while there were not in the cartel). The results do not differ substantially from those originally presented.

[27] This estimation was replicated by including the variable "vehicle segment" both as an explanatory variable in the model (in which case there may be correlation between the segment and the model) and as a cluster option to reduce standard errors. The overall results remain unchanged. See results in the Appendix A (Table A.1).

[28] The model estimating the cartel effects of prices with taxes achieves similar results, although in that case the effect is around 10.5%. See results in the Appendix A (Table A.2).

[29] In addition, we have analysed the joint test of all leading terms (coefficients from -5 to -1) being equal to zero. The null hypothesis reads as follows: $H_0 : \beta_{-5} = \beta_{-4} = \beta_{-3} = \beta_{-2} = \beta_{-1} = 0$. We cannot reject the null hypothesis that all coefficients being jointly equal to zero, as the p-value is 0.4547.

[30] See Section 3.1 for a detailed discussion of dealer margins and the vertical structure of automobile distribution in Spain.

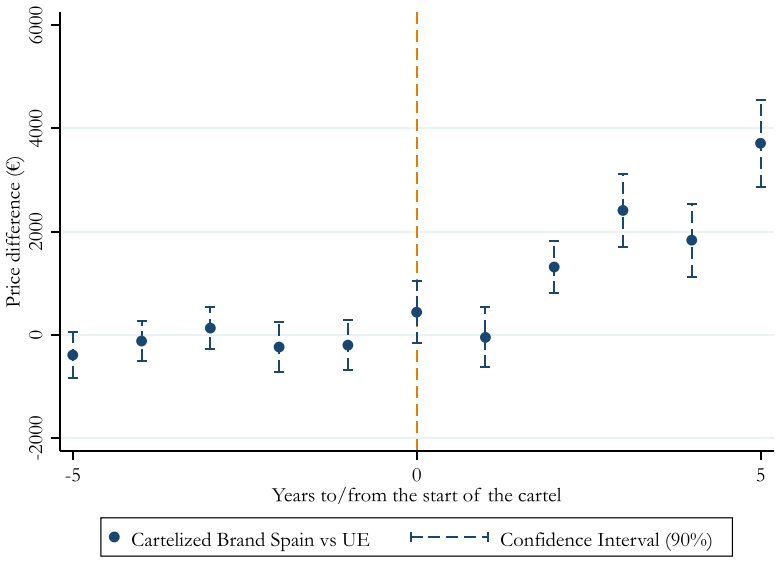


**Fig. 6.** Average prices differences (Spain vs. EU) for cartelized brands, using estimated coefficients.
Source: Own elaboration.

### 5.1. Robustness-check

#### 5.1.1. Control group

In this section we perform a robustness check regarding the control group used in the estimations. In this case, non-cartelized brands in EU and in Spain are gradually included in addition to cartelized brands in EU. The results presented in Table 4, which replicate the estimations of models (1) and (4), are robust and very similar to the ones obtained previously: the model (4b) shows a 9.36% increase in car prices in Spain due to cartel.

It should be noted that the non-cartelized brands may have experienced an umbrella effect as a consequence of the cartel. As explained in Section 3.3, the combined market shares of participating brands accounted for around 91% of the Spanish car distribution market, covering almost all mainstream brands and some premium brands. Non-cartelized brands exerted only limited competitive pressure, insufficient to counteract the cartel's effects and may have benefited from higher prices in the market. Umbrella effects increase with cartel inclusivity, as the fewer firms that remain outside the cartel, the larger the cartel price wave that outsiders can "ride" (Inderst et al., 2014; Holler and Schinkel, 2017). Additionally, some of the brands classified as non-cartelized are corporately linked to cartelized brands through group structures or cross-shareholdings; for instance, MINI is part of the BMW Group, and Subaru maintains equity ties with Toyota. These links could, in principle, give rise to umbrella effects, as pricing or strategic decisions in cartelized brands might indirectly affect non-cartelized brands within the same group.

Reflecting this pattern, the results obtained in this section are similar to the ones obtained when considering only cartelized brands. We also estimate the potential effect of the cartel on the prices of non-cartelized brands in Spain (umbrella effect). These results should be interpreted with caution, as the number of observations for non-cartelized brands in Spain is very small. When all controls are included (model 4), the estimated impact is positive and significant, around 11.3%. While Caoui (2022) documents this mechanism in the context of first-price procurement, his estimates show that umbrella effects can account for a substantial share of total cartel harm, sometimes approaching the magnitude of the direct overcharge. Our finding is therefore consistent with the idea that, under certain conditions, partial collusion can relax competitive pressure, allowing outsiders to raise prices beyond the cartel's adjustments.

#### 5.1.2. Placebo test

In this section we apply a robustness check or placebo test to confirm the validity of the results obtained from the DiD models. To this end, we remove the price data for Spain and take another European Union country as if the cartel had taken place there (and not in Spain), re-estimating equation [1] by using Model [4] of the previous tables. If the DiD coefficient is statistically significant, it would imply that vehicle prices in that country have behaved differently from the rest, and therefore, our estimates for Spain could be biased.

In our case, we tested with more than one country. Thus, we separately treated France, Italy, and Germany as the treated countries. The estimation of equation [1] in this case is presented in Table 5.

The DiD coefficients do not show statistical significance for two of the three countries in this placebo analysis, and in the case of Germany it is negative (prices decreased in this period), so we can confirm that the increase in prices in Spain during the cartel period is a causal effect of the creation of the cartel.[31]

[31] We replicate these estimations for the whole control group (including non-cartelized brands) as in Table 4. Results remain.

**Table 4**
Difference-in-differences estimations. Prices before taxes (in natural logarithms). Instrumental variables (sales). 2000–2011.

| | Model (1a) | Model (4a) | Model (1b) | Model (4b) |
|---|---|---|---|---|
| DiD (Spain) | 0.0591* | 0.0958*** | 0.0575 | 0.0936*** |
| | (0.04) | (0.01) | (0.04) | (0.01) |
| Treated brand | Included | Included | Included | Included |
| Cartel period | Included | Included | Included | Included |
| Sales | Not Included | Included | Not Included | Included |
| Scrappage schemes | Not Included | Included | Not Included | Included |
| Brand effect | Not Included | Included | Not Included | Included |
| Model effect | Not Included | Included | Not Included | Included |
| Version effect | Not Included | Included | Not Included | Included |
| Country effect | Not Included | Included | Not Included | Included |
| Control group | Cartelized & non-cartelized brands in EU member states other than Spain | Cartelized & non-cartelized brands in EU member states other than Spain | Cartelized & non-cartelized brands in EU member states other than Spain & non-cartelized brands in Spain | Cartelized & non-cartelized brands in EU member states other than Spain & non-cartelized brands in Spain |
| Observations | 24,851 | 23,141 | 24,962 | 23,249 |
| $R^2$ | 0.0003 | 0.95 | 0.0002 | 0.95 |
| Durbin Chi2 | - | 831.507 | - | 840.921 |
| Wu-Hausman F | - | 834.47 | - | 844.22 |
| F-statistic | - | 503.624 | – | 502.276 |
| Critical value (10%) | - | 19.93 | | 19.93 |

Note 1: Standard error in brackets
Note 2: Durbin Chi2 and Wu-Hausman F are used for the endogeneity test of the variable *sales*, where the null hypothesis is that the variable is exogenous. In all cases the null hypothesis is rejected. The F-statistic - or minimum eigenvalue statistic of Cragg and Donald (1993) - and the critical value representing the highest rejection rate of a nominal Wald test of 5% that we are willing to tolerate, are used to test the null hypothesis of Stock and Yogo (2005) that the instrument is weak. If the statistic is greater than the critical value, we can conclude that our instruments are not weak.
*p < 0.10, **p < 0.05, ***p < 0.01 significance test.

**Table 5**
Difference-in-differences. Placebo analysis. Treated country=Netherlands, Italy or Germany. Instrumental variables (sales). 2000–2011.

| | Model (Netherlands) | Model (Italy) | Model (Germany) |
|---|---|---|---|
| DiD | 0.005 | 0.0111 | -0.0161* |
| | (0.009) | (0.009) | (0.009) |
| Treated brand | Included | Included | Included |
| Cartel period | Included | Included | Included |
| Sales | Included | Included | Included |
| Brand effect | Included | Included | Included |
| Model effect | Included | Included | Included |
| Version effect | Included | Included | Included |
| Country effect | Included | Included | Included |
| Control group | Cartelized brands in EU member states other than France (& Spain) | Cartelized brands in EU member states other than Italy (& Spain) | Cartelized brands in EU member states other than Germany (& Spain) |
| Treatment group | France | Italy | Germany |
| Observations | 20,066 | 20,066 | 20,066 |
| $R^2$ | 0.95 | 0.95 | 0.95 |

Note: Standard error in brackets
*p < 0,10, **p < 0,05, ***p < 0,01 significance test.

## 6. Concluding rermarks

The estimation of price overcharges caused by cartels remains a fundamental challenge in antitrust damage assessment. Early estimates largely relied on descriptive methods, which did not fully isolate the causal impact of cartel behavior. More recently, difference-in-differences (DiD) approaches have been increasingly applied to address this issue. However, applying these causal inference techniques continues to be difficult due to limitations in data quality and the challenge of identifying suitable control groups unaffected by the cartel under analysis.

This study focuses on a major cartel in the Spanish automobile sector, involving 21 firms operating in wholesale vehicle distribution between 2006 and 2013. The cartel was uncovered through a leniency application and sanctioned by the Spanish Competition Authority (CNMC). To overcome common data limitations in causal cartel analysis, we construct a novel dataset of manufacturer-recommended retail prices for both Spain (the treated group) and several unaffected EU countries (the control group), covering the period 2000–2011.

Our econometric analysis applies a DiD strategy that exploits variation in the timing of cartel entry across brands and controls for confounding factors such as sales volume, scrappage schemes, and brand fixed effects. The results indicate a robust causal price increase of approximately 9.3% in Spain relative to the rest of the EU during the infringement period. These estimates are validated through several robustness checks: the parallel trends assumption is satisfied, the findings are consistent across alternative control groups, and placebo tests using other EU countries as hypothetically treated confirm that the observed effect is not spurious.

Beyond quantifying the average overcharge, our findings contribute to the understanding of how upstream collusion in vertically structured markets can affect final consumer prices. This case provides valuable evidence on price transmission mechanisms and supports the economic basis for damage claims brought by affected car buyers. More broadly, the empirical strategy and robustness validation employed in this study serve as a reference for future cartel overcharge estimations, particularly in settings where cartel participation is staggered and market coverage is extensive.

The clear identification of a significant causal overcharge highlights the importance of rigorous cartel detection and sanctioning, as even upstream collusion can substantially distort final retail prices and harm consumers. These findings underscore the value of leniency programs in uncovering complex cartels and the need for competition authorities to have access to high-quality, detailed price and sales data to enable robust empirical damage assessments. Moreover, the transmission of upstream collusion effects to consumer prices suggests that policymakers should consider the entire supply chain when designing antitrust interventions and calculating damages.

Future research could extend this approach to other sectors and over longer periods, improving damage quantification and deterrence. While our analysis focuses on the Spanish automobile market, the findings may be relevant for other industries with similar vertical relationships, particularly regarding the transmission of collusive effects through upstream information sharing.

## Disclosure statement

This article is part of a research project funded by a potential claimant. However, it has not been used in judicial proceedings.

## Data availability

The data and replication package supporting this study are publicly available at: https://doi.org/10.5281/zenodo.19238725.

## CRediT authorship contribution statement

**Juan Luis Jiménez:** Writing – original draft, Software, Investigation, Formal analysis, Conceptualization. **Carmen García-Galindo:** Writing – original draft, Software, Investigation, Data curation, Conceptualization. **José Manuel Ordóñez-de-Haro:** Writing – review & editing, Writing – original draft, Conceptualization, Investigation.

## Declaration of competing interest

None.

## Appendix A

**Table A.1**
Difference-in-differences estimations. Prices before taxes. Instrumental variables (sales). 2000–2011. Cluster by segment is included.

| | Model (1) | Model (2) | Model (3) |
|---|---|---|---|
| DiD (Spain) | 0.0928*** | 0.0958*** | 0.093*** |
| | (0.01) | (0.01) | (0.01) |
| Cartelized brand Spain | Included | Included | Included |
| Cartel period | Included | Included | Included |
| Sales | Included | Included | Included |
| Scrapagge schemes | Included | Included | Included |
| Brand effect | Included | Included | Included |
| Model effect | Included | Included | Included |
| Version effect | Included | Included | Included |
| Country effect | Included | Included | Included |
| Control group | Cartelized brands in EU member states other than Spain | Cartelized & non-cartelized brands in EU member states other than Spain | Cartelized & non-cartelized brands in EU member states other than Spain & non-cartelized brands in Spain |
| Observations | 21,244 | 23,141 | 23,249 |
| $R^2$ | 0.95 | 0.95 | 0.95 |

Note: Standard error in brackets *p < 0,10, ** p < 0,05, *** p < 0,01 significance test.

**Table A.2**
Difference-in-differences estimations. Prices with taxes. Instrumental variables (sales). 2000–2011.

| | Model (1) | Model (2) | Model (3) |
|---|---|---|---|
| DiD (Spain) | 0.1048*** | 0.1075*** | 0.1057*** |
| | (0.01) | (0.01) | (0.01) |
| Cartelized brand Spain | Included | Included | Included |
| Cartel period | Included | Included | Included |
| Sales | Included | Included | Included |
| Scrapagge schemes | Included | Included | Included |
| Brand effect | Included | Included | Included |
| Model effect | Included | Included | Included |
| Version effect | Included | Included | Included |
| Country effect | Included | Included | Included |
| Control group | Cartelized brands in EU member states other than Spain | Cartelized & non-cartelized brands in EU member states other than Spain | Cartelized & non-cartelized brands in EU member states other than Spain & non-cartelized brands in Spain |
| Observations | 21,245 | 23,141 | 23,249 |
| $R^2$ | 0.92 | 0.93 | 0.92 |

Note: Standard error in brackets * p < 0,10, ** p < 0,05, *** p < 0,01 significance test.

## Appendix B

Fig. B.1

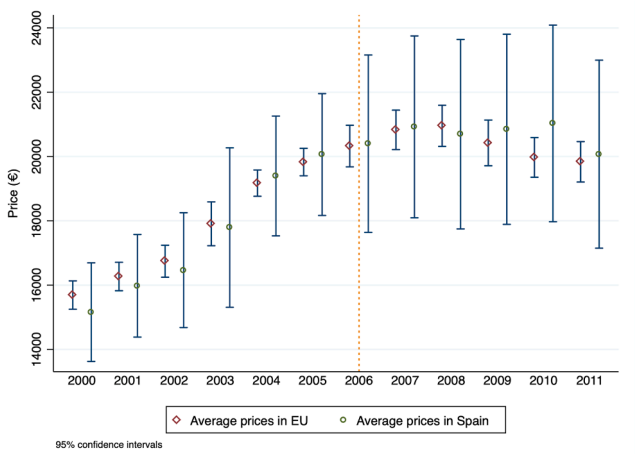


**Fig. B.1.** Time serie analysis. Average prices (before taxes) of cartelized brands, before and during the cartel. 2000–2011.
Source: Own elaboration.

Fig. B.2

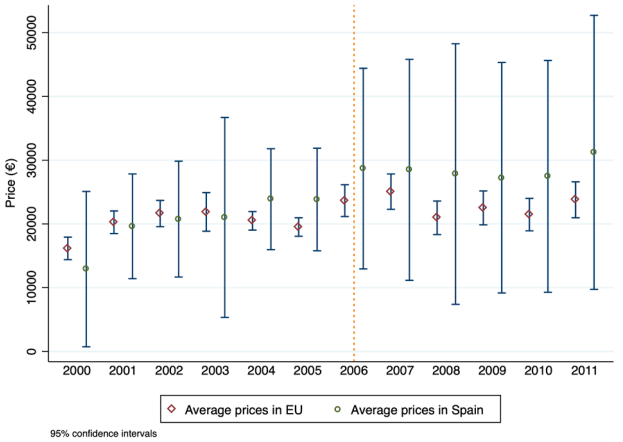


**Fig. B.2.** Time serie analysis. Average prices (before taxes) of non-cartelized brands, before and during the cartel. 2000–2011. Source: Own elaboration.

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