Does Marketing Widen Borders? Cross-Country Price Dispersion in the European Car Market

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Abstract

We study cross-country price differences in the European car market using detailed pricing and technical data. Pricing-to-market is pervasive: model-specific real exchange rates for mechanically identical cars differ significantly from unity. They also vary significantly across countries and, within countries, across car manufacturers. We find strong evidence that car manufacturers price discriminate by manipulating the menu of included car options and features available in each country. Such bundling decisions sustain cross-country price differences of 10% and more. Relative car prices show no sign of convergence during the covered period 2003 – 2011.

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Pricing-to-market (PTM), the practice of differentiating the retail or wholesale price of a good across markets, is an established fact (e.g. Alessandria and Kaboski, 2011; Atkeson and Burstein, 2008; Berman, Mayer and Martin, 2012; Gron and Swenson, 1996; Strasser, 2013). Much less is known about the exact mechanisms through which PTM is achieved in practice. Price differentials between countries are often attributed to the structure of the economy, e.g. to differential distribution costs (Burstein, Neves and Rebelo, 2003; Corsetti and Dedola, 2005) or border costs (Engel and Rogers, 1996). In advanced economies transaction and travel costs are low, and governments routinely promote competition through trade agreements and regulatory measures, so one would expect the ability of firms to price to market to be limited. The persistence of PTM in these countries remains therefore something of a puzzle.

In this paper we show that some of these price differences stem from a specific form of price differentiation by manufacturers: versioning an otherwise homogeneous good across countries. In particular, country-specific versions of a car are created by manipulating the menu of included car options and features available in each country. This practice makes PTM feasible and may allow manufacturers to collect some monopoly rents. We examine the practice of PTM in what is perhaps the most studied example in the literature: the European car market (e.g. Auer, 2013; Gil-Pareja, 2003; Goldberg and Verboven, 2001, 2005; Mertens and Ginsburgh, 1985; Verboven, 1996a,b). Countries of the European Union (EU) are natural candidates for any discussion of market integration. They share a highly integrated transportation infrastructure, a common regulatory framework, and deep trade relations. Not least, most of them either use a common currency (the euro) or use currencies which are credibly pegged to it.

A car, the most significant purchase of a tradable good that most households make, is a highly visible symbol of European market integration and as such the focus of intense scrutiny. For this reason, and despite exempting the passenger car market from the unrestricted competition article of the EU treaty, the European Commission (EC) aims to increase market integration within Europe: car warranties must be respected across the EU; cross-border car buyers are exempt from taxes and fees in the country of purchase; car registration documents are valid EU-wide; even cross-border purchases to and from the British Isles are accommodated by requiring manufacturers to deliver upon request right-hand drive steering cars to dealers on the Continent (European Commission, 2002; European Commission DG-COMP, 2002).[1]

Comparing car prices across countries, however, is a non-trivial exercise, for consumers as well as economists. A typical car is sold with a variety of optional features and auxiliary services which makes direct comparison difficult. A basic and necessary contribution of this paper is the creation of a data set which allows conducting price comparisons of identical products. For this purpose we collect and merge data on prices, technical characteristics, and tax regimes, so that we are certain that the specification-adjusted pre-tax price of, for example, a Ford Focus purchased by a German buyer from a French dealership is directly comparable to the pre-tax price *that same consumer* would have paid in Germany. We consider our assessment quite reliable because we know many determining features of the Ford Focus in question: the car's engine size, its CO_2 emission rating, its model year, applicable tax rates, the standard options, and the price of extra options such as air conditioning (AC) and power steering.

Our data set allows us to calculate the extent of PTM in the European car market, and to test whether European car prices have been converging. A second contribution of this paper is to show that PTM in Europe is pervasive throughout the period covered by our data (2003–2011), with little evidence of absolute convergence.[2] Figure 1 presents a typical case. It shows the cross-country price dispersion for the Ford Focus, a mid-size model popular across Europe. We measure the pre-tax, feature-adjusted (i.e. mechanically identical), euro-denominated price to maintain an "apples-to-apples" comparison.[3] Two features of the data stand out: first, substantial variation exists in the price of a Ford Focus across Europe at any given period covered in our data. The difference between the 25th percentile and the 75th percentile is never less than €1500, and sometimes closer to €2000. These are economically significant price differences for a car whose mean price hovers between €13300 and €15600. Second, price dispersion shows no clear trend over time. The difference between the 25th percentile and the 75th percentile first decreases during 2003–2005, then increases until 2010, and decreases slightly thereafter.

[Figure 1 about here.]

We define the real exchange rate between a given country in the EU and a base country, for example Germany or the Netherlands, as the relative feature-adjusted, pre-tax, euro-denominated price. This real exchange rate $r_t^{i,c}$ is defined per period t, country c, and car model i. Figure 2 presents a histogram of the log real exchange rate over time. Under the law of one price, these distributions would be concentrated tightly around zero. We see instead that real exchange rates are widely spread out, with no sign of convergence to zero (absolute convergence) over time. If anything, real exchange rates diverge slightly from 2003 to 2011.

[Figure 2 about here.]

What can explain these features of the data? Our main contribution in this paper is to identify the particular mechanisms which allow PTM to take place. We find that manufacturers' prices respond to differences across countries in population, income, tax rates, and demand conditions, taking advantage of existing market segmentation in Europe. We also find, however, that manufacturers engage in what seems to be deliberate versioning of their products across markets. For some features such as AC and ABS, which can be either standard or optional features of the car, bundling matters: if the feature is included in the car's price as standard in one country, then whether it is standard or optional in the other country will significantly affect the real exchange rate between the two countries. The effect is economically significant as well, ranging to 10% and more of the car price. In other words, we observe a significant price difference between mechanically identical cars which is driven by differences in the sets of options available to buyers in different countries. These price differences vary widely depending on the country pair and the car feature in question, creating ample space for price discrimination.

We present a simple model of intentional price discrimination across and within countries to help account for these findings. In the model, car customers in some countries disagree more than in other countries about the value of a certain car feature, for example an installed AC. In countries where the willingness to pay of some customers for this particular feature is very high, the manufacturer may charge a large amount for the option, ensuring that only the high-value customers will choose to buy the car with AC installed, while the low-value customers will buy the car without AC. This is optimal if the gains from charging the high-value customers for the option outweigh the loss of revenue incurred by not selling the option to the low-value customers. In these countries, offering AC as standard would not be ideal because that would force the manufacturer to sell the car at the same price to both groups of customers, leaving the high-value customers with a large consumer surplus. In other countries, however, the difference among customers with regards to the willingness to pay for AC might not be as large, therefore trying to separate the customers in the way described might reduce profits instead of raising them. The manufacturer will then offer AC as standard in those countries, but at a lower price since it has to appeal to the entire customer base, rather than to the high-value customers only. Clearly this scheme is limited in neighboring countries by the ability of customers to purchase across borders: the high-value customers in the former type of countries would like to purchase the car with AC in the latter type of countries. However they would face some transaction costs. We derive conditions under which, for a given cost of cross-border purchases, this type of price discrimination is still possible. Note that price discrimination in the model is driven by *differences across countries in the composition of demand*. It is this effect which we are capturing in our regressions.

It is important to distinguish between absolute and conditional convergence of prices across countries. While there is no evidence of absolute convergence in our data, conditional convergence to a country-specific mean is actually quite rapid. We estimate that the half-life of deviations of the real exchange rate from the country-specific mean at considerably less than two years. Conditional convergence has become faster in the period 2003-2011 relative to earlier estimates (Goldberg and Verboven, 2001, 2005). But we do not see any evidence of convergence towards a single European price for passenger cars in our data, contrary to recent EU reports (e.g. European Commission, 2009, p.6).

We proceed as follows. We first provide a brief overview of previous research on PTM and price dispersion in the European car market. We then examine price dispersion and mean reversion of real exchange rates within Europe in Section 2. After a brief discussion of our empirical approach we present the main empirical results in Section 3. In Section 4 we explain the uncovered behavior of car manufacturers with a simple model, and conclude in Section 5.

1 Related Research

Due to its visibility and the regulatory attention it receives (described in Appendix B), the market for European new passenger cars has been the subject of many studies. The focus of these are price differentials between countries of the EU, in particular whether they have declined since the start of the common market in 1993. We discuss these studies in Section 1.1. We then relate our paper to other studies on PTM and the law of one price (LOP) in Section 1.2.

1.1 Price Dispersion in the European Car Market

The studies of the late 1980s and early 1990s (Ginsburgh and Vanhamme, 1989; Kirman and Schueller, 1990; Mertens, 1990; Mertens and Ginsburgh, 1985) arrive at mixed conclusions about price convergence before 1990. Clearly, the price differences in the early 1990s were still very large (Verboven, 1996a), which most likely contributed to the subsequent regulatory attention the car market received. Verboven (1996a) contains a cross-section nested-logit estimation of a pricing and demand equation for five countries (Belgium, France, Germany, Italy, United Kingdom) for the year 1990. Not surprisingly given the large price differences, all countries except Belgium displayed low price elasticities and therefore local market power and potentially cross-country price discrimination. In the same vein Mertens and Ginsburgh (1985) find that price discrimination is much larger than product differentiation in a hedonic price regression, and that car manufacturers "use product lines to discriminate across EU countries" (see also Ginsburgh and Weber, 2002).

In response to this apparent lack of market integration, the European Commission (EC) in 1993 started collecting pre-tax and post-tax prices for about 75 car models at least once a year. Beginning with the report of Degryse and Verboven (2000) to the Competition Directorate-General of the EC in 2000, this data set (henceforth "EC data set") forms the basis for most subsequent analyses of the European car market.

Degryse and Verboven (2000) base their analysis on pre-tax list prices for the years 1993–2000 taken from the EC data set and converted into a common currency. There is no evidence of diminishing price differentials of models across countries. Also, price variation across countries differs substantially from model to model. Except for luxury cars, where variation is somewhat smaller in percentage (but not in absolute) terms, price variation appears to be model idiosyncratic. As expected, high tax countries have a comparatively low pre-tax price. A special survey allows Degryse and Verboven (2000) to adjust for differences in customer discounts and dealer margins across countries, but this has no effect on the results. In the end, more than half of the price differential for individual car models remains unexplained by their explanatory variables (taxes, exchange rates, margins, right-hand drive). Whereas this study works with specification-adjusted list prices, it does not explore – as we do – the impact of the car specification on the price differentials.[4]

The papers that follow these seminal studies (e.g. Brenkers and Verboven, 2005; Gil-Pareja and Sosvilla-Rivero, 2008; Goldberg and Verboven, 2001, 2004, 2005; Lutz, 2004) describe a car market characterized by substantial price dispersion, though declining over time.[5] Even today, large price differentials remain (Gil-Pareja and Sosvilla-Rivero, 2008; Goldberg and Verboven, 2005), and PTM is widespread (Gil-Pareja, 2003). Regarding the sources of price dispersion, Goldberg and Verboven (2001) conclude that cost differences across countries account for a higher fraction of price dispersion than brand-specific markups. Lutz (2004) also finds evidence of variable markups, but concludes that barriers to arbitrage between markets play the bigger role.

More generally, recent studies of price convergence and product market integration in the EU (e.g. Engel, Rogers, Veronese and Midelfart, 2004) find no tendency of price convergence after the introduction of the euro in 1999, but considerable convergence in the 1990s, the period during which most intra-EU trade barriers were lifted.[6] The end of convergence after the mid-1990's applies to almost any product. Fischer (2009), for example, finds hardly any price convergence of washing machines during the period 1995 to 2005 in a study based on scanner data.

1.2 Deviations from the Law of One Price and Pricing-to-Market

Substantial price dispersion within and across countries is extremely common. Moreover, measured price dispersion is often quite large, and difficult to rationalize using common explanations, such as the cost of crossing a border or differences in costs of non-traded goods. In fact, tariffs and regulatory import hurdles have fallen to historic lows across the industrialized world as well as in many developing countries, but price dispersion in traded goods does not seem to have become smaller. Also, price dispersion among US cities is even larger for traded goods than for non-traded goods (Engel and Rogers, 2001). Using micro data, Crucini and Shintani (2008) find no meaningful difference in price dispersion between traded and non-traded goods. At the same time, cross-border arbitrage in some markets can be substantial (Asplund, Friberg and Wilander, 2007), indicating that there is no lack of potential arbitrageurs. Currently there is no satisfactory explanation as to why price differences across countries persist.

These deviations from LOP have been the subject of intense debate in the international finance literature on real exchange rates for some time. This literature has, since the seminal paper by Engel and Rogers (1996), increasingly used micro data to examine cross-country price dispersion. Whereas for commodities LOP holds (Baffes, 1991), already within a global retailer such as IKEA price differences between currency areas cannot be explained with distribution costs or taxes (Haskel and Wolf, 2001; Hassink and Schettkat, 2001). Online stores of two large fashion chains, as well as of Apple and IKEA, however, seem to obey the law of one price within the Euro Area (Cavallo, Neiman and Rigobon, 2012) – a comparison which necessarily abstracts from store coupons and customer discount cards.

Our paper revisits this debate but examines a very different market. Instead of small and (after sample selection) easy-to-compare household items, we compare large ticket items, namely cars, which are the largest household expenditure item after buying a house. Compared to household items, cars are a very heterogeneous good, but with well-documented differences, which we exploit in this paper. Furthermore, we do not rely on online prices, but dealership prices for made-to-order cars.[7]

Broda and Weinstein (2008) use Universal Product Codes (UPC) to ensure that they are comparing identical products, and find no additional price dispersion across the border. In contrast, Gopinath, Gourinchas, Hsieh and Li (2009), also using UPC codes, find a considerable price gap between identical products in stores belonging to the same retail chain but located across the US-Canada border. This price gap is almost entirely driven by variation in wholesale costs borne by the retailer and consistent with full segmentation of markets. However, the essence of a UPC bar code is that the product is identical across countries. In this paper we focus instead on differentiation of the standard bundles of product features, which turns out to be an important avenue for manufacturers of implementing PTM and presumably collecting monopoly rents.

2 Properties of Feature-Adjusted Car Prices

In this section we first define the feature-adjusted prices and real exchange rates. Then, we examine the evolution of price dispersion and mean reversion of the real exchange rates. Our sources and data cleaning procedure are described in detail in Appendix A.

2.1 Definitions

Using information on technical features we adjust the reported car prices to obtain prices of mechanically identical cars, $P_t^{i,c}$, where i denotes the car model, c the country, and t the survey period. We define a model i by its technical properties, such as engine size, fuel type, CO_2 emissions, and fuel consumption. The cars offered also differ in the availability and pricing of options: whether the model is sold with or without air conditioning (AC), an automatic gearbox, ABS brakes, power steering, or an airbag; and whether the steering is on the right or left. We use this information in our data set to calculate for each model the all-options-included price. This allows us to compare the prices in continental Europe of, for example, a model 2007 Peugeot 207, 1.4 liter gasoline engine, 5 doors, 90 horse power (66 kW), manual transmission, with AC, ABS, power steering, and airbags. We can also compare prices of the same car, now equipped with right hand steering, across all European countries, including the countries where driving is on the left side of the road. We exclude from our analysis cars where some of this data is missing, inconsistent across countries, or clearly wrong. Note that we compare pre-tax prices, because European buyers of new cars pay registration taxes in the country in which they live, not in the country in which they buy the car.[8]

We define the model-specific real exchange rate, $r_t^{i,c}$ as the log difference between the feature-adjusted price in each country (converted into euros if necessary) and the price in a base country. We choose the Netherlands as base country because of its intermediate car price level as well as its central location.[9] The real exchange rate is then:

$$r_t^{i,c} = \log P_t^{i,c} - \log P_t^{i,NL} \tag{1}$$

In the case of countries where driving is on the left side of the road (UK, Ireland, Cyprus, and Malta), the real exchange rate is defined as the log difference between the car's price with all available options in that country and the price of an equivalent, right-hand steering car in the Netherlands.

2.2 Price Dispersion and Violations of the LOP

We look first at the evolution of price dispersion over time in the entire European car market.

[Figure 3 about here.]

Figure 3 shows the range of within-model price dispersion across models, for each survey period. We define model price dispersion, Ξ_t^i, as the standard deviation of the log pre-tax, feature-adjusted price $p_t^{i,c} = log(P_t^{i,c})$ for a given model i across countries c. Until 2008 there is no trend in the level of price dispersion, and its variation across models remains about the same from year to year. In 2009 the average dispersion of car prices jumps up drastically for all models. This observation of a very similar dispersion of models shows that for the most part country-specific, not model-specific price movements are the reason for the change occurring in 2009. This may due to the heterogeneous performance of European countries during the recession, as well as large exchange rate movements of some European currencies vis-à-vis the euro. Also, “cash for clunkers” programs in some countries may have stabilized car prices in those countries, whereas countries without such programs experienced much larger price drops. The following two years show a slow convergence toward the pre-2008 situation, but in 2011 the average dispersion is still above its 2008 value. The behavior of the outlier models in 2009 is particularly interesting, since it exposes large differences among manufacturers in response to the crisis: some models’ prices converged, while others diverged. After one year most, and by 2011 all but one, of these idiosyncratic prices have disappeared.

A panel regression leads to similar conclusions: regressing the price dispersion on a time trend and model fixed effects ($\Xi_t^i = \alpha_1^i + \alpha_2 t + \varepsilon_t^i$) uncovers a highly significant upward time trend, as shown in the first column of Table 1. We next investigate how segments[10] and brand centrality[11] affect price dispersion with the regression specification:

$$\Xi_t^i = \alpha_1^{s(i)} + \alpha_2^{s(i)} t + \beta_1 x^{b(i)} + \beta_2 y_t^i + \nu^i + \varepsilon_t^i, \tag{2}$$

where $\nu^i \overset{iid}{\sim} (0, \sigma_\nu^2)$ and $\varepsilon_t^i \overset{iid}{\sim} (0, \sigma_\varepsilon^2)$. $s(i)$ denotes the segment, and $b(i)$ denotes the brand of model i, $x^{b(i)}$ are brand-specific covariates like brand centrality, and y_t^i are model-specific covariates like the emission standard of the model. Very central brands (such as Toyota) tend to differentiate prices more across countries, whereas brands in niche markets (such as Mini) do not set widely different prices across Europe. Inspection of columns (3) and (4) reveals that prices are on average the more dispersed the more upscale the car segment is. Expensive models within a segment price-differentiate less; either because of higher customer attention or because manufacturers combine price increases with price harmonization across Europe. Columns (5) to (7) show that the increase in price dispersion during 2003–2011 is common to all car segments, but most pronounced in the upscale segments executive (E) and luxury (F). We see that car manufacturers in recent years have significantly increased cross-country price discrimination overall, with larger and more upscale models showing the most pronounced increase.

[Table 1 about here.]

We now turn to model-specific real exchange rates, $r_t^{i,c}$. The upper panel of Figure 4 shows the distribution of real exchange rates relative to Germany, separately for each survey. We see that the distribution of real exchange rates is more spread out in 2011 than in 2003. Far from converging, pre-tax car prices in EU countries have actually drifted away from the pre-tax prices in Germany for mechanically identical cars. Looking at real exchange rates relative to the Netherlands in the lower panel, there is again no evidence of convergence over time. If anything, pre-tax prices have diverged.

[Figure 4 about here.]

A closer look at the data[12] reveals that real exchange rates vary not only across but also within countries and brands. But whereas countries differ from each other in mean real exchange rate across brands, over time the mean real exchange rate in each country seems to be quite stable. An exception is the 2009 survey, where a number of countries exhibit large drops in their mean real exchange rates. Figure 4 shows the resulting massive increase in real exchange rate dispersion in 2009. These large deviations from parity have only partially decayed since then.

2.3 Mean Reversion of Real Exchange Rates

In this subsection we examine the transitional properties of the real exchange rate. For comparison of our results with previous studies we examine how quickly prices revert to their country-pair-specific mean real exchange rate after a shock. Fast mean reversion here implies that prices are not sticky — however it does not prove reversion to the law of one price (LOP), not even in the long run.

We first regress the real exchange rate $r_t^{i,c}$ on country dummies. Almost all dummies are highly significant. We therefore reject absolute price convergence for European car prices, just as Crucini and Shintani (2008) do for consumer goods among cities across the world. Clearly, the EU Internal Market is not sufficient in the case of passenger cars: the LOP is grossly violated within Europe. We examine the causes of this unsettling finding in detail in the next section by decomposing these country fixed effects.

[Table 2 about here.]

But before getting to the permanent LOP violations, let us examine the transitory violations first. Using the residuals $\hat{r}_t^{i,c}$, i.e. $r_t^{i,c}$ net of the country mean, we model the autoregressive property of the real exchange rate by

$$\hat{r}_t^{i,c} = \rho_1 \hat{r}_{t-1}^{i,c} + \rho_2 \hat{r}_{t-1}^{EUR,i,c} + \alpha^{i,c} + \beta x_t^{b(i)} + \gamma_t + \varepsilon_t^{i,c} + \kappa \varepsilon_{t-1}^{i,c}, \tag{3}$$

where γ_t are time fixed effects and $\varepsilon_t^{i,c} \overset{iid}{\sim} (0, \sigma_\varepsilon^2)$. If a country is member of the Euro Area at time t, then $\hat{r}_t^{EUR,i,c} = \hat{r}_t^{i,c}$, and $\hat{r}_t^{EUR,i,c} = 0$ otherwise. We estimate this dynamic panel by one-step GMM using the Arellano-Bover system estimator (Arellano and Bover, 1995; Blundell and Bond, 1998). In choosing the set of instruments we treat the lag of brand interest[13] as predetermined, and the VAT rate as exogenous. Weak evidence of MA(1) idiosyncratic errors makes us exclude variables lagged by less than three periods from the set of instruments in the semi-annual specifications.

Table 2 reports the results for the real exchange rate vis-à-vis the Netherlands. The annualized AR coefficients are quite small. The annualized AR coefficient ranges in the single variable specifications (1), (2) and (5) from 0.31 to about 0.64.[14] Deviations of real exchange rates from their country-specific mean are not very persistent — the implied half-time is far less than two years.

These autoregressive coefficients are slightly smaller than the ones that Goldberg and Verboven (2005) find for a subset of five countries over the period 1970–2000 for the base countries Belgium and Germany, and very close to the ones that Goldberg and Verboven (2004) find among 15 EU countries over the period 1993–2000 for the base country Netherlands. It might well be that European integration since the late 1990s sped up the – already very quick – mean convergence within the EU.

Specification (4) gives no evidence that price differentials vis-à-vis the Netherlands of Euro Area members are more persistent than those of other EU members. When including recent surveys in specification (6), we see that the price of models of a given brand in a given country strongly increases with the Internet search intensity for that brand in that country.

We conclude from this analysis that car prices are not sticky at all. Whenever there is demand-side pressure on price differences, car manufacturers appear to react promptly.[15]

In this sense the transitory behavior of real exchange rates within Europe is not the locus of price differentiation. Instead, market integration seems to be hampered by border effects, which – as in most studies – are left in this section as an unexplained fixed effect. As we saw in Section 2.2, price dispersion within Europe does not show any sign of shrinking. In the next section we therefore turn our attention to these country effects, and in particular, why they do not disappear in spite of voluminous harmonization and competition regulation by the EC.

3 Determinants of Prices and Real Exchange Rates

We start this section by describing our method of identifying the impact of bundling on car prices. After that, we examine the determinants of prices and of the real exchange rate within Europe.

3.1 Empirical Approach

Besides carving out differences in the pricing of car properties and general brand valuation across countries, we want to examine how differences in the option bundle across countries affect the price. Our data set provides a unique opportunity to do this. We have data on the availability and pricing of the following options: whether the model is sold with or without air conditioning (AC), automatic gearbox, ABS brakes, power steering, or an airbag; and whether the steering is on the right or left. Recall that $P_t^{i,c}$ and $r_t^{i,c}$ are already feature-adjusted using this information: they include all available options. Whereas the models we compare are therefore identical in terms of what the customer gets, they differ in how they are offered. For some country-model pairs, AC is part of the standard option bundle (and cannot be deselected). For others, it has to be actively selected for an extra charge, and the customer could also buy the car without AC.

We therefore include in all regressions dummy variables that reflect the offered option bundle. The dummies indicate whether a given option (AC, ABS, airbag) is included as standard in the car's list price. These regressors allow us to measure the effect of including an option as standard – alone, separate from the actual price of this option. The option dummies measure an effect that is solely based on a change in the menu of alternative offers, potentially combined with a change in presentation or positioning of the car in the market.

3.2 Prices

Which factors determine the price of a car model in Europe? To answer this question, we examine the relevance of model, brand and country properties for the pre-tax, feature-adjusted price, $P_t^{i,c}$ with the regression:

$$P_t^{i,c} = \alpha_t + \beta_1^i + \beta_2^c + \beta_3^{b(i)} + \gamma_1^c x_t^c + \gamma_2^c y_t^i + \gamma_3^c z_t^{i,c} + \varepsilon_t^{i,c}. \tag{4}$$

Our interest focuses on the model-specific variables y_t^i and $z_t^{i,c}$. The first group of regressors, y_t^i, is comprised first and foremost of the car's mechanical properties: engine size, engine power, fuel type, gearbox type, emissions (CO_2, HC, NO_x), the model's published emissions rating, as well as its measured fuel consumption.[16] The second group of regressors, $z_t^{i,c}$, includes dummy variables indicating whether a given option is included as standard in the car's price, as discussed in Section 3.1. Both groups of model-specific regressors contain several controls, such as warranty coverage and the availability of dealer services (roadside assistance, delivery).[17] We also include the model's effective registration tax, which of course varies by country, as well as its market segment as defined in footnote 10.

We account for variation at the country level by including population, GDP per capita, distance from the car's assembly plant (if in Europe, otherwise distance from port of entry), the rate of VAT, and the amount of tax on gasoline and diesel fuel as controls x_t^c. In the fixed effects specification we include model fixed effects and time dummies. In the random effects specifications we include time, country, and brand dummies.

[Table 3 about here.]

Table 3 presents the results of four variants of regression (4). The fixed effects regression in column 1 already uncovers some expected and some surprising features of the data. As one would expect, more powerful cars and cars with a larger engine are more expensive. In contrast, higher emissions of HC and NO_x and a higher fuel consumption depress, ceteris paribus, the price. The inclusion of options as standard entails a “bundle discount”. An extended warranty has no significant impact on price, all else equal. The role of CO_2 emissions is somewhat surprising. Since in many countries CO_2 emissions are taxable, one might expect a reduction in price. Our regressions show, however, that another effect dominates. Cars with high CO_2 emissions are often cars that target drivers which value “sportive” acceleration more than CO_2- and tax-efficient engine settings. CO_2 emissions seem to proxy for this, and thus increase, ceteris paribus, the price.

Turning to the country controls, in the lower part of the table we see that countries with higher GDP per capita pay higher prices for the same car. Distance from the nearest assembly location does not play a big role for prices in the European car market, implying a small role for distribution costs in price determination, at least those costs that are correlated with geographical distance. The effect of tax rates is not straightforward. The model-specific registration tax tends to lower the car price, in line with monopolistic price setting, but only insignificantly. Instead general taxes, not specific to a car model, such as fuel tax and VAT, increase the price. A possible explanation of this effect might be that in high-tax countries cars, especially inefficient cars, are to some extent a positional good (Veblen good). A deeper look (see Appendix C.3) uncovers that the positive relationship indeed stems mostly from the segments D, E and G, i.e. cars that might serve as status symbol.

Columns 2 and 3 of Table 3 present the results of the random effects specifications. Column 2 includes model-specific regressors that are constant over time, and column 3 includes additionally country-specific cubic time trends.[18] Neither the sign and significance of individual coefficients nor the overall explanatory power are greatly affected by the switch to random effects. We continue with random effects, for reasons that will become apparent in the next subsection, namely, that we would like to allow interactions among observed and unobserved effects. The random effects specification allows us to extract the effect of car features that do not vary over time.

[Table 4 about here.]

We report the brand effects of column 3 separately in Table 4, ordered by size. The ordering is strikingly intuitive. For a car with identical features and options, the price of a Mercedes is more than €10000 higher than the price of a Suzuki. High-volume producers such as Toyota and Volkswagen command almost identical prices, all else equal. Comparing columns 2 and 3 also shows that all of the population and GDP dynamics can be picked up by country-specific cubic time trends.

As for mechanical properties, an automatic gearbox and a better euronorm classification are associated with a higher price on average. The coefficients on market segments show a steady increase in average price for larger, more upmarket models, as we would expect.

Overall, random effects and fixed effects models give the same results. Importantly for our purposes, the coefficients for the included options are consistently negative and strongly significant. They show evidence of a "bundle discount", that is, the price of a car with an optional feature will be lower if that feature is offered as part of the standard bundle of features. These effects turn out to be very useful for the purpose of price discrimination, as we show in the next section.

[Figure 5 about here.]

In order to explore country heterogeneity at more detail we expand the specification of column 3 in Table 3 further by interacting all variables (except the country-related ones) with country dummies. Particularly interesting is the variation of segment effects across countries. Figure 5 confirms that throughout Europe the rule "The higher the segment, the higher the price premium." holds. In all European countries the premium increases monotonically from the mini car segment (A), via small, medium, large (D), and executive, to luxury cars (F).

Multipurpose cars are approximately at the executive car price level, which is the reason for category E not being visible in Figure 5 for some countries. The prices of the Segments A to D are very close. In contrast, luxury cars constitute a completely different price segment. In Finland, luxury cars appear to face the most elastic demand within Europe. Most importantly, there is considerable heterogeneity in terms of segment price dispersion. For example, the price difference between the adjacent segments executive and large cars in Denmark is larger than the price difference between executive and mini cars in the UK – i.e. between cars four segments apart.

The variation across countries highlighted in Figure 5 for the case of segments is actually quite typical. Coefficients on most car features vary considerably between countries in the expanded specification. This implies that pricing-to-market efforts on the part of manufacturers can be traced to particular car features. Next, we examine model-specific real exchange rates directly.

3.3 Real Exchange Rates

Our main regression is designed to distinguish among car properties or features which contribute significantly to price differences across countries, and those which do not. To that end, we regress the real exchange rate, $r_t^{i,c}$, on several groups of variables, which are similar to the groups of variables referenced in the price regression, but not exactly the same.

$$r_t^{i,c} = \alpha_1^i + \alpha_2^c + \beta_1^c x^{b(i),c} + \beta_2^c x_t^i + \beta_3^c y_t^{i,c} + \beta_4^c z_t^c + \gamma_t + \varepsilon_t^{i,c} \tag{5}$$

Our main interest now lies with the variables grouped under $y_t^{i,c}$. This group of regressors includes dummy variables indicating the mode of sale of the car's features: AC, ABS, etc. We define four dummy variables to cover all possible combinations: for each model in any given survey, either the feature is standard in both countries, or it is standard in the

Netherlands (NL) but optional in the other country (OC), or it is standard in the other country but optional in the Netherlands, or it is optional in both countries. We then omit the dummy variable for the combination which is most common in the data – usually, that the feature is included as standard in both countries. In our preferred specifications, we interact these variables with country dummies. We also include in our regressions interaction terms for "home bias": for example, Peugeot cars historically developed and were produced in France, and may command a certain loyalty among French car buyers, quite separate from the actual assembly location.[19] Our country-level group of regressors z_t^c includes the same variables as before, but now these are defined relative to the Netherlands, our preferred base country. For example, the VAT variable now measures the difference, averaging over all observations, between the VAT of the country where the model is sold, and the VAT effective in the Netherlands at that period in time. Our model-level group of variables x_t^i are the car's mechanical properties, defined as before, and the car's segment. We include as well our measure of brand centrality $x^{b(i),c}$, which is a country-brand measure of demand. The more central a particular brand is in a given country relative to the Netherlands, the more competition it faces there, again relative to the Netherlands, and therefore it enjoys less monopoly power. We control throughout for differences between the Netherlands and other countries in warranty coverage, roadside assistance service, and cost of delivery. Our random effects regressions include country, brand, and time dummies.

[Table 5 about here.]

Table 5 presents the regression results for the model-specific real exchange rates. Columns 1 and 2 show a specification analogous to columns 1 and 2 of the price regression in Table 3, with fixed effects or random effects included, respectively. The specification now differs in that the object of interest here is not the price per se, rather the price relative to the price of an identical model sold in the Netherlands in the same time period. Wherever appropriate, the regressors are therefore defined as differences between any given country and the Netherlands. As in the price regression, we see that the coefficients do not change much between the fixed effects and random effects specifications. We prefer the random effects specification because it allows us to observe the effects of particular variables by country and by brand, as we do in the regressions shown in columns 4 and 5. The regression shown in column 3 includes some more controls relative to column 2, but no interactions. Looking across columns, we see that most coefficients are stable in sign and significance.

We now turn to the variables indicating the combinations of standard vs. optional inclusion of features. For each feature – AC, ABS, and airbag (power steering is very rarely priced separately in our data) – the default is always the same, namely that the feature is included as standard in the Netherlands as well as in the country in question. The coefficients shown in columns 1 to 3 of the table then are the average effect across countries of choosing a different combination than the default. We see that models where AC is optional in both countries are not significantly different than the default models where AC is included as standard in both countries. However models where AC is optional only in the Netherlands are almost 8% more expensive in the Netherlands on average relative to the default (column 3), whereas models where AC is included only in the Netherlands are almost 8% less expensive in the Netherlands on average, again relative to the default. We interpret these results in the following way: cars are not significantly differently priced in European countries relative to the Netherlands if they are sold in the same way in both countries, i.e. either with AC included as standard in both countries or AC priced separately in both countries. However, cars are priced differently when they are sold in different ways, even though, recall, the cars are mechanically identical. In the next section we present a simple model which can account for this observation. For now, note that the effect is practically the same, whether the country where AC is included is our base country, the Netherlands, or some other European country.

The coefficients for ABS show a very similar pattern: there is no significant difference in prices whether ABS is included as standard in both countries (the default) or priced separately in both countries. However, if included as standard in the Netherlands only, it becomes about 4% less expensive in the Netherlands on average, again relative to the default (column 3). Models where ABS is optional in the Netherlands only are about 4% more expensive in the Netherlands on average. The coefficients for airbag tell a different story. Note first that the combination for models where an airbag is included in the other country but optional in the Netherlands is missing. That is because this set is empty in our data. The opposite case, where an airbag is included in the Netherlands only, is never significantly different from the default where an airbag is included as standard in both countries. However the combination where an airbag is priced separately in both countries is associated with an almost 8% difference in price, relative to the default. It appears that in other countries, whether an airbag is included as standard or not does not matter much on average for pricing purposes, however in the Netherlands it does.

We see, as we would expect from the results already presented, that model-specific real exchange rates are significantly affected by country-level variables, even after the inclusion of country, brand, and time dummies. In other words, price differentiation across country borders can be associated with a number of country-level variables, whose signs and statistical significance are quite stable across specifications. The coefficient signs are broadly the same as in the price regressions: for example, an increase of a country's population by one million, keeping the Netherlands' population constant, reduces the real exchange rate by about 0.5% in the column 4 regression. We interpret this number as the cross-country average effect of population increases over time. Similarly, we see a positive effect on the real exchange rate of a higher per capita GDP (PPP adjusted), a higher VAT rate, a higher petrol tax, and a higher diesel tax, regardless of whether or not the model in question has a diesel engine. Again we interpret these effects as the cross-country average effect of changes over time. In contrast, the effective registration tax is always insignificant, implying that the effects of varying registration taxes across countries are completely absorbed by the country dummies. Lastly, the minimum distance variable, measuring for each model the distance to the nearest assembly location for the country in question relative to that distance for the Netherlands, is consistently negative: an increase of 1,000 km leads to a drop of less than 1% in the real exchange rate. Because distances are by definition constant, except in the relatively rare case when the assembly location of a model changes, our interpretation is that within brands, models which are assembled further away, relative to the distance from the Netherlands, are in fact slightly cheaper on average, all else equal.

In column 5 we interact all of these variables with the brand dummies. This raises the explanatory power of the regression, implying that brand- and country-level effects are important in determining the real exchange rate. In other words, cross-country price differentiation, which can be attributed to the country-level variables we observe, seems to vary by manufacturer.[20] The controls for home demand effects reveal that in some countries, real exchange rates for their "home" brands are indeed significantly different from real exchange rates for the same brands sold in other European countries. For example, French brands sold in France are on average more expensive than French brands sold outside of France.

[Table 6 about here.]

We now turn to the country-specific coefficients from the regression in column 5 of Table 5. They are shown in Table 6. The table shows the effects of three variations in the way cars are sold across Europe on relative prices. Column 1 (AC excl.) presents the average change in real exchange rates, by country, when models are sold with AC optional in both countries, relative to the default where models are sold with AC included as standard in both countries. Column 2 (AC NL only) presents the effect, by country, on the real exchange rate when models are sold with AC optional only in the Netherlands (i.e. sold with AC included as standard in the country in question), again relative to the default. Column 3 (AC OC only) presents the opposite case, the effect on the real exchange rate when models are sold with AC included only in the Netherlands (i.e. sold with AC optional in the other country in question), again relative to the default. The coefficients shown in column 2 are mostly positive and significant, but vary quite a bit across countries. The coefficients in column 3 are mostly negative and significant, reflecting a bundling discount in the Netherlands of varying size.

The coefficients in column 1 are insignificant for most countries, but where they are significant they reveal an important heterogeneity of preferences across countries: they uncover where the existence of a bundle — AC being included as standard as opposed to being sold separately — changes the perceived value of the car. In Italy, for example, we interpret the coefficient as follows: a car without AC included as standard is considered "cheap" by Italian customers, relative to Dutch customers, and as a result the bundling discount in Italy is smaller than the one in the Netherlands. In the UK cars offered in this way do not suffer from this stigma, resulting in a positive coefficient in column 1. Offering AC as optional instead of including it as standard equipment allows car manufacturers to sustain an additional price difference of more than 8% between Italy and the UK.[21]

In column 1 the same bundle is offered in both countries of interest. Market differentiation can exploit yet another dimension, however. The same car might be offered in bundles differing by country. In columns 2 and 3 of Table 6 we explore this possibility. We see that, for example, a car (with AC!) sold in Belgium with AC optional is on average more than 11% more expensive than the same car sold in the Netherlands with AC included as standard. In the opposite case, a car sold in Belgium with AC included as standard is about 8% less expensive on average than the same car (with AC!) sold in the Netherlands with AC optional. Clearly customers in countries where AC is offered as standard receive a discount relative to customers who buy the same car in countries where it is priced separately, and moreover this discount varies considerably across countries. This pattern repeats itself across countries, as we can see in the table, with the vast majority of countries showing signicant coefficients of same sign.

We offer a simple explanation for these empirical observations, formalized in a simple model, in the next section.

4 A Model of Price Discrimination Within and Across Borders

In this section we explore when the bundling choices of car manufacturers uncovered in the previous section are optimal. That is, we derive conditions under which manufacturer optimally offer a menu of optional features in some countries but only a pre-installed set of features in other countries.

In the model, car customers in some countries disagree more than in other countries as to the value of a certain car feature, for example installed air conditioning (AC). In countries where some customers' willingness to pay for this particular feature is high, the manufacturer may charge a large sum for the option, ensuring that only the high-value customers will choose to buy the car with AC installed, while the low-value customers will buy the car without AC. This is optimal if the gains from charging the high-value customers for the option outweigh the loss of revenue incurred by not selling the option to the low-value customers. In these countries, offering AC as standard would not be optimal because it would force the manufacturer to sell the car at the same price to both groups of customers, essentially leaving the high-value customers with a large consumer surplus. In other countries, however, the difference among customers with regards to the willingness to pay for AC might not be as large, therefore separating the customers in the way described might reduce profits instead of raising them. The manufacturer will then offer AC as standard in those countries, but at a lower price since it has to appeal to the entire customer base, rather than to the high-value customers only. Clearly this scheme is limited by the ability of customers to purchase across borders.

Consider a monopolistic car manufacturer selling a particular car in two countries, F and B. Assume that consumer types can be defined by the vector (θ, γ, c), where θ is the willingness to pay for the car, γ the willingness to pay for a feature option installed in the car by the manufacturer (say, air conditioning), and c the cost to the consumer of purchasing the car in another country. Consumers in both countries are divided in two groups:

1. Type 1 consumers, with $(\theta, \overline{\gamma}_X, c)$, of whom there are $\overline{N}_X$ in country $X \in \{F, B\}$.

2. Type 2 consumers, with $(\theta, \underline{\gamma}_X, c)$, of whom there are $\underline{N}_X$ in country $X \in \{F, B\}$.

Assume that $\overline{\gamma}_X > \underline{\gamma}_X$ for any country X. For simplicity we assume that the cost of producing the car with or without the option is zero. Therefore the monopolist will want to sell as many cars as possible. The monopolist will always prefer to sell the car with the option installed, because he can ask for a higher price without increasing costs. However he may choose to sell it to some customers without the option if in so doing he can sell it to other customers with the option installed at a higher price, thereby increasing his profits. We will assume throughout that consumers will choose to buy the car if indifferent, and further that when indifferent between two versions of the car, they will choose the car with the option installed. Also assume without loss of generality that $\underline{\gamma}_F > \underline{\gamma}_B$, so that Type 2 consumers in Country F place a higher value on the option.

The monopolist can choose among the following pricing and selling schemes:

Scheme I — Sell in both countries only **with** the installed option, at price $p_F^{WITH} = \theta + \underline{\gamma}_F - \varepsilon_F^I$ in country F, and at price $p_B^{WITH} = \theta + \underline{\gamma}_B$ in country B. All consumers buy under our assumptions. The country-specific discount ε_F^I is chosen by the monopolist to dissuade consumers from buying in another country at a lower price. Consumers in country F buy the car in their own country if the discount ε_F^I satisfies

$$\underline{\gamma}_F - \underline{\gamma}_B + c \geq \varepsilon_F^I \geq max(\underline{\gamma}_F - \underline{\gamma}_B - c, 0). \tag{6}$$

The expression $\underline{\gamma}_F - \underline{\gamma}_B - c$ need not be large, indeed it could well be negative, implying that ε_F^I may be quite small. Assuming the monopolist chooses ε_F^I such that the above condition holds, its profit is[22]

$$\Pi_I = (\overline{N}_F + \underline{N}_F)(\theta + \underline{\gamma}_F - \varepsilon_F^I) + (\overline{N}_B + \underline{N}_B)(\theta + \underline{\gamma}_B). \tag{7}$$

Scheme II — Sell the car in both countries **with** and **without** the option, at the following prices: $p_F^{WITH} = \theta + \overline{\gamma}_F - \varepsilon_F^{II}$, $p_B^{WITH} = \theta + \overline{\gamma}_B$, $p_F^{WITHOUT} = p_B^{WITHOUT} = \theta$. Here the monopolist is able to increase his profit from type 1 consumers in both countries (assuming again that ε_F is chosen appropriately, i.e.

$$\varepsilon_F^{II} \geq max(\overline{\gamma}_F - \overline{\gamma}_B - c, 0) \tag{8}$$

to dissuade cross-border purchases), but can only sell the car to type 2 consumers without the installed option, thereby losing some profits as well. The profits are therefore

$$\Pi_{II} = (\underline{N}_F + \underline{N}_B)\theta + \overline{N}_F(\theta + \overline{\gamma}_F - \varepsilon_F^{II}) + \overline{N}_B(\theta + \overline{\gamma}_B). \tag{9}$$

Scheme III — Sell the car in country F only with the option, but sell both versions in country B. Prices will be: $p_F^{WITH} = \theta + \underline{\gamma}_F$, $p_B^{WITH} = \theta + \overline{\gamma}_B - \varepsilon_B$, $p_B^{WITHOUT} = \theta$. Here the monopolist essentially forces type 2 consumers in country B to buy the car without the option installed (same result as in Scheme II), but type 2 consumers in country F now buy the car with the option (same result as in Scheme I). Type 1 consumers in country B are given a discount ε_B which satisfies

$$\varepsilon_B \geq max(\overline{\gamma}_B - \underline{\gamma}_F - c, 0) \tag{10}$$

to dissuade them from cross-border purchases. Profits are now be given by

$$\Pi_{III} = \underline{N}_B \theta + \overline{N}_B(\theta + \overline{\gamma}_B - \varepsilon_B) + (\overline{N}_F + \underline{N}_F)(\theta + \underline{\gamma}_F). \tag{11}$$

We now examine under which conditions Scheme III is optimal. To keep notation at a minimum we assume in the following $\overline{\gamma}_F > \overline{\gamma}_B > \underline{\gamma}_F > \underline{\gamma}_B$ and examine two polar scenarios: first a scenario where markets are naturally separated, and then a scenario where arbitrage opportunities abound.

Separated Markets — Suppose that markets are separated by a sufficiently high border cost, i.e. $\overline{\gamma}_F - \underline{\gamma}_B \leq c$, so that arbitrage is not possible and thus $\varepsilon_F^I = \varepsilon_F^{II} = \varepsilon_B = 0$.

Scheme III is preferable to Scheme II if the profits gained from selling the option to type 2 customers in country F are larger than the profits lost by selling the option at a lower price to type 1 customers in country F. That is, if

$$\underline{N}_F \underline{\gamma}_F > \overline{N}_F(\overline{\gamma}_F - \underline{\gamma}_F). \tag{12}$$

Scheme III is preferable to Scheme I if the profits gained from selling the option to type 1 customers in country B at a higher price are larger than the profits lost by not selling the option to type 2 customers in country B. That is, if

$$\overline{N}_B(\overline{\gamma}_B - \underline{\gamma}_B) > \underline{N}_B \underline{\gamma}_B. \tag{13}$$

Therefore, we would expect to observe Scheme III if countries are very different in:

- the relative size of customer segments, in our scenario $\underline{N}_F >> \overline{N}_F$ and $\underline{N}_B << \overline{N}_B$,

- the heterogeneity of their customers, in our scenario $\overline{\gamma}_F - \underline{\gamma}_F$ small, $\overline{\gamma}_B - \underline{\gamma}_B$ large, and
- the valuation for the option by the lower segment, in our scenario $\underline{\gamma}_F$ large, $\underline{\gamma}_B$ small.

This is in particular satisfied in the extreme case $\overline{\gamma}_F = \overline{\gamma}_B = \underline{\gamma}_F = \underline{\gamma}_B + c$.

Open Markets — Suppose now that $\overline{\gamma}_F - \overline{\gamma}_B > c$, $\overline{\gamma}_B - \underline{\gamma}_F > c$, and $\underline{\gamma}_F - \underline{\gamma}_B > c$, so that arbitrage constrains the sustainable prices.

In this case the monopolist chooses in each scenario the minimum discount such that the inequality constraints (6), (8), and (10) bind. Therefore the profit in Scheme I given by Equation (7) becomes

$$\Pi_I = N(\theta + \underline{\gamma}_B) + (\overline{N}_F + \underline{N}_F)c.$$

Profit in Scheme II (Equation 9) becomes

$$\Pi_{II} = N\theta + (\overline{N}_F + \overline{N}_B)\overline{\gamma}_B + \overline{N}_F c,$$

and in Scheme III (Equation 11) it is now

$$\Pi_{III} = N\theta + (\overline{N}_F + \overline{N}_B + \underline{N}_F)\underline{\gamma}_F + \overline{N}_B c.$$

Comparing again schemes, we find that Scheme III is preferable to Scheme II if

$$\underline{N}_F \underline{\gamma}_F > \overline{N}_F(\overline{\gamma}_B - \underline{\gamma}_F + c) + \overline{N}_B(\overline{\gamma}_B - \underline{\gamma}_F - c).$$

Compared to (12) two things change: first, the sustainable price differences become smaller, and second, the spillover to the other market shows up in the last term. Analogously, Scheme

III is preferable to Scheme I if

$$\overline{N}_B(\underline{\gamma}_F - \underline{\gamma}_B + c) + (\overline{N}_F + \underline{N}_F)\left(\underline{\gamma}_F - \underline{\gamma}_B - c\right) > \underline{N}_B\underline{\gamma}_B.$$

Combining these two inequalities we get

$$\begin{aligned} & \overline{N}_B(c - \underline{\gamma}_B) - \overline{N}_F(c + \underline{\gamma}_B) + \underline{N}_F\underline{\gamma}_F \\ > \quad & max[-(\overline{N}_F + \overline{N}_B)\overline{\gamma}_F; (\underline{N}_F + \underline{N}_B)\underline{\gamma}_B + \underline{N}_F c - (\overline{N}_F - \overline{N}_B)\underline{\gamma}_F] \end{aligned}$$

We get similar conditions: we would expect to observe Scheme III if the difference between high and low valuations is relatively small in country F and relatively large in country B, and/or if the low valuation in country F is high relative to that of country B, and/or if the ratio of type 1 to type 2 consumers in country F is small relative to the ratio in country B.

The results in Table 6 suggest that substantial price differences can be sustained using strategies based on these differences.

5 Conclusion

With this paper we expand our understanding of international price differences on three fronts:

First, we construct a rich data set of car prices in Europe which allows for true apples-to-apples price comparisons. We show that pricing-to-market (PTM) is pervasive in the European car market. Model-specific real exchange rates vary significantly both across and within countries.

Second, we show that, whereas reversion to a country-specific mean is fast, there is little evidence of absolute price convergence. The European Commission (EC) recently revised the block exemption regulation governing the European car market, based on the notion that car prices within Europe have converged (European Commission, 2008). Using official EC data, we find only very limited evidence for this. It might be that the claimed convergence is a result of convergence in the car *specifications* reported to the EC over the years of the survey. When controlling for car features and correcting obviously erroneous data the convergence disappears. PTM of passenger cars in Europe is very much an ongoing phenomenon, as of the year 2011.

Third, and perhaps most importantly, our results clearly show that car features are priced very differently throughout Europe. Manufacturers appear to build on differences in consumer preferences and consumer composition among European countries to tailor car-feature bundles to each market. This versioning of car models across Europe seems to go some way towards negating the effects of market integration in bringing prices closer together. In particular, we identify car features which are a likely basis for active price differentiation by manufacturers. These include air conditioning and ABS. Differences in bundling of these features across countries are associated with changes in relative prices of 10% and more for many countries.

In this paper we use no data on quantities of cars sold or registered. While not necessary for the analysis of cross-country price differences, such data might give additional insights into the determinants of manufacturer market power and their pricing strategy. We plan to explore this in a future paper.

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Notes

[1]We discuss recent regulatory developments in the EU car market in detail in Appendix B.

[2]Conditional convergence, measured by the half-life of deviations from a country-specific mean, is however clearly present in the data. See Section 2.3.

[3]See Section 2.1 for the definition of this measure.

[4]The contemporaneous paper by Gaulier and Haller (2000) uses the same EC data set for the period 1993-1999 only to construct aggregate price indices. Doing so, most of the panel information is lost. They document lower pre-tax prices in high tax countries, as do Kirman and Schueller (1990).

[5]Recently, Gil-Pareja and Sosvilla-Rivero (2012) select 45 models and 15 countries from an updated EC data set. Applying various panel unit roots test to the 1993–2008 data gives them only weak evidence of price convergence.

[6]For French exporters, however, Mèjean and Schwellnus (2009) find considerable convergence of export prices across EU export destinations between 1995 and 2004. An explanation for this is that lower trade barriers attracted smaller firms with no means of implementing PTM to enter the export market.

[7]Online distribution of new cars is still extremely uncommon. For example, online car brokers started entering the German market in 2005, but as of 2011 their market share remained negligible (Dudenhöffer and Neuberger, 2011).

[8]Dealership discounts in Europe for newly built-to-order cars are small and rarely exceed 10%. Degryse and Verboven (2000) arrive at discounts of a similar magnitude based on undercover shoppers and manufacturer responses. They conclude that "the average discounts do not differ substantially across countries," and thus have a negligible effect on real exchange rates.

[9]See Table 7 in Appendix C.1. Our choice is the same as the one of Goldberg and Verboven (2004, p.503). For comparison with a large country we also present some results with Germany as the base country.

[10]The EC assigns each model to one of the following segments: *mini cars* (segment A), *small cars* (B), *medium cars* (C), *large cars* (D), *executive cars* (E), *luxury cars* (F), and *multi-purpose and sports utility cars* (G).

[11]We construct this variable using country- and brand-level Google search data. It measured the extent to which a given brand is perceived, by consumers in a given country, to be similar to other brands. See Appendix A.1.5 for details.

[12]To conserve space we do not include tables of summary statistics by country and model in the paper. They are available upon request.

[13]We define this variable as consumer interest as expressed in Google searches for a given brand in a given country. See Appendix A.1.5 for more details.

[14]With Germany as base country the autoregressive coefficient ranges from 0.26 to 0.48. See to Appendix Table 8.

[15]Our data set is a short panel with a frequency change, and thus our estimates of an autoregressive coefficient should be taken with caution. Car prices change only infrequently, and are thus may not the best object for studying price stickiness.

[16]Since the gearbox type affects the car's other technical specifications, in particular emissions and fuel consumption, we consider it a mechanical property and not a feature. An automatic Ford Fusion and a manual Ford Fusion are thus treated as separate models.

[17]By the EU consumer directive, manufacturers must offer at least a two-year EU-wide standard warranty regardless of where the car was purchased. However they are free to offer more, as well as extend the number of kilometers a car may accumulate before the warranty expires, and might take advantage of that to price-differentiate across countries. Similarly, roadside assistance services can conceivably be offered with geographic restrictions, and delivery charges may pertain only to dealerships within a certain country or group of countries. These factors could theoretically explain part of the log-difference in price; fortunately, we can control for them in our regressions.

[18]The country-specific time trends are not reported in the table, but discussed in Appendix C.4.

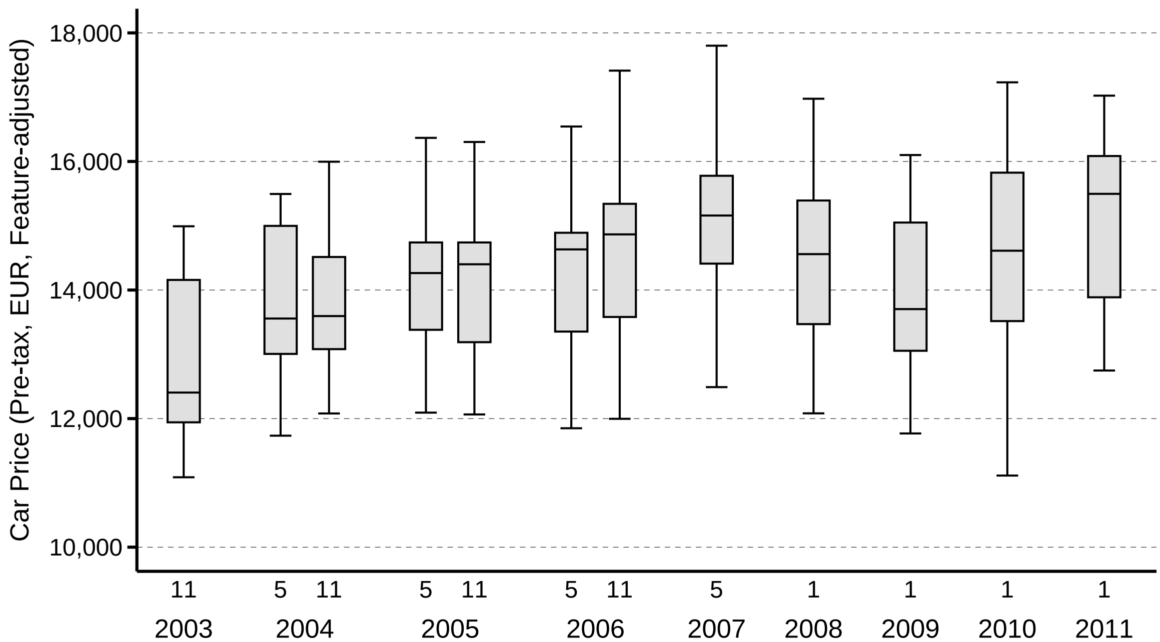
[19]See Appendix A.1.6.

[20]Brand-specific coefficients are too numerous to include in the paper, but are available from the authors upon request. Columns 3–5 also include various controls at the model and brand level: differences between the Netherlands and the other country in terms of dealer services included in the price (roadside assistance, delivery cost) are controlled for, as are differences in the number of years of warranty between the Netherlands and the other country. The regressions also include all of the mechanical specifications of the model in question, its market segment, as well as the difference in our measure of brand centrality for that model between the Netherlands and the other country.

[21]In Appendices C.6 and C.7 we present results for ABS and airbag.

[22]A variation of Scheme I where the car is sold in Country B at a higher price $p_B^{WITH} = \theta + \overline{\gamma}_B - \varepsilon_B$ with discount $\varepsilon_B \geq \overline{\gamma}_B - \underline{\gamma}_F - c$, is more profitable if $\underline{N}_B \theta > \overline{N}_B(-\underline{\gamma}_F + \overline{\gamma}_B - c)$. It is dominated by selling to all customers (see Scheme III below) if θ, the margin on the car itself, is sufficiently large.

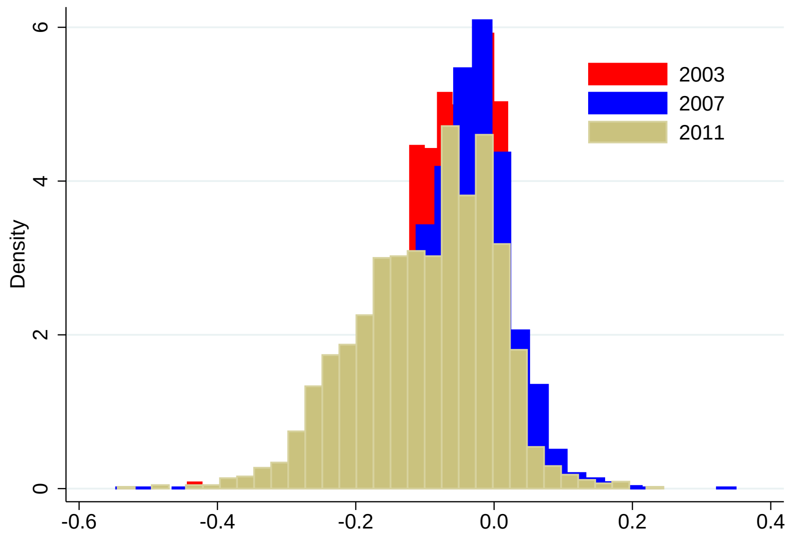
Figure 1: Cross-country Price Dispersion of Ford Focus



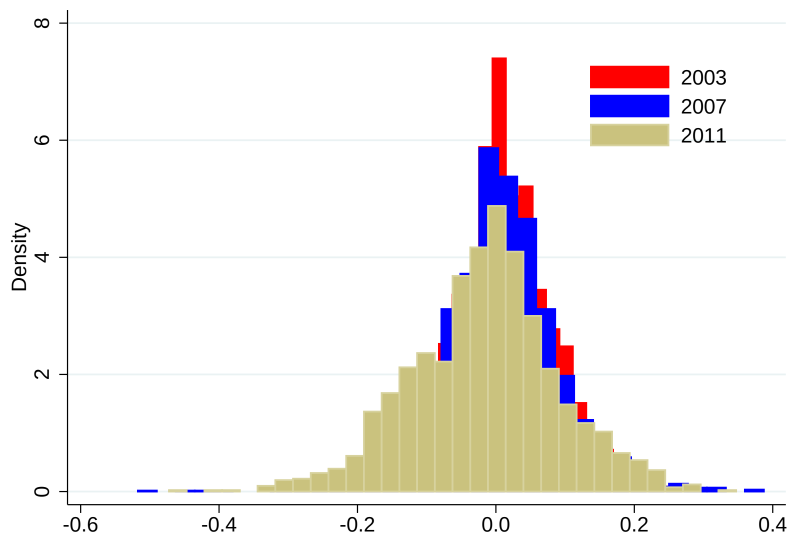
The graph shows the dispersion of feature-adjusted, pre-tax EUR prices of the Ford Focus with manual transmission, $P_t^{Ford\,Focus\,M,c}$, by year across the European countries where it is sold.

Figure 2: Frequency Distribution of Model-Specific Real Exchange Rates

(a) vis-à-vis Germany

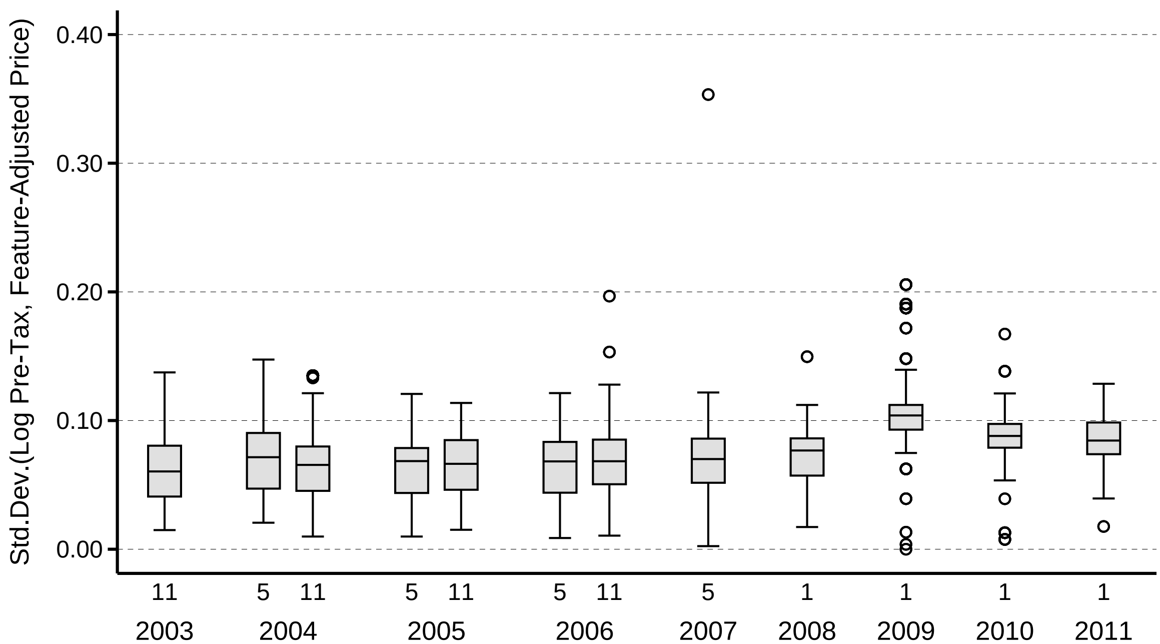


(b) vis-à-vis The Netherlands



The histogram shows the frequency distribution of model-specific real exchange rates, $r^{i,c}_{2003m11}$, $r^{i,c}_{2007m5}$, and $r^{i,c}_{2011m1}$ relative to Germany in the upper panel and relative to the Netherlands in the lower panel. All models, excluding Seat. The real exchange rates are based on log, feature-adjusted, pre-tax prices.

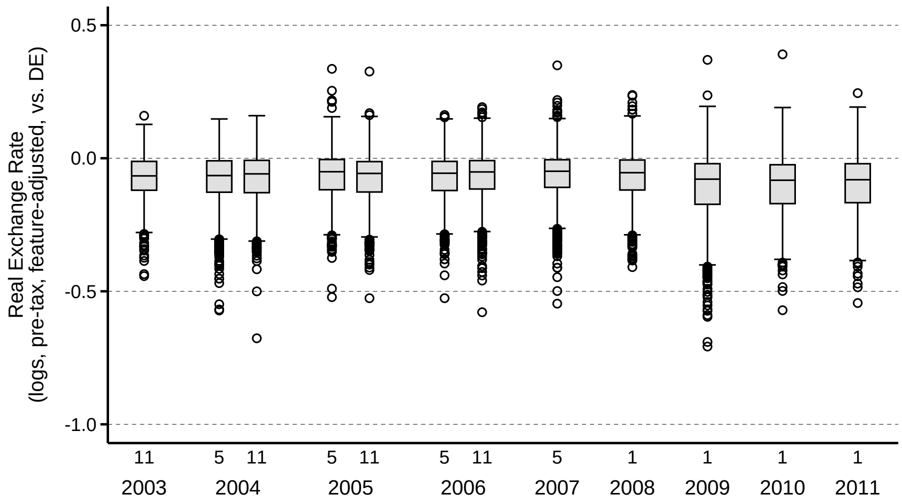
Figure 3: Log Price Dispersion



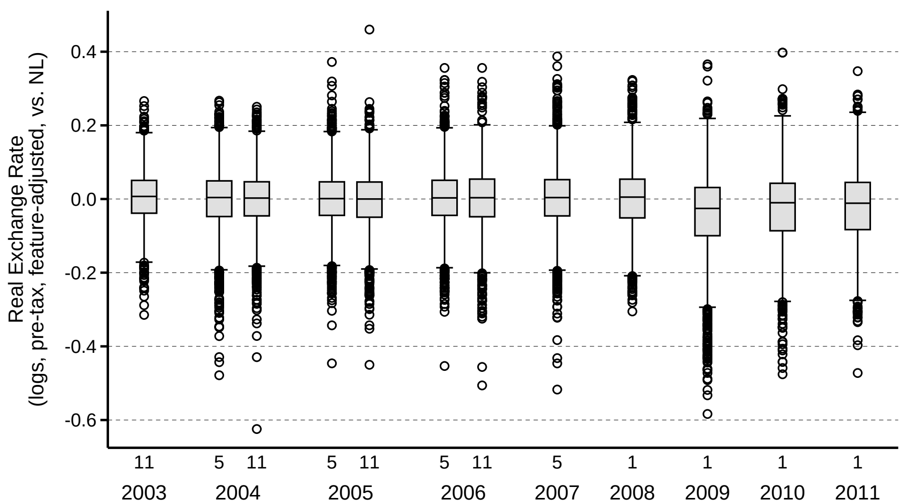
The graph shows the distribution across models of the model-specific cross-country dispersion of prices, Ξ_t^i. All models, excluding Seat. The underlying prices are in natural logs, feature-adjusted, and pre-tax.

Figure 4: Model-Specific Real Exchange Rates

(a) vis-à-vis Germany

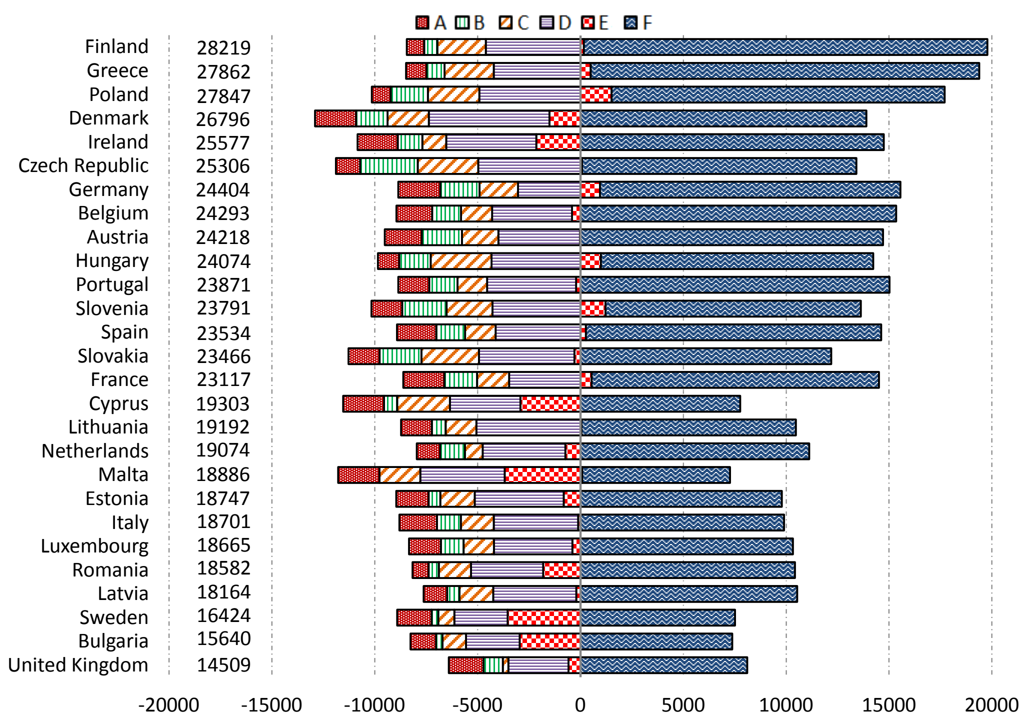


(b) vis-à-vis The Netherlands



The graphs show the evolution of the dispersion of model-specific real exchange rates, $r_t^{i,c}$, relative to Germany in the upper panel and relative to the Netherlands in the lower panel. All models, excluding Seat. The real exchange rates are based on log, feature-adjusted, pre-tax prices.

Figure 5: Segment Effects by Country



The graph shows the segment fixed effects relative to multipurpose cars (segment G) by country, in euros, based on regression (4), specified as described in the text. All models, excluding Seat. The underlying prices are in euros, feature-adjusted, and pre-tax.

Table 1: Time Trends in Price Dispersion

		(1) FE	(2) RE	(3) RE	(4) RE+Cov.	(5) RE	(6) RE	(7) RE+Cov.
Time		0.006^{***}	0.005^{***}	0.005^{***}	0.006^{***}			
(years)		*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*			
Segment	A					0.003^{**}	0.003^{***}	0.004^{**}
x Time						*(0.001)*	*(0.001)*	*(0.001)*
	B					0.004^{***}	0.004^{***}	0.004^{***}
						(0.001)	*(0.001)*	*(0.001)*
	C					0.003^{***}	0.004^{***}	0.004^{***}
						(0.001)	*(0.001)*	*(0.001)*
	D					0.005^{***}	0.006^{***}	0.006^{***}
						(0.001)	*(0.001)*	*(0.001)*
	E					0.010^{***}	0.010^{***}	0.010^{***}
						(0.002)	*(0.002)*	*(0.002)*
	F					0.010^{***}	0.010^{***}	0.010^{***}
						(0.001)	*(0.001)*	*(0.001)*
	G					0.008^{***}	0.008^{***}	0.009^{***}
						(0.001)	*(0.001)*	*(0.002)*
Constant		0.055^{***}	0.073^{***}	0.414^{***}	0.502^{***}	0.082^{***}	0.434^{***}	0.503^{***}
		(0.003)	*(0.010)*	*(0.058)*	*(0.164)*	*(0.012)*	*(0.058)*	*(0.153)*
Segment	B		0.007	0.010^{**}	0.010^{**}	0.005	0.008	0.008
			(0.005)	*(0.005)*	*(0.005)*	*(0.007)*	*(0.006)*	*(0.007)*
	C		0.007^{*}	0.023^{***}	0.022^{***}	0.008	0.023^{***}	0.020^{***}
			(0.004)	*(0.005)*	*(0.005)*	*(0.007)*	*(0.006)*	*(0.007)*
	D		0.006	0.033^{***}	0.031^{***}	0.000	0.026^{***}	0.023^{***}
			(0.004)	*(0.006)*	*(0.007)*	*(0.007)*	*(0.007)*	*(0.008)*
	E		-0.005	0.034^{***}	0.031^{***}	-0.021^{**}	0.017^{**}	0.014
			(0.006)	*(0.008)*	*(0.009)*	*(0.008)*	*(0.009)*	*(0.009)*
	F		-0.008	0.044^{***}	0.032^{***}	-0.028^{***}	0.025^{***}	0.013
			(0.007)	*(0.009)*	*(0.009)*	*(0.008)*	*(0.010)*	*(0.009)*
	G		-0.010^{*}	0.026^{***}	0.026^{***}	-0.024^{***}	0.012^{*}	0.010
			(0.005)	*(0.006)*	*(0.007)*	*(0.008)*	*(0.007)*	*(0.007)*
Brand			0.062^{***}	0.038^{**}	0.039^{**}	0.062^{***}	0.038^{**}	0.038^{*}
Centrality			*(0.017)*	*(0.018)*	*(0.021)*	*(0.018)*	*(0.018)*	*(0.022)*
Euronorm			-0.007^{***}	-0.005^{**}	-0.007^{***}	-0.008^{***}	-0.006^{**}	-0.007^{***}
			(0.003)	*(0.002)*	*(0.002)*	*(0.003)*	*(0.002)*	*(0.002)*
Avg. Pre-Tax				-0.037^{***}	-0.047^{***}		-0.039^{***}	-0.049^{***}
Car Price				*(0.006)*	*(0.016)*		*(0.006)*	*(0.015)*
R^2 within		0.13	0.14	0.15	0.14	0.17	0.18	0.17
R^2 between		0.06	0.20	0.28	0.32	0.21	0.29	0.33
R^2 overall		0.09	0.21	0.30	0.33	0.23	0.32	0.35
# obs.		1310	1307	1307	1307	1307	1307	1307

Dependent variable: Standard deviation across models of model price dispersion based on log, feature-adjusted, pre-tax EUR prices, Ξ_t^i. All models, excluding Seat. Model fixed effects in specification (1), and other model covariates in specification (4) and (7) not reported. Random effects GLS estimation of Equation (2) in specifications (2)–(7). Bootstrap standard errors in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level. Controls in specification (4) and (7) are engine power (kW), engine size (ccm), average and dispersion of effective tax due at registration (%), average and dispersion of VAT (%), average fuel consumption (l/100km), diesel dummy, CO_2 and NO_x emissions (g/km).

Table 2: Autoregressive Properties of the Real Exchange Rate versus the Netherlands

	2003–2007				2003–2011	
Freq. (months)	6				12	
	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{r}_{t-1}$	0.799***	0.556***	0.867***	0.786***	0.320***	0.367***
	(0.063)	*(0.031)*	*(0.060)*	*(0.144)*	*(0.047)*	*(0.055)*
$\hat{r}_{t-1}^{EUR}$				0.036		
				(0.281)		
Brand Interest			-0.001			0.413***
in Country			*(0.014)*			*(0.077)*
Brand Interest			-0.000			-0.357***
in the Netherlands			*(0.010)*			*(0.048)*
# instruments	28	35	46	28	23	37
MA(q) of id. err.	1	0	1	1	0	0
# observations	9952	9952	9806	9952	6352	6321
# groups	3522	3522	3483	3522	3684	3673

Dependent variable: Demeaned real exchange rates $\hat{r}^{i,c}$ given by the residuals of a random effects regression of $r_t^{i,c}$ on country dummies. Arellano-Bover system estimation of Equation (3). All models, excluding Seat. Survey fixed effects are not reported. Arellano-Bond robust standard errors adjusted for clustering on model-country in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

Table 3: Price Regression

	(1) FE	(2) RE	(3) RE + T^3
Engine Capacity	4.15***	6.22***	6.10***
(ccm)	*(0.45)*	*(0.53)*	*(0.51)*
Engine Power	13.48***	41.72***	40.69***
(kW)	*(4.07)*	*(3.87)*	*(3.88)*
CO_2	72.03***	122.51***	117.56***
(g/km)	*(15.06)*	*(15.60)*	*(14.82)*
HC	-14.86***	-7.91***	-8.04***
(mg/km)	*(1.50)*	*(1.60)*	*(1.45)*
NO_x	-3.24***	-1.27**	-1.17**
(mg/km)	*(0.51)*	*(0.52)*	*(0.52)*
Fuel Consumption	-235.03***	-333.38***	-324.02***
(l/1000km)	*(40.80)*	*(40.77)*	*(39.02)*
Warranty	6.69	-26.05	-23.85
(years)	*(44.78)*	*(38.41)*	*(43.32)*
Fuel Type	-253.48	-1009.77***	-998.31***
(1=diesel)	*(350.83)*	*(338.69)*	*(336.40)*
Euronorm		245.13***	246.85***
		(70.45)	*(66.90)*
AGB		1885.79***	1916.64***
(1=yes)		*(122.08)*	*(121.93)*
AC	-765.30***	-557.24***	-535.44***
(1=standard)	*(56.30)*	*(59.78)*	*(55.84)*
ABS	-690.26***	-409.98***	-415.22***
(1=standard)	*(139.60)*	*(128.88)*	*(140.84)*
Airbag	-914.86***	-1233.99***	-1199.09***
(1=standard)	*(145.96)*	*(153.76)*	*(167.44)*
Segment A		-9042.25***	-9255.55***
		(369.12)	*(360.84)*
B		-7571.66***	-7769.02***
		(326.35)	*(313.62)*
C		-6524.69***	-6656.22***
		(264.52)	*(256.76)*
D		-5027.51***	-5095.29***
		(239.30)	*(218.44)*
E		-1052.72***	-1111.81***
		(274.28)	*(261.91)*
F		9704.52***	9894.71***
		(793.58)	*(745.74)*
Population	-106.97*	-101.96*	8.42
(1000s)	*(64.30)*	*(62.02)*	*(121.97)*
GDP p.c.	42.73***	42.48***	-26.78*
(1000 EUR @ PPP)	*(15.02)*	*(14.82)*	*(15.98)*
Distance	32.02	149.69*	104.95
(1000 km)	*(118.43)*	*(86.57)*	*(85.80)*
VAT	125.84***	129.44***	149.27***
(%)	*(20.76)*	*(22.40)*	*(26.33)*
Petrol Tax	107.30***	104.91***	133.34***
(ct/l)	*(9.07)*	*(9.36)*	*(11.02)*
Diesel-Petrol Tax	85.39***	84.02***	60.35***
(ct/l)	*(10.75)*	*(11.15)*	*(12.64)*
Eff. Registration Tax	-6.77	-9.22	-9.29
(%)	*(7.92)*	*(6.17)*	*(7.73)*
R^2 within	0.41	0.37	0.43
R^2 overall	0.98	0.91	0.91

Dependent variable: Feature-adjusted, pre-tax EUR prices, $P_t^{i,c}$. Estimation equation (4). All models, excluding Seat, 23028 observations in 4352 groups. Constant, fixed effects, and time trends are not reported. Bootstrap standard errors in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

Table 4: Brand Effects

Mercedes-Benz	6587***
Saab	5823***
BMW	5726***
Land Rover	4512***
Subaru	2803***
Audi	2655***
Alfa Romeo	2607***
Mini	2100***
Citroen	747***
Renault	357
Toyota	0
Peugeot	-33
Volkswagen	-242
Volvo	-308
Honda	-692***
Opel	-863***
Fiat	-1037***
Nissan	-1047***
Ford	-1099***
Kia	-1216***
Hyundai	-1339***
Mitsubishi	-1368***
MG Rover	-1445***
Mazda	-1609***
Skoda	-2384***
Daihatsu	-2742***
Suzuki	-4705***

Brand effects from regression specification (3) relative to Toyota. See notes to Table 3.

Table 5: Real Exchange Rate Regression

	(1) FE	(2) RE	(3) RE	(4) RE	(5) RE
Czech Republic			4.77***	4.49***	2.53
(Home Effect)			*(1.56)*	*(1.63)*	*(1.53)*
France			5.91***	5.96***	6.91***
(Home Effect)			*(0.69)*	*(0.77)*	*(1.01)*
Germany			-3.03***	-3.52***	-1.03
(Home Effect)			*(1.03)*	*(1.09)*	*(1.21)*
Italy			1.07	1.07	1.63
(Home Effect)			*(1.45)*	*(1.35)*	*(1.27)*
Sweden			-8.62***	-6.31***	-9.21***
(Home Effect)			*(1.52)*	*(1.90)*	*(2.67)*
United Kingdom			-1.97	-3.32	2.35
(Home Effect)			*(3.48)*	*(3.31)*	*(2.34)*
Warranty Diff.	0.25	0.14	0.13	0.04	0.12
(years)	*(0.25)*	*(0.25)*	*(0.24)*	*(0.24)*	*(0.25)*
Brand Centrality Diff.			-4.11*	-2.90	-5.07**
			(2.28)	*(2.24)*	*(2.51)*
AC	-0.49	-0.09	-0.05		
(Excluded in Both)	*(0.81)*	*(0.70)*	*(0.71)*	Inter-	Inter-
AC	7.56***	7.85***	7.83***		
(Included in NL Only)	*(1.19)*	*(1.05)*	*(1.05)*		
AC	-7.89***	-7.81***	-7.75***	acted	acted
(Included in Other Country Only)	*(1.76)*	*(1.55)*	*(1.54)*		
ABS	0.16	-0.66	-0.79		
(Excluded in Both)	*(0.61)*	*(1.07)*	*(1.03)*	with	with
ABS	4.41**	3.97**	3.96**		
(Included in NL Only)	*(1.95)*	*(1.75)*	*(1.77)*		
ABS	-4.78***	-4.02***	-4.13***	Country	Country
(Included in Other Country Only)	*(0.72)*	*(1.35)*	*(1.34)*		
Airbag	-7.59***	-7.71***	-7.76***		
(Excluded in Both)	*(0.71)*	*(0.65)*	*(0.66)*	Dummies	Dummies
Airbag	0.48	0.13	0.17		
(Included in NL Only)	*(1.00)*	*(0.92)*	*(0.94)*		
Population Diff.	-0.36*	-0.38**	-0.37**	-0.55***	Inter-
(1000s)	*(0.18)*	*(0.17)*	*(0.17)*	*(0.19)*	
GDP p.c. Diff.	0.19***	0.20***	0.21***	0.20***	
(1000 EUR @ PPP)	*(0.05)*	*(0.04)*	*(0.04)*	*(0.04)*	acted
Distance Diff.	-0.30	-0.71*	-0.81**	-0.81**	
(1000 km)	*(1.04)*	*(0.35)*	*(0.34)*	*(0.32)*	
VAT Diff.	0.42***	0.39***	0.40***	0.40***	with
(%)	*(0.10)*	*(0.09)*	*(0.09)*	*(0.08)*	
Petrol Tax Diff.	0.56***	0.55***	0.55***	0.55***	
(ct/l)	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*	Brand
Diesel-Petrol Tax Diff.	0.46***	0.45***	0.48$^{***\#}$	0.50$^{***\#}$	
(ct/l)	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*	
Diesel-Petrol Tax Diff.			0.43***	0.46***	Dummies
(ct/l, Diesel Cars Only)			*(0.04)*	*(0.04)*	
Eff. Registration Tax Diff.	-0.01	0.01	0.01	0.01	
(%)	*(0.03)*	*(0.02)*	*(0.02)*	*(0.02)*	
Technical Spec. Controls	Yes	Yes	Yes	Yes	Yes
Segment Controls	No	Yes	Yes	Yes	Yes
Dealer Services Controls	No	No	Yes	Yes	Yes
R^2 within	0.18	0.18	0.19	0.22	0.24
R^2 overall	0.68	0.40	0.40	0.44	0.50

Dependent variable: Feature-adjusted, pre-tax real exchange rates, $r_t^{i,c}$. Estimation equation (5). All models, excluding Seat, 21528 observations in 4044 groups. Constant, fixed effects, and country, brand, and time dummies are not reported. Standard errors in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level. # signifies that coefficient pertains to petrol cars only.

Table 6: Country Interactions: Air Conditioning

Country	**AC excl.**	**AC NL only**	**AC OC only**
Austria	0.49	9.17***	-10.25***
	(1.01)	*(2.11)*	*(2.43)*
Belgium	-1.47	11.52***	-8.12***
	(1.14)	*(1.32)*	*(2.46)*
Bulgaria	-0.86	7.12*	-4.81
	(1.74)	*(3.97)*	*(3.17)*
Cyprus	-7.52***		-6.50***
	(2.18)		*(2.14)*
Czech Republic	1.71	6.25***	-0.07
	(1.68)	*(2.30)*	*(5.32)*
Denmark	1.02	7.71***	-9.94***
	(1.33)	*(1.28)*	*(3.41)*
Estonia	2.38**	9.36***	-3.14
	(1.21)	*(1.33)*	*(2.89)*
Finland	-2.14	3.99*	-10.72***
	(1.66)	*(2.38)*	*(1.55)*
France	-0.80	3.37	-7.88***
	(1.08)	*(6.32)*	*(1.70)*
Germany	0.42	9.67***	-8.96***
	(0.93)	*(1.10)*	*(1.82)*
Greece	-4.77***	-1.37	-7.59***
	(1.38)	*(2.71)*	*(1.33)*
Hungary	-1.82	5.16**	-8.01***
	(1.59)	*(2.04)*	*(2.76)*
Ireland	3.50***	11.53***	-3.15*
	(1.23)	*(1.67)*	*(1.75)*
Italy	-4.30***	2.00*	-10.62***
	(0.86)	*(1.10)*	*(1.63)*
Latvia	2.14	10.78***	-4.43
	(1.79)	*(2.17)*	*(3.07)*
Lithuania	0.34	9.05***	-5.25**
	(1.08)	*(2.13)*	*(2.67)*
Luxembourg	-0.08	11.84***	-7.75***
	(0.93)	*(1.39)*	*(2.45)*
Malta	-3.53*	36.09***	-6.74**
	(2.06)	*(3.73)*	*(2.71)*
Poland	0.92	7.69***	-9.41***
	(1.50)	*(2.05)*	*(3.21)*
Portugal	-0.41	6.13***	-9.31***
	(1.22)	*(2.10)*	*(2.15)*
Romania	2.74	7.62*	-8.22***
	(2.47)	*(4.46)*	*(3.18)*
Slovakia	-1.91	3.43**	-5.72*
	(1.50)	*(1.42)*	*(3.19)*
Slovenia	-2.07	3.14	-8.91***
	(1.59)	*(2.00)*	*(2.82)*
Spain	-1.26	8.15***	-7.84***
	(1.09)	*(1.79)*	*(1.28)*
Sweden	3.91***	15.00***	-1.16
	(1.51)	*(1.57)*	*(2.51)*
United Kingdom	3.85**	4.58	-7.00***
	(1.84)	*(2.85)*	*(2.22)*

All coefficients are relative to the default of AC being included as standard in both countries of interest.

A Data Appendix

A.1 Data Sources

Our data set has multiple sources. The base data set includes new car prices from the European Commission (EC), described in Subsection A.1.1. We match this price data with car specification data (Subsection A.1.2) and taxation data (Subsection A.1.3). We also include data on car assembly locations (Subsection A.1.4) and brand centrality (Subsection A.1.5) in our regressions. We now discuss each of these sources.

A.1.1 Car Price Data by European Commission

Our car price data comes from the EC's Directorate General for Competition. It is based on regular surveys of car manufacturers done by the EC. The data include the car list price, with and without tax, as well as information on standard features and the availability and pricing of several optional features, again pre- and post-tax as appropriate. In countries where driving is on the right-hand side, the data includes the price of right-hand side steering separately. The data also includes the warranty offered on the car, whether the price includes an emergency roadside assistance service, and whether the price includes a delivery charge. It is collected and distributed by the EC as a service to European consumers who wish to compare prices across countries. The data covers all 27 EU members, but because some countries joined the EU after the start date of our sample the panel is unbalanced. We cover all EC car price reports since November 2003. Until 2006 (inclusive), the EC published semi-annual reports. They switched to annual reports in 2007, and ended publication in 2011.[23] The data covers the most popular models in Europe, 29 manufacturers or brands, and 148 models in all. We carefully check the data for consistency, which reveals the need for extensive data cleaning. Because our analysis hinges on the availability and pricing of features and installed options, we painstakingly search for input errors, inconsistent measurement units, and the like.[24]

A.1.2 Car Specification Data from the UK

We obtain technical data on all car models sold in the United Kingdom (UK) from the website of the UK government's Royal Certification Agency (RCA). Every car model sold in Britain must undergo testing and certification by this agency. Each car's official emissions and fuel consumption data are determined in this way.[25]

We are able to match almost all of the models in our price data with the models in the RCA data set. The only major exception is the Italian brand Lancia, which was not sold in the UK during the sample period, and which we therefore exclude from our analysis. We match the cars based on engine size, fuel type, and/or engine power, depending on which of these features were noted in the price data. We match manual and automatic cars separately, because RCA tests these separately and thus assigns different emissions and fuel consumption values. As a rule, we match the models in each EC survey period to the models which were tested at the same time. However, if there are no tests of the relevant model close to the time of the EC survey, we use test results from a future or past date, as long as we are certain that all relevant specifications match. We employ extensive cross-checks using all available sources to rule out any false positives (i.e. erroneously matched but substantially different models, e.g. in engine size or fuel type). Unfortunately engine power is not always noted by the RCA, nor is it always reported in the EC survey. When neither the EC survey nor the RCA data contains engine power, we impute this variable using standard methods.

A.1.3 Taxation Data

We collect taxation data from the International Fleet Guide, published by PricewaterhouseCoopers (2004, 2006, 2008, 2009, 2010, 2011). This series of industry publications is designed to give European company fleet managers an accurate snapshot of current tax rates imposed by European countries on the registration of new passenger cars. Information on missing countries and additional detail comes from a recent EU report (European Commission DG-

MOVE, 2012). All cars in Europe are subject to value added tax (VAT), whose rate differs by country. European countries tax new cars at registration based on not only value, but also engine size, engine power, and various emissions: carbon dioxide (CO_2), hydrocarbons (HC), and nitrate oxides (NO_x), overall particles emitted, or the overall EU emission standard. Less common are taxes based on fuel consumption, weight, or length of the car. As a result there are large, sometimes very large, differences in effective tax rates across countries.

Based on these reports we calculate, at each point in time and for each country, the tax due at the time of the first registration for each car model, given the car's price, features, and emissions. This allows us to uncover reporting errors in the EU data set, which turn out to be particularly egregious for the Seat brand.[26] The total tax ranges from about €600 for a Peugeot 107 in Luxemburg 2011 to more than €170000 for a BMW 730D in Denmark in 2010. The small Peugeot 107 is subject to the lowest effective tax rate in the sample. Including VAT, the effective tax rate is less than 7% of the pre-tax price, because of tax incentives. On the other end of the spectrum, an Audi A8 in Denmark is subject to an effective tax of more than 240%. In 2011, the median effective tax rate across all models as a percentage of the pre-tax price was lowest in Luxemburg (15.0%) and Germany (19.5%) and highest in Greece (63%) and Denmark (189%).

A.1.4 Assembly Plant Location

We collect annual data on the European assembly locations of all car models sold in Europe from the industry publication Automotive News Europe.[27] For each model-country pair we calculate the distance from the nearest assembly plant to the country's capital city, using exact coordinates and applying the great circle formula. Some models are not produced in Europe at all, but are imported from the US or Japan. For these models – mostly Japanese and Korean brands – we calculate the distance from the European port of entry if we know what it is. For some models we could not get this information; we assume that these models are imported through Rotterdam, the largest port in Europe.

A.1.5 Brand Centrality

We collect data from the internet search engine Google on brand proximity. Google Insights reports which search terms are most commonly entered together with the brand names in our sample. Using this information we are able to calculate the centrality of each brand in a given country, which we use as a proxy for the monopoly power of a given brand. We describe the data collection and the calculation of the eigenvector centrality measure in more detail in Appendix A.3.

The centrality measure varies by country and brand. It ranges from zero (about 7% of all observations) to slightly more than 0.5 for Toyota in Malta. Overall, Toyota is the most central brand, with a centrality average of 0.36 across all countries, followed by Nissan and Citroen. The most idiosyncratic brands are MG Rover and Land Rover, with a centrality average close to zero, followed by Mini and Saab.

Likewise, from the time series on searches for brand names on Google we derive a brand interest time series. Because the raw data is transformed by Google, so that levels are not comparable across countries, we use only the time variation of these series.

A.1.6 Other Covariates

We also define brand nationality variables. These are interaction terms of a country indicator with indicators for the brands associated with that country. These brands have historically been produced in the country in question, and may command a certain loyalty among car buyers in that country in particular. Recall that we have separate data on the actual assembly location of cars sold in Europe (Section A.1.4); therefore these brand nationality variables should be thought of as indicating demand only. They are: Peugeot, Renault, and Citroen (France), Fiat and Alfa Romeo (Italy), Audi, BMW, Mercedes-Benz, Opel, and Volkswagen

(Germany), Skoda (Czech Republic), Volvo and Saab (Sweden), Jaguar, MG Rover, Land Rover, and Mini (UK).

Finally, we collect country-level data on population and GDP per capita (constant international prices) from Eurostat, the statistical office of the EU.[28] We also have data on the indirect taxes paid at the pump by consumers when they purchase gasoline or diesel fuel, from the EC's Oil Bulletin.[29] These taxes are given in euro cents (using nominal exchange rates as needed) per liter of the relevant fuel.

A.2 Data Cleaning

In this appendix we describe our procedure to standardize and clean the EC price data in more detail. The cleaning proceeds in the following sequence:

1. We convert all prices, for car models and for the various options, to the US numerical convention, i.e. commas denote the thousands separator, and periods denote the decimal separator. This is crucial since prices were reported using both the European and the US conventions, a fact which creates numerous order-of-magnitude errors which have to be manually corrected.

2. We convert all prices to euros. Some manufacturers report all prices in euros, but others report option prices in domestic currency for some models and in some periods. We use the exchange rate at the date of the report for currency conversion purposes.

3. We create dummy variables for the various options. A value of one signifies that the appropriate option is reported as standard for the model in a particular country. A value of zero signifies that the option is either unavailable for that model-country combination, or that a price is given for that option. A missing value signifies that we cannot determine whether the option was offered or not.

4. Some options require more detailed treatment: warranty information is reported in years and/or in kilometers, as is information on the availability of roadside assistance. We create the appropriate variables to facilitate correct comparison across borders.

5. There were several instances where we choose to disregard a data point. This occurs where the data, as reported, is clearly wrong. Examples include: an unreasonably high or low price, a pre-tax price which is higher than the after-tax price, or instances where the prices reported were clearly copied from adjacent columns by mistake. There are other instances where we choose to insert a data point. A typical case for this is where a pre-tax price is not reported, but the after-tax price is. Exploiting the data's cross section features (other models of the same manufacturer in the same period) as well as its time series features (same model in other periods), we are often able to insert the missing data with confidence.

A.3 Construction of Brand Perception Data

The basis of the brand centrality and proximity measures are the Google search statistics available at Google Insights (`http://www.google.com/insights/search/#`). We are using the information of search terms that were entered simultaneously with any given car brand in our sample.

We extracted the statistics on "Web Search" in "all categories" for the time period "2004-present" from the list of "Top searches" available after logging into a Google account. The search terms, submitted in UTF-8 encoding were: '"alfa romeo"', 'audi', 'bmw', 'citroen + CITROËN', 'daihatsu', 'fiat', 'ford', 'honda', 'hyundai', 'kia', 'lancia', '"land rover"', 'mazda', 'mercedes + benz + daimler + "Mercedes-Benz"', 'rover + "land rover"', 'mini + cooper', 'mitsubishi', 'nissan', 'opel + vauxhall', 'peugeot', 'renault', 'saab', 'seat', 'skoda + ŠKODA', 'subaru', 'suzuki', 'toyota', 'volkswagen + vw', 'volvo'. The data set was downloaded, separately for each country in our sample, in multiple sessions between August 13$^{\text{th}}$, 2011 and August 19$^{\text{th}}$, 2011. Search results in Greek and Russian characters where transformed into ANSI coding and then translated. Terms in Bulgarian and Hungarian were examined by native speakers.

According to Google, the reported data are not exact, but approximations. The data was scaled and truncated from below at an unpublished number of searches, leading to shorter brand lists in smaller countries.

From this initial list of co-search terms we extract the ones that refer to other brands in our sample. In the case of double appearances of a given brand we use the maximum. In the case of "Toyota" in Ireland, for example, "Ford" shows up once as "Ford (15)" and once as "Ford Ireland (5)". We therefore use "15" as the joint search intensity of Ford and Toyota. Maintaining the example of "Toyota" in Ireland, a search in all years returns the cobrands: Ford 15+5, Nissan 15+5, Honda 10, Volkswagen 5, BMW 5, Mitsubishi 5, and Hyundai 5.

We summarize this information in a brand proximity matrix Ψ_c for each country, with the value "100" on the diagonal, and zeros for brand pairs with no information on Google Insights. We convert this matrix into the symmetric matrix $S_c = v_c \Psi_c' \Psi_c v_c$, where v_c is the inverse of the Cholesky decomposition of the matrix obtained by setting all off-diagonal elements of $\Psi_c' \Psi_c$ to zero.

Our measure of brand centrality for a given brand in a given country c is the corresponding element of the Eigenvector of the largest Eigenvalue of matrix S_c. Using the largest Eigenvalue also guarantees that all elements of the Eigenvector are positive.

B Recent Developments in Regulation of the EU Car Market

This appendix gives a short background regarding the regulatory environment relevant to our data. Since the late 1990s, the regulatory framework of the European new car market has radically changed. The most relevant regulations for the new car market during our sample period are

- 2002: EU Consumer Goods Directive (European Commission, 1999): EU-wide two-year warranty, incl. used cars (Commission Directive 1999/44/EC),
- 2002: Block Exemption Regulation (European Commission, 2002): Delayed unbundling of sales, service, and warranty (Commission Regulation 1400/2002),
- 2005: Car Registration Directive (European Commission, 2004): Introduction of a Europe-wide car registration documents (Commission Directive 2003/127/EC amending 1999/37/EC)

The European Commission's (EC) interest in the evolution of price dispersion in the car market stems from the need to design block exemption regulations for the car market. These block exemption regulations exempt certain agreements between manufacturers and downstream dealers and repair shops from the EU ban on restrictive business practices, in particular from Article 101(1) of the Treaty on the Functioning of the European Union. This is in contrast to other consumer goods markets, where any "prevention, restriction or distortion of competition within the internal market" is prohibited (Article 101(1) of the Treaty). Replacing the principles of Article 101(1) without giving up competition in the new car market completely requires a large set of rules tailored to the car market, which are collected in the block exemption regulation. The block exemption regulation grants the car industry special rights, for example to determine how and by whom their new cars can be sold, as long as certain conditions are met.

Conditions, which the 2002 block exemption regulation (European Commission, 2002) specifies, are among others:

- Manufacturers must choose between selective and exclusive distribution; i.e. either the manufacturer assigns regions to sellers, but permits resale by third-party dealers, or he selects dealers without assigning regions, but prohibits all sales to third-party dealers.

- Manufacturers cannot prohibit the dealer to sell cars of other brands in the same location.

- Manufacturers cannot force dealers to operate a repair shop; independent repair shops get better access to OEM spare parts, tools, and technical information; spare parts can be obtained directly from its manufacturer, not necessarily the car maker

- Manufacturers cannot impose "restrictions impeding dealers in one Member State to sell vehicles with specifications pertaining to another Member State (e.g. right-hand drive cars)" (European Commission DG-COMP, 2002, p.13).

Despite these conditions, manufacturers have many levers to restrict new car trade across intra-European borders. For example, they can prohibit sales from authorized dealers to resellers. Due to these restrictions, there are only few dealers selling cars Europe-wide. The European car reimport market is dominated by car brokers, who have to obtain documentation from their customers to prove the "end-consumer status" to the manufacturer or brand dealership.

The eagerness of the EC to further liberalize the European new passenger car market seems to have been limited. In its 2009 report it states: "The Commission's third objective was to encourage intra-brand competition across borders. The objective appears to have been achieved, as prices between Member States have converged and cases of hindrances to parallel trade, including complaints from final consumers, have significantly diminished."(European Commission, 2009, p.6)

A new block exemption regulation (European Commission, 2010) went into effect on June 1^{st} 2010 for the markets for repair, maintenance and spare parts. The new regulations on the purchase, sale or resale of new motor vehicles replaced European Commission (2002) starting June 1^{st} 2013, and are thus not relevant for our sample period. Nevertheless, the changes of the new block exemption regulation showcase where – in the EC's point of view – competition was most severely constrained during the sample period. In particular, the new regulation:

- prohibits discrimination by manufacturers of independent repair shops in obtaining technical information and spare parts, if the manufacturer's repair shop network has above 30% market share.
- prohibits conditioning manufacturer warranty on the car only being serviced (oil changes, etc.) at manufacturer-authorized garages. However, repairs covered by the warranty can still be restricted to the manufacturer-authorized network.
- lifts some restrictions on manufacturers imposed by European Commission (2002): Under certain conditions, manufacturers are again allowed to require single-brand showrooms. This is supposed to reduce distribution costs which are claimed to have increased due to European Commission (2002) because manufactures increased the investments required from the dealers to ensure a unique and separate brand presentation.

Clearly, even under the new regulation car manufacturers will have opportunities to limit cross-country new car trade.

C Additional Regression Results, Robustness Checks, Country Comparisons

C.1 Average Price Deviation by Country

Table 7 shows that the Netherlands, Spain and Italy have the most representative car prices in Europe. Prices in Denmark and the UK tend to be in the extremes. Interestingly, despite its central location, infrastructure, and size, the new car prices for any given model in Germany are far from the European average. Feature-adjusted prices are more dispersed than unadjusted prices.

[Table 7 about here.]

C.2 Mean Reversion versus Germany

Table 8 presents the auto-regressive properties of real exchange rates vis-à-vis Germany. We see broadly similar results to those we get in Table 2 in the main text, where real exchange rates are calculated vis-à-vis the Netherlands. Mean reversion here appears to be even faster than in the results presented in Table 2.

[Table 8 about here.]

C.3 Tax Effect by Segment

[Table 9 about here.]

All regression specifications of Table 3 show a positive response of prices to an increase in VAT and fuel taxes. In this appendix we explore if this could be the result of conspicuous consumption, i.e. that fuel-inefficient cars are a Veblen good. A well-known example, although not in our data set, is the Hummer brand – high fuel consumption as a status symbol, a way for consumers to differentiate themselves from the crowd. Table 9 shows some evidence for this hypothesis. It shows the coefficient of the interaction terms between taxes (VAT, petrol tax, and the diesel-petrol tax differential) and car segments in a regression specification that is otherwise identical to column 2 of Table 3. The positive relationship between tax rates and prices increases with the car segment. The effect for the highest segments executive (E) and luxury (F) is double to four times as large as the effect among small (B) cars.

C.4 Country-Specific Time Trends

[Figure 6 about here.]

New car prices in Europe during the past decade followed a marked price pattern. Increasing until 2007, prices have fallen since. Some countries did not follow this common trend. Most notably, as Figure 6 shows, Germany and Spain display fairly stable conditional price levels since 2007.

C.5 AC Bundle Discount by Location

Figure 7 shows that in southern countries cars with air conditioning (AC) as standard feature are as expensive as cars for which air conditioning is purchased separately. In northern countries, however, there is a significant bundle discount. The figure shows that the discount grows linearly with latitude. The further a country is in the North, the more AC is treated as a luxury feature.

[Figure 7 about here.]

C.6 Country Interactions: ABS

Table 10 presents the results of column 5 in Table 5 where the three dummy variables related to ABS are interacted with country dummies. We see, similarly to the case of air conditioning, that the way in which a car is sold — ABS included as standard or priced separately — matters for relative pricing in many European countries. Empty cells in the table denote combinations of dummy variables and countries which do not exist in our data.

[Table 10 about here.]

C.7 Country Interactions: Airbag

Table 11 presents the results of column 5 in Table 5 where the two dummy variables related to the airbag option are interacted with country dummies. We see, similarly to the case of air conditioning, that the way in which a car is sold – airbag included as standard or priced separately – matters for relative pricing in many European countries. However the pattern here is less clear, whereas the coefficients of column 1, indicating the change in real exchange rate associated with selling models with airbags optional in both countries, are consistently negative. This suggests a strong demand for airbags in the Netherlands, our base country.

[Table 11 about here.]

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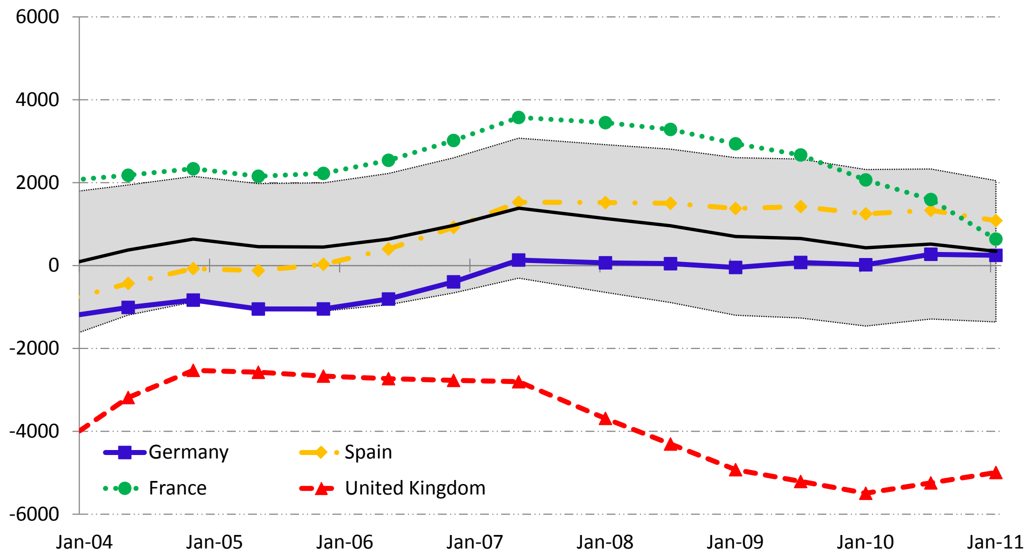
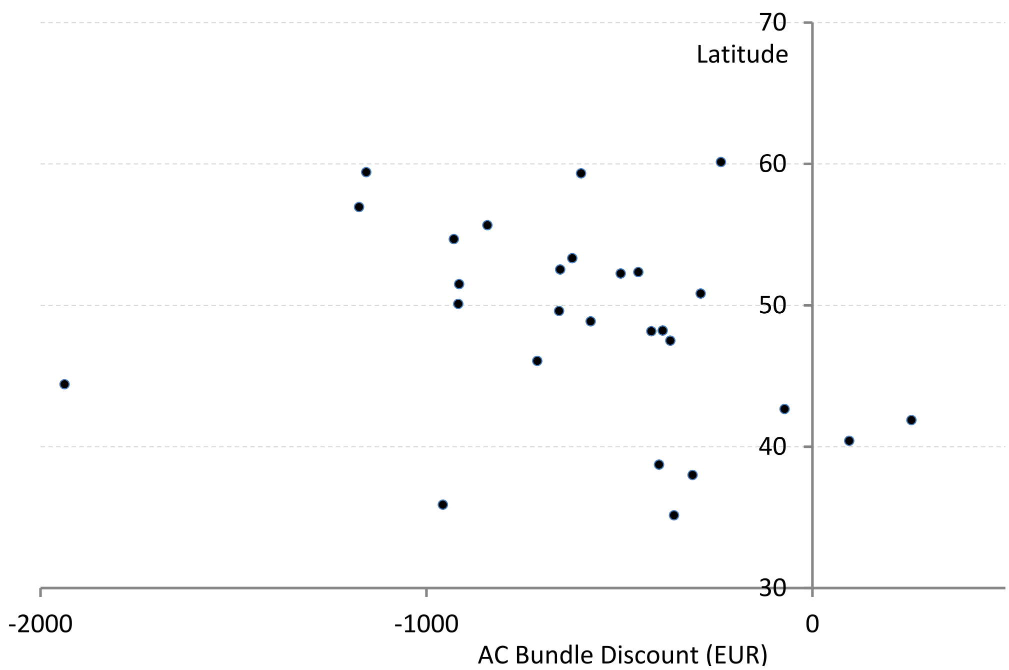
Figure 6: Time Trends



The graph shows the country-specific time trends in prices from column 3 in Table 3. The average across 25 countries (excluding the short time series of Bulgaria and Romania) is given by the light solid line, and the one standard deviation interval across countries by the shaded region. All models, excluding Seat. The prices are in EUR, feature-adjusted, and pre-tax.

Figure 7: Airconditioning Bundle Discount by Latitude



The graph shows the price discount (-) or surcharge (+) in EUR by country when AC is included as standard option. Based on specification (2) in Table 3, with AC interacted with country. Latitude is measured by the latitude of the country's capital. All models, excluding Seat. The underlying prices are in euros, feature-adjusted, and pre-tax.

Table 7: Absolute Price Deviations from EU Average, by Country

	feature adjusted		not feature adjusted	
country	mean	sd.	mean	sd.
Netherlands	681	650	650	639
Spain	694	609	654	595
Italy	705	647	666	654
Luxembourg	795	623	756	616
Belgium	810	650	776	634
France	825	777	823	773
Portugal	839	829	789	827
Ireland	856	900	805	887
Austria	877	708	869	699
Greece	914	982	801	976
Estonia	951	697	940	687
Lithuania	967	873	957	862
Slovenia	972	832	941	832
Latvia	994	825	948	820
Bulgaria	1080	884	1044	889
Finland	1095	957	1022	955
Slovakia	1108	1053	1091	1041
Cyprus	1227	1311	1156	1264
Germany	1233	784	1195	766
Hungary	1237	997	1249	981
Romania	1276	1260	1261	1268
Poland	1419	1404	1412	1387
Czech Rep.	1496	1261	1434	1247
Sweden	1533	1563	1514	1546
Malta	1549	1297	1507	1289
UK	1912	2484	1874	2434
Denmark	1915	1632	1896	1606

Mean and standard deviation of the absolute deviation of the pre-tax car price in a given country from the EU average, calculated for each model and survey, in euros. The countries are sorted by the mean absolute deviation of the feature adjusted price. Seat models and models available in only one country are excluded.

Table 8: Autoregressive Properties of the Real Exchange Rate versus Germany

	2003–2007				2003–2011	
Freq. (months)	6				12	
	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{r}_{t-1}$	0.514***	0.506***	0.534***	0.499***	0.475***	0.464***
	(0.058)	*(0.032)*	*(0.066)*	*(0.129)*	*(0.047)*	*(0.048)*
$\hat{r}^{EUR}_{t-1}$				0.041		
				(0.285)		
Brand Interest			0.068***			0.287***
in Country			*(0.024)*			*(0.074)*
Brand Interest			-0.115***			-0.247***
in the Netherlands			*(0.028)*			*(0.039)*
# instruments	28	35	46	28	23	37
MA(q) of id. err.	1	0	1	1	0	0
# observations	9884	9884	9738	9884	6430	6402
# groups	3546	3546	3508	3546	3861	3853

Dependent variable: Demeaned real exchange rates $\hat{r}^{i,c}$ given by the residuals of a random effects regression of $r_t^{i,c}$ on country dummies. Arellano-Bover system estimation of Equation (3). All models, excluding Seat. Survey fixed effects are not reported. Arellano-Bond robust standard errors adjusted for clustering on model-country in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

Table 9: Taxes by Segment

Segment		VAT	Petrol Tax	Diesel-Petrol Tax
A	-4409.98***	118.39***	79.59***	72.90***
	(1643.99)	*(22.69)*	*(10.68)*	*(13.00)*
B	-1400.23	57.39***	67.13***	52.40***
	(1681.66)	*(22.37)*	*(10.36)*	*(13.82)*
C	-1497.89	70.83***	87.93***	65.18***
	(1615.75)	*(24.16)*	*(10.61)*	*(13.44)*
D	-2769.66*	155.42***	119.34***	98.64***
	(1568.33)	*(27.09)*	*(11.30)*	*(14.43)*
E	-1193.39	252.80***	132.60***	112.09***
	(1890.09)	*(49.80)*	*(15.87)*	*(23.26)*
F	7341.31**	272.50**	177.29***	128.75**
	(2912.24)	*(122.74)*	*(38.36)*	*(64.20)*
G		223.92***	142.10***	115.73***
	(base)	*(73.52)*	*(20.27)*	*(30.50)*

Dependent variable: Feature-adjusted, pre-tax euro prices, $P_t^{i,c}$. All models, excluding Seat. Regression specification (2) of Table 3 augmented by taxes interacted with segment. Bootstrap standard errors in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

Table 10: Country Interactions: ABS

Country	**ABS excl.**	**ABS NL only**	**ABS OC only**
Austria	6.49***		-5.75*
	(2.28)		*(2.96)*
Belgium	2.46		-6.09***
	(2.58)		*(0.94)*
Bulgaria		-1.06	
		(4.33)	
Cyprus	-2.89*	1.62	6.72
	(1.60)	*(4.68)*	*(4.90)*
Czech Republic	-4.18***	5.66***	-12.28***
	(1.32)	*(1.66)*	*(1.07)*
Denmark			-0.56
			(1.24)
Estonia	5.73***	17.59***	
	(0.91)	*(5.32)*	
Finland		6.22***	1.42
		(1.98)	*(2.68)*
France	-12.37***		-6.12**
	(3.42)		*(2.95)*
Germany	-2.24		-4.09***
	(2.81)		*(1.00)*
Greece	-5.51***	-1.05	-5.47
	(1.75)	*(3.73)*	*(4.28)*
Hungary	1.91	5.74***	
	(4.42)	*(1.11)*	
Ireland	-0.89	3.65***	
	(1.26)	*(1.02)*	
Italy	-4.54	0.61	-4.78*
	(5.95)	*(1.07)*	*(2.67)*
Latvia		5.50	
		(4.98)	
Lithuania		7.16	
		(6.19)	
Luxembourg	-0.38		-5.32***
	(2.04)		*(1.69)*
Malta		-12.34**	2.61**
		(5.63)	*(1.08)*
Poland	3.61	-0.50	-17.63***
	(2.55)	*(3.14)*	*(1.40)*
Portugal	-7.22***	3.22	-5.77**
	(1.59)	*(5.28)*	*(2.41)*
Romania			
Slovakia	4.04***	2.55*	-11.07***
	(1.09)	*(1.51)*	*(2.16)*
Slovenia	-0.60	9.15**	
	(1.40)	*(3.81)*	
Spain	-6.24**	-1.34	-3.10***
	(3.08)	*(1.50)*	*(0.73)*
Sweden			6.99*
			(3.63)
United Kingdom	-4.48	6.79***	6.71*
	(6.28)	*(0.87)*	*(3.94)*

All coefficients are relative to the default of ABS being included as standard in both countries of interest.

Table 11: Country Interactions: Airbag

Country	AIRBAG excl.	AIRBAG NL only
Austria	-7.10***	-2.92*
	(1.09)	*(1.69)*
Belgium	-9.48***	-6.73***
	(0.79)	*(0.64)*
Bulgaria		
Cyprus	12.26*	17.68*
	(6.47)	*(10.36)*
Czech Republic	0.45	3.13***
	(1.65)	*(1.02)*
Denmark	-10.25***	5.61***
	(0.84)	*(0.57)*
Estonia	-11.14***	-1.98*
	(1.30)	*(1.07)*
Finland	-3.45***	2.92***
	(1.04)	*(0.94)*
France	-9.58***	-5.71***
	(0.81)	*(1.17)*
Germany	-5.66***	-1.18
	(1.02)	*(0.93)*
Greece	4.19***	2.51***
	(1.11)	*(0.86)*
Hungary	-20.45***	-2.53
	(1.85)	*(3.29)*
Ireland		-1.17
		(2.22)
Italy	-11.29***	-2.67**
	(0.84)	*(1.08)*
Latvia	-13.52***	-3.33
	(1.78)	*(2.60)*
Lithuania	-6.72***	1.04
	(1.57)	*(1.54)*
Luxembourg	-8.99***	-4.21***
	(0.71)	*(0.73)*
Malta	-2.13*	-1.79
	(1.18)	*(1.12)*
Poland	-4.89***	-2.19
	(1.37)	*(3.05)*
Portugal	-12.18***	3.30***
	(0.90)	*(1.27)*
Romania		
Slovakia	-5.22***	3.49
	(1.39)	*(2.89)*
Slovenia	-14.91***	-5.43***
	(1.51)	*(0.84)*
Spain	-8.16***	2.48***
	(0.98)	*(0.64)*
Sweden	-5.97***	3.80***
	(1.00)	*(1.17)*
United Kingdom	-8.10***	-7.29*
	(2.13)	*(3.60)*

All coefficients are relative to the default of an airbag being included as standard in both countries of interest.