Pricing-to-Market in Quality Dimension and Income Inequality

Job Market Paper

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October 2013

Abstract

This paper documents the price discrimination practice based on destinations' per-capita income levels from the automobile industry. It is found that low-quality model manufacturers practice price discrimination while high-quality model manufacturers set price more uniformly across destinations. A highly tractable model was developed to capture these different practices of pricing strategies by including the distribution cost in the firm's decision. Each firm in the model simultaneously chooses quality and price to maximize its profits. The model predicts that highly productive firms not only produce higher quality products, but also price their products more uniformly across destinations. An extension of the model that features consumer income inequality predicts that products are sold at higher prices in countries with high income inequality. This result reconciles observations of high prices found in some developing countries such as China. Empirical results support the model's two key predictions: firms with higher productivity price their products more uniformly; and countries' income inequalities affect price positively.

Keywords: Pricing to market, price discrimination, product quality, income inequality

JEL classification: F12, F14

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1. Introduction

Product quality plays an important role in determining international trade flows. It has been documented that the quality level affects the unit value systematically (Manova and Zhang 2012, Kugler and Verhoogen 2012); and the quality is systematically related to the incomes of importing countries (Hallak 2006, Khandelwal 2010, Hallak and Schott 2011). Despite the growing trade literature linking quality, price, and countries' per-capita incomes, there are fewer studies that examine firms' pricing-to-market strategies along the quality dimension. Simonovska (2010) studies the pricing to market behavior of Mango Inc., a Spanish clothing company, and discovers that Mango imposes higher price markups in affluent countries and lower markups in poor countries. Because Simonovska (2010) examines the prices of identical products across markets, she does not link pricing-to-market strategy to different product quality levels[1].

In order to show that not all firms practice price discrimination on the basis of income, this study first uses the automobile prices from 2008 to 2011 in Europe to illustrate the price dispersion of 172 automobile models sold in 28 European countries. The data were obtained from the European Commission website[2], where all automobile prices are adjusted so that any given model has the same technical specifications in every country sold. Each car model's price dispersion is illustrated by first calculating the standard deviation over average price (in percentage). It is then plotted against each model's average price in Figure 1. A low price dispersion (standard deviation/average price) suggests the automobile model is sold at a rather uniform price across destinations and vice versa.

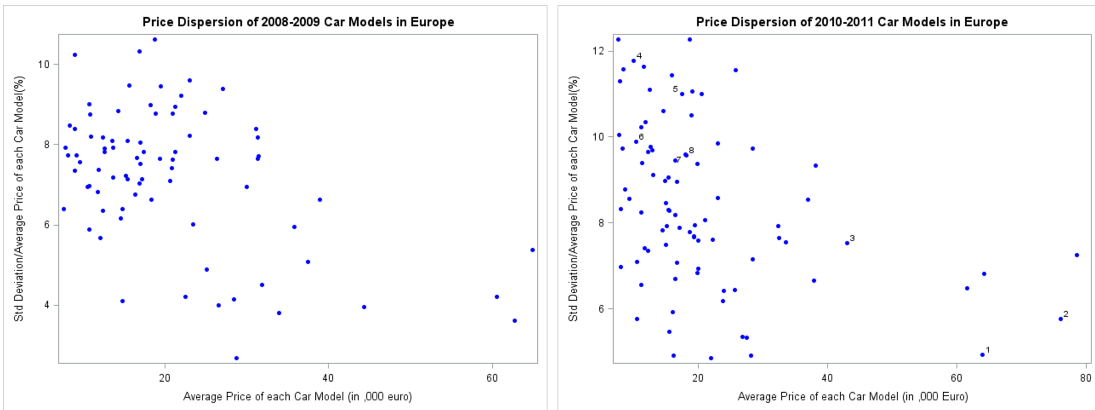
In both plots of Figure 1, automobiles with higher average prices tend to have lower price dispersions across countries while automobiles with lower average prices have a wide range of price dispersions (from low to high). This indicates that more expensive model manufacturer tend to set the price more uniformly across destinations while the pricing strategy of less expensive model manufacturers may vary. For the purpose of more detailed illustration, eight car models in the 2010-2011 plot in Figure 1 are picked. They include three luxury car models (1: Mercedez S350, 2: Jaguar XK and 3: Jaguar XF) from the bottom right corner and five less expensive automobile models with high price variations located on the top left corner (4: Opel Corsa, 5: Renault Scenic, 6: Ford Fiesta, 7: Opel Zafira, and 8: Volkswagen Passat). Each of these eight models' prices (in log) are then plotted against the (log of) GDP per capitas in all the countries where the model is sold (Figure 2 and 3). For the luxury models, not surprisingly, most of the prices in Figure 2 stay in a narrow band. This result shows that the producers of

[1] Here 'quality' is defined anecdotally. We will define product quality carefully later in the model section of the paper.

[2] http://ec.europa.eu/competition/sectors/motor_vehicles/prices/report.html

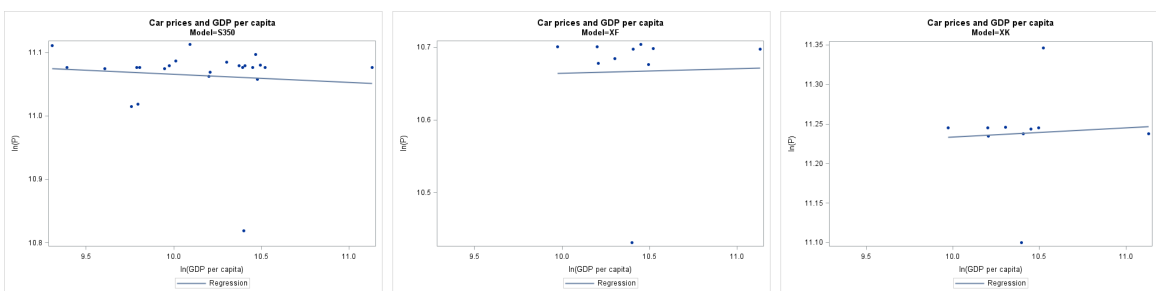
these luxury automobiles do not practice pricing-to-market strategy.

Figure 1: Standard Deviation/Average Price (%) and Average Price of European Car Models in 2008-2009 and 2010-2011.



Note: Standard Deviation/Average Price (%) and Average Price of 172 European Car Models in 2008-2009 and 2010-2011. In the 2010-2011 plot, 1: Mercedez S350, 2: Jaguar XK, 3: Jaguar XF, 4: Opel Corsa, 5: Rebault Scenic, 6: Ford Fiesta, 7: Opel Zafira, 8: Volkswagon Passat

Figure 2: Prices versus GDP per capita for three expensive automobile models.



Note: Prices of 2010-2011 Mercedez S350, Jaguar XF, and Jaguar XK versus destination countries′ GDP per capita (both in logs).

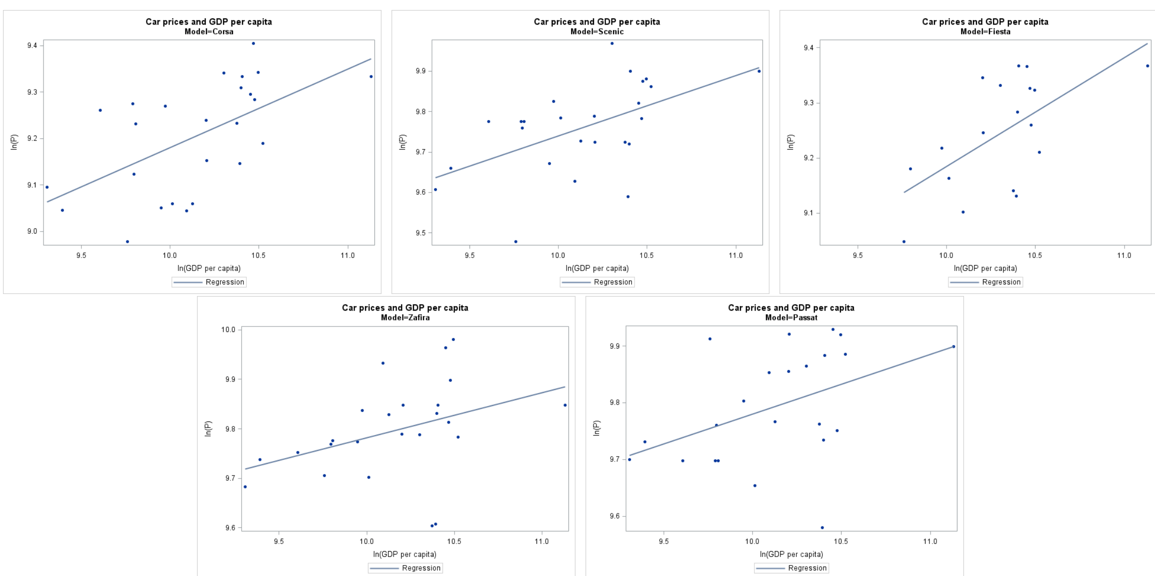
Next we show the similar plots for the five inexpensive automobiles with high dispersions. A high price dispersion does not necessarily suggest a systematic price discrimination. Hence, it is interesting to study whether the high price dispersion of the inexpensive automobiles can be systematically explained by destination country's GDP per capita (as suggested by Simonovska (2010)). These five models are very popular in Europe and are sold in almost all the countries as presented in the data. Five plots were generated to show the log of price versus the log of GDP per capita for these five automobile models in Figure 3.

Each plot in Figure 3 shows an apparent pricing-to-market behavior with respect to destination's GDP per capita (all the slope coefficients are significantly positive for all models). Namely, for these five models, the price is higher in countries with high GDP per capita and is lower in countries with low GDP per capita. The contrasting results of Figure 2 and **??** motivate us to study the pricing-to-market behavior by firms with different qualities.

What role does the automobile company play in the pricing-to-market stylized fact? The answer is that it varies. Some automobile companies have more uniformed pricing strategy and some have different strategy for each automobile model. Both cases are documented and shown in Appendix A.

In addition to the automobile industry, similar stylized fact can be found in the apparel industry. Simonovska (2010) uses Mango Inc. in her study of firm's pricing-to-market behavior. This study extends her study to further include apparel items with different qualities and finds a similar trend in the automobile industry. The stylized facts are reported in Appendix B.

Figure 3: Prices versus GDP per capita for five inexpensive automobile models.



Note: Prices of 2010-2011 Opel Corsa, Renault Scenic, Ford Fiesta, Opel Zafira, and Volkswagen Passat in Destination Countries.

In summary, this study finds that the pricing-to-market strategy is often exercised by producers of low quality while high-quality producers often charge more uniformly across all destinations. This stylized fact is found in both the automobile industry (Figures 2 and 3) and apparel industry (Appendix B). To reconcile these two seemingly contrasting pricing strategies, a model incorporating both choices of quality and price is needed so we can trace through the relationship between quality and prices. An ideal model will illustrate a tractable mechanism on how the product quality, price, and country's income interplay with one another. The remainder of the paper is organized as follows: Section 2 discusses some related literature. Section 3 discusses the model and is followed by data description in Section 4 and results in Section 5. Section 6 considers the transportation cost and the wage in exporting countries in a reduced sample case. Section 7 concludes the paper.

2. Related Literature

With the availability of detailed firm-level data, it has been confirmed that the deviation from law of one price (LOP) is a norm (Broda and Weinstein 2008, Haskel and Wolf 2001, Goldberg and Verboven 2005, Fitzgerald and Haller 2010, Kugler and Verhoogen 2012). On a general note, unit values of similar products are positively correlated with the productivities of exporting firms or the sizes of exporting countries. Product quality is often considered as a key explanation to this correlation (Mandel 2010, Khandelwal 2010, Feenstra and Romalis 2012). Specifically, highly productive firms optimally choose to produce high-quality products, and in turn increases the marginal cost of production. Other studies like Schott (2004), Hummels and Klenow (2005), and Baldwin and Harrigan (2011) also suggest that firms with relatively higher productivity engage in production of higher quality, thus leads to higher unit values.

For the same product sold internationally, many studies have found the deviation from LOP is systematically affected by the destination country's characteristics. Besides the border effect explanations (among many, Rogoff (1996)), Simonovska (2010) uses a non-homothetic utility setup and successfully builds a pricing-to-market model where firms charge higher price markups to more affluent markets and lower markups to countries with lower income. Even though Simonovska (2010) offers the explanation to pricing-to-market behavior according to destination countries' wages, it only addresses part of our study question. Bastos and Silva (2010) uses several regressions and conclude that f.o.b. unit values is higher for destinations that are more distant and wealthier. Within each product category, highly productive firms ship greater quantities at higher unit value to a given destination, which is consistent with the quality argument.

So far the studies on firm's pricing strategy have been dichotomous, studies capturing the pricing-to-market behavior (Simonovska 2010) usually do not address the varying markup as quality level changes; and the ones that focus on the quality-price relationship (Kugler and Verhoogen 2012, Feenstra and Romalis 2012) usually overlook the pricing-to-market behavior with respect to destination country's characteristics. This study uses a highly tractable model to bring together these two crucial aspects of firm's pricing strategy. We believe this study contributes to the current literature by enhancing our comprehensive understandings of firm's pricing strategy.

On the note of quality difference and pricing strategy, Auer, Chaney, and Saure (2012) document the different exchange rate pass-through in high and low quality European automobiles. In particular, they find that the exchange rate pass-through is larger for low than for high quality automobiles. They argue that high quality firms, facing less competition in international market, enjoys higher market power, higher price markup, and has lower exchange pass-through than low quality firms. To our best knowledge, their study is the only one that addresses firms' varying pricing behaviors in the quality dimension.

Along the same line of partial pass-through, Berman, Martin, and Mayer (2012) analyze French firm-level data and find that firms increase more in their price markups than their export volumes as the the currency depreciates. In one of the explanations they provide, they argue that the distribution cost, which consists a large share (40%-60%) of consumer prices, generates such heterogeneous pricing-to-market action. In their model, the markup in consumer price consists of two additive parts - the unit cost and the distribution cost (paid for each unit sold) where the former is denominated in the exporting country's price and the latter is denominated in the destination country's price. The composition of the markup leads to partial exchange rate pass-through and as a result, the markup changes as the exchange rate changes even in a CES utility framework. Following Berman, Martin, and Mayer (2012), Chatterjee, Dix-Carneiro, and Vichyanond (2012) extend the distribution-cost framework to a multi-product model with a standard CES utility setup. The distribution cost, denoted by $w_c\eta_c$, is directly related to destination country's wage but independent from the marginal cost of production. Similar to the conclusion made by Berman, Martin, and Mayer (2012), the distribution cost leads to a non-constant price markup. In the same way, our model incorporates the distribution cost characteristic and this characterization leads to a feature of pricing-to-market result in quality dimension. Overall, our model is most related to the framework by Feenstra and Romalis (2012) with the additional feature of distribution cost by Berman, Martin, and Mayer (2012).

3. Model

3.1. Consumer's Problem

Utility of a typical consumer in country j:

$$U_j = \left[\int_{\omega \in \Omega_{ij}} \left(x_{ij}(\omega) z_{ij}(\omega) \right)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where ω denotes the variety, x_{ij} is the quantity and z_{ij} is the quality of the differentiated product ω from country i entering country j. Ω_{ij} is the complete set of products available to the consumer. We assume that firms from the same country with the same productivity will choose the same optimal price. The demand for good x_{ij} can be expressed as (omitting all ω):

$$x_{ij} = \frac{w_j}{z_{ij} P_j} \left(\frac{P_j}{p_{ij}/z_{ij}} \right)^{\sigma} \tag{2}$$

where w_j is the income of consumer in country j, p_{ij} is the c.i.f. price of the product ω and P_j is the quality-adjusted price index:

$$P_j = \left(\int_{\omega \in \Omega_{ij}} \left(\frac{p_{ij}(\omega)}{z_{ij}(\omega)} \right)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}} \tag{3}$$

3.2. One Quality, Different Pricing

In this section, we will explore the case where a firm simultaneously chooses *one* quality and *many* prices. This assumption will allow us to explain the stylized fact presented in the introduction. In this model, labor is the only input and the marginal cost of the product is derived from cost minimization given product's quality z. Here the quality specification by Kugler and Verhoogen (2012) is modified, and the cost of one unit of production is assumed as $w_i l_i$:

$$\min_{l_i} w_i l_i \quad s.t. \;\; z_i(\omega) = (\psi_i^{\theta} + \phi(\omega) l_i(\omega)^{\theta})^{1/\theta} \tag{4}$$

where w_i is the wage in country i, ψ_i denotes the infrastructure of country i, $\phi(\omega)$ is the productivity of ω-producing firm, $l_i(\omega)$ is the labor required to produce one unit of quality $z_i(\omega)$ and θ is the elasticity of substitution between country's infrastructure and the labor used in production, and $0 < \theta < 1$. The quality specification means that to attain the same level of product quality, a firm located in a poor-infrastructure country needs to use more labors than a firm located in a country with well-established infrastructure. For presentation clarity, all ω is omitted because the focus is on the ω-producing firm's behavior, the marginal cost can be written down as a function of w_i, ψ_i, and z_i, and ϕ:

$$w_i l_i = w_i \left(\frac{z_i^{\theta} - \psi_i^{\theta}}{\phi} \right)^{1/\theta} \tag{5}$$

Denoting firm's f.o.b. price as p_{ij}^*, we can write the following relation between f.o.b. and c.i.f. prices:

$$p_{ij} = \tau_{ij} p_{ij}^* \tag{6}$$

where τ_{ij} stands for *ad valorem* tariff. This will later allow us to see whether or not the *ad valorem*-type tariff affects the optimal choices on quality and prices. We assume that there is a fixed cost of f_{ij} for the firm from country i to enter country j. For generality, we make it explicit that the firm may enter each of the countries j, but the firm will not enter a market if the profit is less than zero. Besides the marginal cost of production and the tariffs, firms need to consider the distribution cost after the product arrives the destination. Examples of the distribution costs include the cost of moving the product from the port to local warehouses, and from local warehouses to retailers, or the cost of setting up local distributors, and in automobile case, the distribution costs include the cost of setting up dealership in destination countries. Hence it is reasonable to assume that the distribution cost is denominated in destination country's wage. Particularly, we assume the distribution cost is a per unit cost $w_j \eta_j$ where w_j is the wage in the destination country and η_j is the unit of labor required to deliver one unit of the product from the port to the consumer. Thus the profit function can be written as:

$$\begin{aligned} \pi_i &= \sum_{j=1}^{J} \pi_{ij} \delta_{ij} \\ &= \sum_{j=1}^{J} \left\{ L_j x_{ij} \left(p_{ij}^* - w_i \left(\frac{z_i^\theta - \psi_i^\theta}{\phi} \right)^{1/\theta} - w_j \eta_j \right) - f_{ij} \right\} \delta_{ij} \\ &= \sum_{j=1}^{J} \left\{ \frac{L_j w_j z_i^{\sigma-1} P_j}{\left(\tau_{ij} p_{ij}^*\right)^\sigma} \left(p_{ij}^* - w_i \left(\frac{z_i^\theta - \psi_i^\theta}{\phi} \right)^{1/\theta} - w_j \eta_j \right) - f_{ij} \right\} \delta_{ij} \end{aligned} \tag{7}$$

where $w_j \eta_j$ is the distribution cost paid for each unit sold, f_{ij} is the fixed cost of entering country j. δ_{ij} is defined as:

$$\delta_{ij} = \begin{cases} 1 & \text{if } \pi_{ij} \geq 0; \\ 0 & \text{if } \pi_{ij} < 0. \end{cases} \tag{8}$$

Assuming each firm chooses its f.o.b. price p^*_{ij} and quality z_i simultaneously, we therefore use the methodology used by Feenstra and Romalis (2012) and denote the quality-adjusted and tariff-inclusive price as P_{ij} where:

$$P_{ij} = \frac{\tau_{ij} p^*_{ij}}{z_{ij}}$$

We suppose that in the pool of J destinations, J^* of them yield non-negative profit. Grouping the J^* firms subset and denote them as $j^* = 1, ..., J^*$, we have,

$$\pi_i = \sum_{j=1}^{J} \pi_{ij}\delta_{ij} = \sum_{j^*=1}^{J^*} \pi_{ij^*} \tag{9}$$

Since all of our discussion will focus on the J^* firms, we drop all the asterisks on j and J in all of the following context for the purpose of simplicity. So following equations (7) and (9), we have:

$$\begin{aligned}
\max \pi_i &= \max_{p^*_{ij}, z_i} \sum_{j=1}^{J} \left\{ L_j x_{ij} \left(p^*_{ij} - w_i (\frac{z_i^\theta - \psi_i^\theta}{\phi})^{1/\theta} - w_j \eta_j \right) - f_{ij} \right\} \\
&= \max_{P_{ij}, z_i} \sum_{j=1}^{J} \left\{ L_j (x_{ij} z_i) \frac{1}{z_i} \left(\frac{P_{ij} z_i}{\tau_{ij}} - w_i (\frac{z_i^\theta - \psi_i^\theta}{\phi})^{1/\theta} - w_j \eta_j \right) - f_{ij} \right\} \\
&= \max_{P_{ij}, z_i} \sum_{j=1}^{J} \left\{ L_j Q_{ij} \left(\frac{P_{ij}}{\tau_{ij}} - \left(\frac{w_i}{z_i} (\frac{z_i^\theta - \psi_i^\theta}{\phi})^{1/\theta} + \frac{w_j \eta_j}{z_i} \right) \right) - f_{ij} \right\} \qquad (10)
\end{aligned}$$

Note that the firm chooses *one* quality for all markets, but sets *different* prices in different market. The last line of equation (10) consists of quality-adjusted quantity as well as quality-adjusted and tariff-inclusive price. We can then solve for the optimal quality choice by minimizing the last two terms (which represents the average variable cost of quality). The optimal quality for the firm with productivity ϕ is:

$$z_i = \left[\phi^{\frac{1}{1-\theta}} \left(\frac{D}{\psi_i^\theta w_i} \right)^{\frac{\theta}{1-\theta}} + \psi_i^\theta \right]^{1/\theta} \tag{11}$$

where

$$D = \frac{\sum_{j=1}^{J} L_j Q_{ij} w_j \eta_j}{\sum_{j=1}^{J} L_j Q_{ij}}$$

D is the quality-inclusive weighted distribution cost of the J countries. The optimal quality is now independent from single destination country's characteristics. The optimal pricing is then derived as:

$$p_{ij}^* = \frac{\sigma}{\sigma - 1}\left(w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^{\theta}}\right)^{\frac{1}{1-\theta}} + w_j \eta_j \right) \tag{12}$$

There are several interesting implications from the firm's f.o.b. price in equation (12). First of all, it shows firm's pricing-to-market behavior - with higher w_j, the price gets higher. Secondly, the optimal price is higher as the firm becomes more productive (higher ϕ). This is because more productive firm produce higher quality and requires more labor input (equation (11)). This second implication is consistent with the findings of most firm-level data. The optimal price can be further decomposed as:

$$\begin{aligned} p_{ij}^* &= \frac{\sigma}{\sigma - 1}\left(w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^{\theta}}\right)^{\frac{1}{1-\theta}} + w_j \eta_j \right) \\ &= \underbrace{\underbrace{\frac{\sigma}{\sigma - 1}}_{\text{CES constant markup}} \underbrace{\left(1 + \frac{w_j \eta_j}{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^{\theta}}\right)^{\frac{1}{1-\theta}}} \right)}_{\text{non-constant markup>1}}}_{\text{total markup}} \underbrace{\left(w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^{\theta}}\right)^{\frac{1}{1-\theta}} \right)}_{\text{marginal cost}} \end{aligned} \tag{13}$$

Equation (13) shows that the optimal f.o.b. price can be decomposed into two parts - price markup and marginal cost. Similar to the result in Berman, Martin, and Mayer (2012), the markup here is determined endogenously. It is clear that the pricing-to-market action comes solely from the price markup part. In order to link this result back to the stylized facts, it is supposed that the variety ω enters two countries, j and k. Equation (13) shows that the f.o.b. prices p_{ij}^* and p_{ik}^* only differ in the non-constant markup part. Specifically, the relative price between country j and k can be equated as:

$$\frac{p_{ij}^*}{p_{ik}^*} = \frac{1 + \frac{w_j \eta_j}{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}}}}{1 + \frac{w_k \eta_k}{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}}}} = \frac{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} + w_j \eta_j}{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} + w_k \eta_k} \tag{14}$$

The numerator and the denominator in equation (14) show that the prices of the same good sold in two destinations are determined by two components: the marginal cost ($w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}}$) and the unit distribution cost ($w_j \eta_j$ or $w_k \eta_k$). Equation (14) shows a pricing-to-market behavior where high income in destination leads to higher price. However, the pricing-to-market behavior varies as the components in the price changes. Specifically, if the marginal cost part is much larger relatively to the unit distribution cost, the two prices converge; if the marginal cost is much smaller than the unit distribution cost, the prices in two countries diverge. And the marginal cost is directly related to firm's productivity. Here we derive the change in the relative price of $\frac{p_{ij}^*}{p_{ik}^*}$ with respect to the change in firm's productivity ϕ:

$$\frac{\partial \left(\frac{p_{ij}^*}{p_{ik}^*}\right)}{\partial \phi} = \underbrace{\frac{1}{1-\theta}}_{>0} \underbrace{\frac{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} \phi^{\frac{1}{1-\theta}}}{\left(w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} + w_k \eta_k\right)^2}}_{>0} \underbrace{(w_k \eta_k - w_j \eta_j)}_{\substack{<0 \text{ if} \\ w_j > w_k \text{ and} \\ \eta_j = \eta_k}} \tag{15}$$

Here we assume that the wage in country j is greater than the wage in country k ($w_j > w_k$) and for simplicity, we also assume that the labor required to distribute one unit of product is the same in two countries ($\eta_j = \eta_k$). According to equation (14), the f.o.b. price in country j is higher than it in country k (the firm price discriminates according to destination's income, or $p_{ij}^*/p_{ik}^* > 1$). However, equation (15) suggests that the price difference diminishes as firm's productivity increases (equation (15) shows a negative result because $w_k \eta_k < w_j \eta_j$). This key result shows that firm's pricing-to-market behavior diminishes with productivity. Since the productivity positively correlates with product's quality, firm's pricing-to-market behavior diminishes when product quality gets higher.

We can conclude with the same result by explaining the equaltion (14). Suppose a firm has a high productivity (ϕ), it produces high quality (according to equation (11)) and has high marginal cost (the first term in the numerator and the denominator of equation (14)). The unit distribution cost becomes relatively smaller than marginal cost in equation (14) and the prices in two destinations converge. Analytically, assuming that the productivity distribution $G(\phi)$

is characterized by Pareto distribution[3] with support $[1, \infty)$, equation (14) has the following interesting results in two extreme cases:

$$\lim_{\phi \to \infty} \frac{p_{ij}^*}{p_{ik}^*} = 1 \tag{16}$$

$$\lim_{\phi \to 1} \frac{p_{ij}^*}{p_{ik}^*} = \frac{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} + w_j \eta_j}{w_i^{\frac{-\theta}{1-\theta}} \left(\frac{D}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} + w_k \eta_k} \tag{17}$$

In the first case (equation (16)) where productivity goes to infinity, the quality also goes to infinity according to equation (11). The firm sets the same price in both destinations j and k. This is the high-quality case in our stylized fact where the price is not affected by destination country's characteristics systematically. In the second case (equation (17)) where the productivity trends to the lower bound, the relative price is affected systematically by the destination country's wages w_j and w_k (and the unit distribution labor required η_j and η_k). This supports our findings in low-quality goods where firms practice pricing-to-market strategy.

So far we have developed a highly-tractable model to show analytically how the quality, price, and firm's productivity interplay. Specifically, we are able to show the change in firm's pricing-to-market behavior with the change in firm's productivity. To sum up, here are the comparative static results:

$$\frac{\partial z_i}{\partial \phi} > 0, \frac{\partial z_i}{\partial w_j} = 0, \frac{\partial z_i}{\partial \eta_j} = 0, \frac{\partial z_i}{\partial w_i} < 0, \frac{\partial z_i}{\partial \tau_{ij}} = 0$$

$$\frac{\partial p_{ij}^*}{\partial \phi} > 0, \frac{\partial p_{ij}^*}{\partial w_j} > 0, \frac{\partial p_{ij}^*}{\partial \eta_j} > 0, \frac{\partial p_{ij}^*}{\partial w_i} < 0, \frac{\partial p_{ij}^*}{\partial \tau_{ij}} = 0$$

Some important results include 1) Higher productivity leads to higher quality and hence higher f.o.b. price, 2) In this one-quality model, product quality is not affected by characteristics of one single country such as wage (w_j) or distribution cost ($w_j \eta_j$), 3) Destination country's income, however, affects firm's price, or pricing-to-market behavior. 4) Higher labor wage from exporting country reduces product quality and price, and 5) *Ad valorem* tariff does not affect the optimal choice of quality or price.

Lastly, the formula for the quality-adjusted price is:

[3]The Pareto distribution assumption is not crucial here because in this prospectus, none of the analytical result depends on any particular distribution.

$$\frac{p_{ij}^*}{z_i} = \frac{\frac{\sigma}{\sigma-1}\left[w_i^{\frac{-\theta}{1-\theta}}\left(\frac{\phi D}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} + w_j\eta_j\right]}{\left[\phi^{\frac{1}{1-\theta}}\left(\frac{D}{\psi_i^\theta w_i}\right)^{\frac{\theta}{1-\theta}} + \psi_i^\theta\right]^{1/\theta}} \tag{18}$$

Even though both f.o.b. price and quality increase as ϕ increases, equation (18) shows that the quality-adjusted price decreases as productivity ϕ increases. This result is consistent with Melitz (2003) and Feentra and Romalis (2012).

3.3. Elasticity

In this section, we are interested in finding the price elasticity of demand with respect to "net-of-distribution-cost" f.o.b. price ($\tilde{p}_{ij} \equiv p_{ij}^* - \frac{\sigma}{\sigma-1}w_j\eta_j$), and study the change in the price elasticity of demand when consumer income changes. The net-of-distribution elasticity of demand will become handy in the next section when we study firm's pricing strategy in the presence of income inequality.

$$\tilde{\epsilon}_{ij} = \frac{\partial \ln x_{ij}}{\partial \ln \tilde{p}_{ij}} = \frac{-\sigma w_i^{\frac{-\theta}{1-\theta}}\left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}}}{w_i^{\frac{-\theta}{1-\theta}}\left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}} + w_j\eta_j} \tag{19}$$

Equation (19) shows that as consumers become wealthier ($w_j \uparrow$), they become less price elastic ($|\tilde{\epsilon}_{ij}| \downarrow$). Equations (19) and (13) can be further combined to illustrate the optimal f.o.b. price in terms of $\tilde{\epsilon}_{ij}$:

$$p_{ij}^* = \frac{\sigma}{\sigma-1}\left(w_i^{\frac{-\theta}{1-\theta}}\left(\frac{D\phi}{\psi_i^\theta}\right)^{\frac{1}{1-\theta}}\right)\left(\frac{-\sigma}{\tilde{\epsilon}_{ij}}\right) = \frac{\sigma}{\sigma-1}\cdot MC\cdot\left(\frac{-\sigma}{\tilde{\epsilon}_{ij}}\right) \tag{20}$$

3.4. Consumers with Income Inequality

So far we have focused on firm's choice in quality and price while assuming each destination country is characterized by numerous consumers with the same income. In this section, the discussion is expanded to incorporate the case where a country consists of groups of consumers with different incomes. In particular, the study focuses on the firm's pricing strategy when the consumers' income changes from a homogeneous level to two groups on different levels. We assume that the change is characterized by "mean-preserving spread". This assumption makes sure the firm's pricing-to-market channel is shut down (the average income remains the same), while the allocation of total wealth diverges among the two groups of consumers[4]. We believe this will lead to some interesting outcomes in firm's behavior and will help us explaining the puzzling high prices in low-income countries.

We first assume that country j consists of two groups of consumers with different levels of income, w_{j1} and w_{j2}. The population in each group is denoted as L_{j1} and L_{j2}. Consumer's quantity demanded, directly affected by consumer's income, is the same within income group. Denoting the demand for the differentiated product from country i as x_{ij1} and x_{ij2}, we show the total demand from country j is:

$$X_{ij} = L_{j1}x_{ij1} + L_{j2}x_{ij2} \tag{21}$$

The 'net-of-distribution-cost' elasticity of the total demand with respect to the change in the price can be expressed as:

$$\begin{aligned}
\frac{\partial lnQ}{\partial ln\tilde{p}_{ij}} &= \frac{\partial X_{ij}}{\partial \tilde{p}_{ij}}\frac{\tilde{p}_{ij}}{X_{ij}} \\
&= \frac{\tilde{p}_{ij}}{L_{j1}x_{ij1} + L_{j2}x_{ij2}}\left[L_{j1}\frac{\partial x_{ij1}}{\partial \tilde{p}_{ij}} + L_{j2}\frac{\partial x_{ij2}}{\partial \tilde{p}_{ij}}\right] \\
&= \frac{L_{j1}x_{ij1}}{L_{j1}x_{ij1} + L_{j2}x_{ij2}}\frac{\partial x_{ij1}}{\partial \tilde{p}_{ij}}\frac{\tilde{p}_{ij}}{x_{ij1}} + \frac{L_{j2}x_{ij2}}{L_{j1}x_{ij1} + L_{j2}x_{ij2}}\frac{\partial x_{ij2}}{\partial \tilde{p}_{ij}}\frac{\tilde{p}_{ij}}{x_{ij2}} \\
&= \frac{L_{j1}x_{ij1}}{L_{j1}x_{ij1} + L_{j2}x_{ij2}}\tilde{\epsilon}_{ij1} + \frac{L_{j2}x_{ij2}}{L_{j1}x_{ij1} + L_{j2}x_{ij2}}\tilde{\epsilon}_{ij2} \\
&= \lambda_{ij1}\tilde{\epsilon}_{ij1} + \lambda_{ij2}\tilde{\epsilon}_{ij2}
\end{aligned} \tag{22}$$

where λ_{ijk} and $\tilde{\epsilon}_{ijk}$ denote the share of the quantity demanded in total consumption volume by group k and the 'net-of-distribution-cost' price elasticity of demand by group k, respectively. Assuming that the firm targets both groups, we can substitute equation (22) into (20) and get its f.o.b. price:

$$p^*_{ij} = \frac{\sigma}{\sigma - 1} \cdot MC \cdot \left(\frac{-\sigma}{\lambda_{ij1}\tilde{\epsilon}_{ij1} + \lambda_{ij2}\tilde{\epsilon}_{ij2}}\right) \tag{23}$$

Equation (23) shows that firm's pricing decision is directly affected by the two consumer

[4]Without this assumption, the main results in this section does not change, but the effects of firm's pricing-to-market strategy and the income inequality are confounded.

groups' net-of-distribution elasticity of demand, which are directly affected by the incomes of two groups. We start from the case where all consumers have the same income ($w_{j1} = w_{j2}$), equation (23) becomes identical to (20) in the equal-income case. Then we increase the income w_{j1} and decrease the income w_{j2} so $w_{j1} > w_{j2}$. The changes of incomes are subject to the mean-preserving spread [5].

Since $w_{j1} > w_{j2}$ and $|\tilde{\epsilon}_{ij1}| < |\tilde{\epsilon}_{ij2}|$, the optimal price p^*_{ij} is lower than the optimal price that the firm would set if the destination has only the wealthy group with income w_{j1}; and higher than the optimal price that the firm would set if the destination has only the less wealthy group with income w_{j2}:

$$\frac{\sigma}{\sigma-1} \cdot MC \cdot \left(\frac{-\sigma}{\tilde{\epsilon}_{ij2}}\right) < \frac{\sigma}{\sigma-1} \cdot MC \cdot \left(\frac{-\sigma}{\tilde{\epsilon}_{ij1}}\right) \tag{24}$$

Since $\lambda_{ij1} + \lambda_{ij2} = 1$, it follows that:

$$\frac{\sigma}{\sigma-1} \cdot MC \cdot \left(\frac{-\sigma}{\tilde{\epsilon}_{ij2}}\right) < p^*_{ij} < \frac{\sigma}{\sigma-1} \cdot MC \cdot \left(\frac{-\sigma}{\tilde{\epsilon}_{ij1}}\right) \tag{25}$$

where p^*_{ij} is in equation (23). The share of total demand λ_{ijk} determines which way the optimal price goes: the equilibrium price becomes higher if the total demand share for group 1, λ_{ij1}, is higher and vice versa.

Since the total demand share by group k depends on the endogenous variables x_{ij1} and x_{ij2}, we would like to see if we can further simplify it. First we modify the demand function in equation (2) for a consumer with income w_{ijk}:

$$x_{ijk} = \frac{w_{jk}}{z_{ij}P_j}\left(\frac{P_j}{p_{ij}/z_{ij}}\right)^{\sigma} \tag{26}$$

Equation (26) shows that given P_j, z_{ij}, p_{ij}, the demand x_{ijk} is proportional to consumer's income w_{jk}. Substituting equation (26) into the demand share λ_{ijk}:

[5] Assuming new wages are w'_{j1} and w'_{j2}, the mean-preserving spread means $w'_{j1}L_{j1} + w'_{j2}L_{j2} = w_{j1}L_{j1} + w_{j2}L_{j2}$ such that the average income remains unchanged, or $\frac{w'_{j1}L_{j1}+w'_{j2}L_{j2}}{L_{j1}+L_{j2}} = \frac{w_{j1}L_{j1}+w_{j2}L_{j2}}{L_{j1}+L_{j2}}$

$$\begin{aligned}
\lambda_{ijk} &= \frac{L_{jk}x_{ijk}}{L_{j1}x_{ij1}+L_{j2}x_{ij2}} \qquad\qquad k\in\{1,2\} \\
&= \frac{L_{jk}\frac{w_{jk}}{z_{ij}P_j}\left(\frac{P_j}{p_{ij}/z_{ij}}\right)^{\sigma}}{L_{j1}\frac{w_{j1}}{z_{ij}P_j}\left(\frac{P_j}{p_{ij}/z_{ij}}\right)^{\sigma}+L_{j2}\frac{w_{j2}}{z_{ij}P_j}\left(\frac{P_j}{p_{ij}/z_{ij}}\right)^{\sigma}} \\
&= \frac{L_{jk}w_{jk}}{L_{j1}w_{j1}+L_{j2}w_{j2}} \\
&= \lambda_{jk} \qquad (27)
\end{aligned}$$

As it turns out the demand share is equivalent to the share of income of each group in the whole economy. Hence the rationale of equation (23) becomes rather straightforward: the firm's f.o.b. price depends on both elasticities and the income share of the two income groups; and the firm's optimal price is higher when the income share of the wealthier part of the population gets higher, or when the overall income is more unevenly distributed among the two groups.

Instead of targeting both income groups, a firm may target only the wealthier part of the population and set its price according to the characteristics of that group. This adds another stage to the firm's decision-making procedures: it needs to first compare the profits from both strategies and then decide which strategy will be practiced. The f.o.b. prices are written in terms of elasticity of demand for both strategies, denoting the strategy targeting both groups as 'b' and the strategy targeting only the wealthier group as 'w'.

$$p_{ij}^{b*} = \sigma\cdot MC\cdot\left(\frac{-1}{\lambda_{j1}\tilde{\epsilon}_{ij1}^{b}+\lambda_{j2}\tilde{\epsilon}_{ij2}^{b}}\right) \qquad (28)$$

$$p_{ij}^{w*} = \sigma\cdot MC\cdot\left(\frac{-1}{\tilde{\epsilon}_{ij1}^{w}}\right) \qquad (29)$$

Using the features of CES utility function, the maximized profits from these two different strategies can be written as:

Targeting both groups (strategy 'b'):

$$\pi_{ij}^{b} = \left(L_{j1}x_{ij1}^{b}+L_{j2}x_{ij2}^{b}\right)\left(\frac{1}{\sigma-1}p_{ij}^{b*}\right)-f_{ij}^{b} \qquad (30)$$

Targeting only the wealthier group (strategy 'w'):

$$\pi_{ij}^{w} = \left(L_{j1}x_{ij1}^{w} + L_{j2}x_{ij2}^{w}\right)\left(\frac{1}{\sigma-1}p_{ij}^{w*}\right) - f_{ij}^{w} \tag{31}$$

Due to the nature of the CES function, it is important to have $f_{ij}^{b} \neq f_{ij}^{w}$[6]. Here we assume the fixed costs for strategy 'b' is larger than the fixed cost for strategy 'w', or $f_{ij}^{b} > f_{ij}^{w}$, because of the ancillary cost incurred from larger quantity entering the destination. Note in equation (31), there is still demand from the lower income group even when the firm targets the wealthier consumers.

The firm will choose to target only the wealthier group if $\pi_{ij}^{w} \geq \pi_{ij}^{b}$, or

$$\left(L_{j1}x_{ij1}^{w} + L_{j2}x_{ij2}^{w}\right)\left(\frac{1}{\sigma-1}p_{ij}^{w*}\right) - f_{ij}^{w} \geq \left(L_{j1}x_{ij1}^{b} + L_{j2}x_{ij2}^{b}\right)\left(\frac{1}{\sigma-1}p_{ij}^{b*}\right) - f_{ij}^{b} \tag{32}$$

Plug in the prices in equations (28) and (29) and then for clarity, we take absolute value for all the elasticities. We get the inequality condition for the firm to choose strategy 'w' over strategy 'b':

$$\left(\lambda_{j1}|\tilde{\epsilon}_{ij1}^{b}| + \lambda_{j2}|\tilde{\epsilon}_{ij2}^{b}|\right)^{\sigma-1} - |\tilde{\epsilon}_{ij1}^{w}|^{\sigma-1} \leq \frac{\left(f_{ij}^{b} - f_{ij}^{w}\right)\tau_{ij}^{\sigma}}{\frac{\sigma}{\sigma-1}P_{j}^{\sigma-1}(L_{j1}w_{j1} + L_{j2}w_{j2})\left(\frac{z_{ij}}{MC}\right)^{\sigma-1}} \tag{33}$$

As discussed previously, we know that $|\tilde{\epsilon}_{ij1}^{b}| < |\tilde{\epsilon}_{ij2}^{b}|$. Hence equation (33) is more likely to be satisfied (choosing strategy 'w') if the income share of the wealthier group (λ_{j1}) is large and the share of the poorer group ($\lambda_{j2} = 1 - \lambda_{j1}$) is small. Firm are also more likely to choose strategy 'w' when the *Ad Valorem* tariff (τ_{ij}) is high. And naturally, the firm is likely to choose strategy 'w' if the fixed cost f_{ij}^{w} is small or if the fixed cost for the other strategy f_{ij}^{b} is large.

Suppose everything else is held constant and we can experimentally adjust the share of income in group 1 and group 2, starting from a relatively small number of λ_{j1} such that equation (33) is not satisfied. Firms will find it more profitable to target both groups of consumers (strategy 'b'). As the income share for group 1 increases (while equation (33) is still not satisfied), equation (28) shows that its optimal price increases as λ_{j1} increases. When λ_{j1} is large enough such that equation (33) is satisfied, firms will switch their strategies from 'b' to 'w' and charge an even higher price in equilibrium. In this exercise, the income inequality (or income shares by different consumer groups) plays a vital role in firm′s pricing decision. The price increases monotonically as the wealthier group′s income share gets larger and the poorer

[6] If $f_{ij}^{b} = f_{ij}^{w}$, strategy 'b' is always preferred.

group′s income share gets smaller.

In summary, we have assumed that a country consists of two groups of consumers with different income and studied firm's pricing strategy facing these two income groups. Firms can either target both income groups by taking both groups′ elasticities of demand into consideration, or target only the wealthy group by charging a higher price. Under the same framework used in previous sections, an interesting result is concluded: the firm charges higher price as the income share of the wealthier group gets larger, and will switch from targeting both groups to only the wealthier group if that share gets sufficiently large. This result is a potential explanation to the seemingly puzzling high prices in some developing countries such as China. This result has an intuitive interpretation in practice, when a firm enters a country with low income inequality (the wealthier group has small portion of total income), it is more likely to consider targeting the general public. On the contrary, if the country has high income inequality (the wealthier group holds large portion of total income), the firm is more likely to target the wealthy group and sets the price with respect to that group's income.

In this section, a highly tractable model is built and it comprehensively includes firm's quality choice and pricing-to-market decision. It shows that low productive firms optimally choose to produce low quality products, and practice pricing-to-market while highly productive firms optimally choose high quality products and set more uniformed prices among all destinations. The model is then extended to discuss the case where the destination country has income inequality where the total income is unevenly distributed among two income groups. It is concluded that under the mean-preserving spread assumption, price level monotonically increases when income inequality worsens. In the next section, the model is put to test and particularly, equation (13) is examined using various empirical models.

4. Data

4.1. JD Power Rating

We use the automobile industry as the subject of study because automobile industry is one of the few industries that have all the product's characteristics standardized and quantified. Characteristics such as horsepower (measured in hp), engine size (measured in c.c.), length, width, curb weight, number of airbags can all be found in each model of automobile. This offers a good base for hedonic analysis.

One of the most comprehensive studies of automobile industry is the JD Power automobile rating. JD Power assigns a rating from 1 to 5 to a model of a given year according to the Initial Quality Study (IQS), which keeps tract of the owner-reported problems within the first 90 days of owning a new automobile. The problems include any breakdown, malfunction, and control features defects. This definition of quality offers an objective measurement of a automobile's feature. Specifically, "this score is based on problems that have caused a complete breakdown or malfunction, or where controls or features may work as designed, but are difficult to use or understand."[7] It is independent from the add-on features of the automobile and is naturally a better proxy than the unit value.

Upon reading the definition of the JD Power Quality rating carefully, it is evident that its definition of quality does not align with the definition of quality specified in our model. Specifically, JD Power rating records the owner-report problems. These problems range from actual defects or malfunctions to hard-to-understand designs or complaints of the voice-recognition system. Raffi Festekjian, JD Power's director of automotive research, said that "we make no judgment about these answers. We simply report the voice of the customers."[8] But the quality defined in this study focuses either on the durability of the automobile (on consumer side) or the level of excellence achieved by more labor input (on producer side). The JD Power rating fails to capture either side of the quality defined in this study. In other words, "lack of complaints on a automobile model" (JD Power definition) is not equivalent to "durability and level of excellence of the automobile model" (quality definition in this study). Hence the JD Power definition is not consistent with the quality definition in our model.

Despite the difference in definition, JD Power rating does reveal some important information about the manufacturer of the automobile. As a matter of fact, the JD Power rating shows not only the technical functionality of a automobile model, it also shows the "attention-to-detail" aspect of the manufacturer. Specifically, in order to make sure all the details of a model works as expected on the consumer end, and deliver the concept consistently from drawing board to consumers, the manufacturer needs to put in enough efforts covering every chain in the production line. This requires a firm of high productivity to successfully achieve that goal of high JD Power rating. Considering this aspect, the JD Power rating actually reflects the manufacturer's productivity (ϕ). Hence instead of using JD Power rating as a quality proxy, we will use it as the productivity proxy in the following part.

To further study the JD Power and how it relates to other variables, we first are interested to see the correlation between the JD Power ranking and the unit value. In Figure 4, we show the boxplot of the European unit value at every JD Power ranking (from 2 to 5).

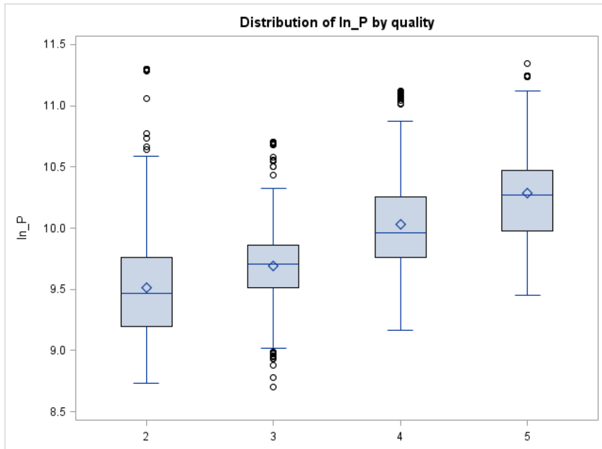
As it shows in the Figure 4, both the median prices (the middle line in each box) and the mean prices (the diamond in each box) are higher when the automobile quality gets higher. This shows that there exists some correlation between the unit-value quality proxy and the JD Power proxy. In other words, luxury automobiles in general have better rating (fewer defects or malfunctions). But of course, exceptions do exist. In the lowest two ratings (ratings 2 and

[7] http://autos.jdpower.com/ratings/quality.htm

[8] http://www.caranddriver.com/features/the-trouble-with-jd-powers-initial-quality-study-feature

3), there are quite a few expensive automobiles. This shows the advantage of the JD Power rating because it is price- and feature-independent. The unit-value quality proxy would not be able to show this information.

Figure 4: 2008-2011 European automobile price boxplot by JD Power ranking.



Note: 2008-2011 European automobile price boxplot by JD Power ranking (on the x-axis): 2008-2011 European automobile prices were grouped by the JD Power quality ranking (from 2 to 5). The upper and lower bounds of the box are 1st and 3rd quantiles. The center bar in the box denotes the median of automobile price, and the diamond denotes the mean of price in that quality category.

Next we apply the JD Power rating in the illustration of the pricing-to-market stylized facts. Here we again use the European automobile models in 2008-2011 totaling 172 automobile models. First we group all the automobile models by their JD Power rating, then we run the simple linear regression of $ln(P_{ijkl}) = \alpha_{ikl} + \beta_{ijkl} \cdot ln(GDP_j) + \epsilon_{ijkl}$ for each model where i, j, k, l denote exporting country, importing country, automobile company, and automobile model, respectively. Table 1 shows the percentages of positive and the significantly positive of β_{ijkl} results in each rating.

In Table 1, we showed the results of the coefficient β_{ijkl} of the simple linear regression model $ln(P_{ijkl}) = \alpha_{ikl} + \beta_{ijkl} \cdot ln(GDP_j) + \epsilon_{ijkl}$ in 172 automobile models. The 172 automobile models were grouped by the JD Power rating as seen in the first column. In the second column of the table, we calculated the percentage of the automobile models with $\beta_{ijkl} > 0$ in that category of level; in the last column, we calculated the percentage of the automobile models with significant $\beta_{ijkl} > 0$ at 10% significant level in that level. The positive and significantly positive slope coefficient suggest that the automobile model is sold at a higher price in countries with higher income and vice versa. In particular, a significantly positive coefficient suggests the pricing-to-market behavior. In both the second and the third columns, the percentages of pricing-to-market automobile models gets higher as the rating gets lower. In particular, more than 90% of the lowest rating models have positive coefficients and in the same rating level, 65% of the automobile models exercise the pricing-to-market strategy. Contrasting to the high percentages of pricing-to-market strategy found in the low-rating models, less than half of the models (45%) have a positive β_{ijkl} in the highest-rating models. In that rating category, only 9% of the models have significant positive β_{ijkl}, or exercising pricing-to-market strategy. This striking contrast is consistent with our observation in the introduction section.

Table 1: The percentage of positive and positive and significant slope coefficient (β_{ikl}) grouped by JD Power quality rating. The linear regression model: $ln(P_{ijkl}) = \alpha_{ikl} + \beta_{ijkl} \cdot ln(GDP_j) + \epsilon_{ijkl}$

JD Power Rating (Number of models in that quality rating.)	% of automobile models with $\beta_{ijkl} > 0$	% of automobile models with significant* $\beta_{ijkl} > 0$
$q = 2$ (N=74)	92%	65%
$q = 3$ (N=52)	88%	38%
$q = 4$ (N=24)	67%	33%
$q = 5$ (N=22)	45%	9%

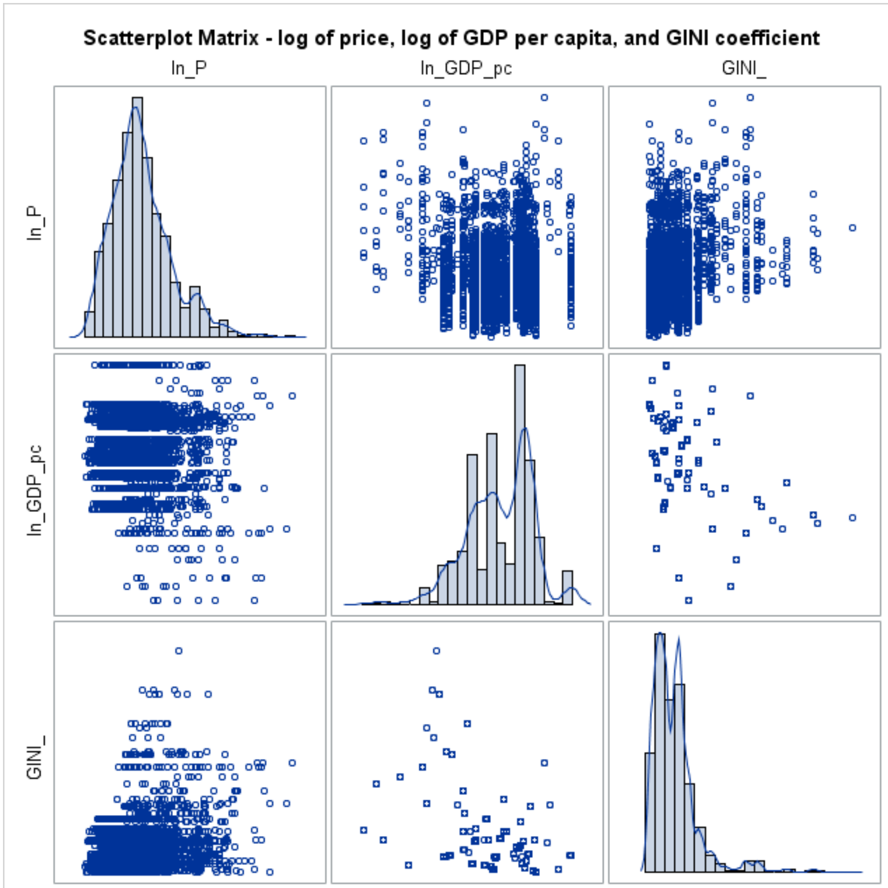
$*$ denotes significant at 10% significance level.

4.2. Price, income per capita, and GINI coefficient

The key predictions in the study involve the automobile's prices, the income and the income inequality (GINI coefficient) of the buying countries. Figure 5 shows how the three variables correlate. It suggests two observable relationships: the price versus the GINI panel (1st row, 3rd column) shows that the price trends upward with the increase of GINI; and the GDP per capita versus the GINI coefficient panel (2nd row, 3rd column) shows that countries tend to have low income inequality when the GDP per capita is higher. The graph only conveys some general correlations without controlling for the hedonic features of the automobile.

The automobile data used in this study come from various sources. Three of the main sources are: European Commission automobile report (2007-2011), WardsAuto U.S. autos (2011), and automobile companies' websites (for 2012 automobile models). The prices from the first two sources are adjusted for tariffs and VAT (value-added tax). The price from the last source (online MSRP: manufacturer's suggested retail price) needs to be adjusted because most of it contains the price information that are tariff- and VAT-inclusive.

Figure 5: Scatterplot matrix of log of automobile price, log of income per capita, and GINI coefficient. The diagonal plots show the histogram and kernel distribution of each variable.



Besides the price information, we also collect information about technical specifications. Technical specifications include horsepower, engine size, curb weight, length, width, height, number of doors, climate control, diesel engine or not, ABS (anti-brake system), number of airbags, stability or traction control, blind spot monitors, all wheel drive or not, and JD Power rating. In equation (11), the optimal choice of quality is a monotonic transformation of a firm's productivity ϕ. Since the firm's productivity is unobservable, the JD Power ranking is used as the proxy for firm's productivity.

5. Results

Previously we derived equation (13) showing that the price can be broken down into the markup and the marginal cost, and the markup is variable and increases with destination country's income. In this section, we will follow this reasoning and study prices in the automobile industry. The first part of the price (the marginal cost) will be estimated by the various hedonic features of a automobile, and the second part of the price (the price markups) will be captured by the country-specific variables. Here we construct six models where models (1)-(3) consider mainly the hedonic features of the automobile model and models (4)-(6) add in the country-specific features to capture the price markups. The results are shown in Table 2. Year fixed effect is included in all models.

The first model focuses on the marginal cost component of the price and regress the (log of) price on only the technical (or hedonic) features of a automobile. This is also a traditional hedonic analysis studied by many automobile studies including Feenstra (1988). The results of this model (model 1) are listed in the second column in Table 2. Here we regress the log of price on whether the automobile is manual transmission (Manual), the horsepower of the automobile (Horsepower in hundreds), engine displacement (Engine in litres), dimension of the automobile (Length and Width in feet), curb weight of the automobile (Weight in hundreds pounds), number of doors (Door Number), fuel consumption (MPG: miles per gallon), whether the automobile is a hybrid or not (Hybrid), whether the automobile has a diesel engine or not (Diesel Engine), number of airbags (Airbags), stability or traction control (Stability), and all-wheel-drive feature (AWD). Different from the traditional hedonic analysis, a few safety features (stability and traction control, number of airbags) and fuel-efficient features (MPG, Hybrid) which are modern features that directly contribute to the price variations are added to the analysis. In Table 2, the results reported under model Hedonic1 (1) show all the variables but one are significant at 95% confidence interval. We first look at the ones with positive and significant results in Hedonic1 (1) model. The significantly positive coefficients suggest that automobiles with higher horsepower, bigger size, heavier weight, a diesel engine, a hybrid engine, safety features such as more airbags, stability control, are more expensive. The negative and significant features suggests that automobiles with manual transmission, higher engine displacement, more doors, higher MPG are set at a lower price. While all the positive and significant results are not surprising, some significantly negative coefficients are counter-intuitive at the first sight, particularly the engine displacement, number of doors, and MPG. Here are some of the explanations of the negative coefficients: the engine displacement calculates the volume of air swept by all the pistons in an engine and is a measurement of a automobile's power. Recently with the invention of fuel-efficient technology, hybrid automobiles (usually more expensive) have smaller combustion engine, thus smaller engine displacement. This is the main reason causing the negative coefficient of the engine displacement. Since we already have the variable Horsepower to capture the power of the automobile, engine size will not be included in models (2)-(6). As for the number of doors, our sample includes some expensive top-line two-door sporty models such as Mercedes SL, SLS and they tend to be more expensive than other sedans. Lastly, the negative MPG coefficient is a puzzling result until we look at the data closely. Although hybrid engine and other fuel-efficient technology usually result in more expensive automobiles, one important determining factor of high MPG is the small size and light weight of the automobile. That is why the MPG coefficient is negative because most small automobiles (cheaper automobiles) have high MPG. Since we have size and weight variables as well as the hybrid dummy, we will leave MPG out in the models (2)-(6). In model Hedonic2 (2), the engine displacement and MPG are not included, and no change in the sign or the significance of the coefficients is present.

As discussed previously, the JD Power rating is used as the productivity proxy in our study. Hence we include the JD Power rating in the model hoping to capture the productivity variable (Prod (3) in Table 2). A significantly positive sign is shown which means that higher productivity leads to more expensive automobiles. This result is consistent with equation (12) where price increases as productivity increases. In the next model Market (4), all the hedonic variables are included and the population is added in order to capture the competitiveness at the destination. The rationale is that larger markets attract more competition and firms should act more competitively in such markets. The result of the population coefficient is significantly negative, suggesting that firms reduce prices (act competitively) in bigger markets. Again, all the hedonic coefficients remain the same sign and significance in the model Market (4).

The findings of this paper (equation (13)) suggest that the price markup is variable across countries and is directly affected by destination country's income. In the model Income (5), we add the income (GDP per capita in log) and the square of it to capture the variable price markup. The coefficients of Income and Income^2 are 0.043 and -0.018, respectively. The result shows that controlling for the hedonic features of the automobile model, automobiles are sold at higher price (at a decreasing rate) in countries with higher income. This suggests a general pricing-to-market behavior exercised by the models in this study.

The last model Inequality (6) is motivated by the discussions in equations (28) and (29) where disproportional wealth allocation lead to higher prices. Here the GINI coefficient is used to capture the level of income inequality in each country. The positive and significant result shows that controlling for all the hedonic, market size, and income variables, firms tend to set higher price in countries with higher income inequality. This supports our findings of counter-intuitive high prices in many developing countries such as China and Thailand. The model (6) brings the adjusted R^2 to 0.92. Figure 6 shows that the automobile price versus the predicted price (both in log).

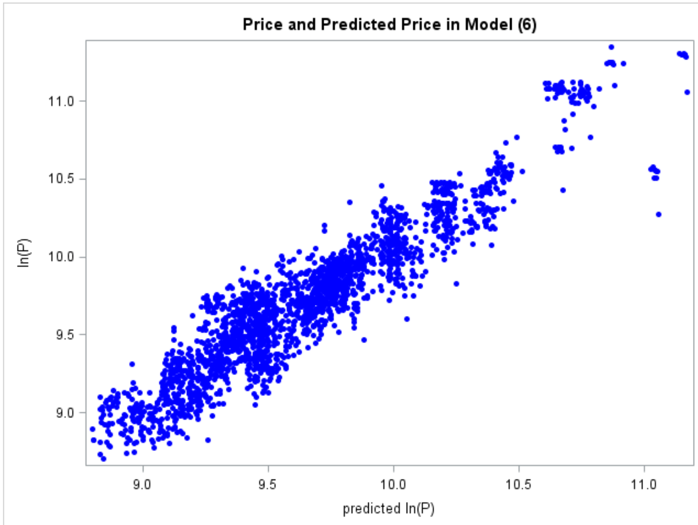
Table 2: Coefficients of various regression models on price (in logarithm) of automobiles.

Coefficients (standard deviations). Dependent variable-price[†].

	Hedonic1 (1)	Hedonic2 (2)	Prod(3)	Market(4)	Income(5)	Inequality(6)
Manual	-0.11*	-0.11*	-0.10*	-0.10*	-0.10*	-0.09*
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0009)
Horsepower[††]	0.44*	0.47*	0.47*	0.46*	0.34*	0.31*
	(0.019)	(0.019)	(0.019)	(0.019)	(0.02)	(0.05)
Engine (in litres)	-0.08*					
	(0.018)					
Length	0.059*	0.059*	0.059*	0.058*	0.049*	0.049*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Width	0.06*	0.062*	0.057*	0.055*	0.051*	0.051*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Weight [††]	0.018*	0.020*	0.018*	0.018*	0.017*	0.017*
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0018)	(0.0018)
Door Number	-0.07*	-0.07*	-0.07*	-0.07*	-0.06*	-0.06*
	(0.0077)	(0.0076)	(0.0076)	(0.0076)	(0.008)	(0.009)
MPG	-0.0025*					
	(0.0003)					
Diesel Engine	0.128*	0.12*	0.12*	0.12*	0.11*	0.11*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.015)	(0.018)
Hybrid	0.08*	0.10*	0.09*	0.081*	0.073*	0.073*
	(0.013)	(0.013)	(0.014)	(0.013)	(0.015)	(0.018)
Airbags	0.05*	0.05*	0.048*	0.047*	0.047*	0.047*
	(0.004)	(0.0042)	(0.0042)	(0.0043)	(0.0048)	(0.0049)
Stability	0.06*	0.06*	0.06*	0.06*	0.06*	0.06*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.018)	(0.018)
AWD	0.017	0.02	0.007	0.005	0.005	0.002
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)
JD Power			0.157*	0.15*	0.15*	0.14*
			(0.033)	(0.034)	(0.034)	(0.037)
Population[†††]				-0.014*	-0.013*	-0.012*
				(0.003)	(0.003)	(0.004)
Income[†]					0.043*	0.04*
					(0.0071)	(0.008)
Income[†]^2					-0.018*	-0.01*
					(0.0023)	(0.003)
GINI(%)						0.30*
						(0.09)
adj. R^2	0.85	0.84	0.86	0.88	0.91	0.92
N	4982	4982	4513	4513	4487	4312

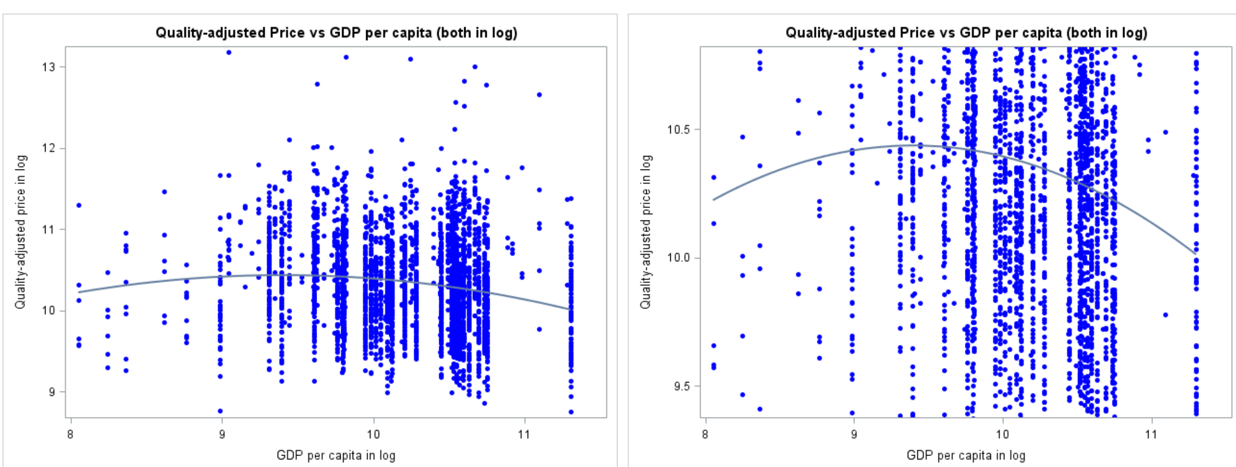
[†] in logarithm.[††] in hundreds.[†††] in thousands.
* Significant at 95% confidence interval.

Figure 6: Car price versus the predicted price (both in logs)



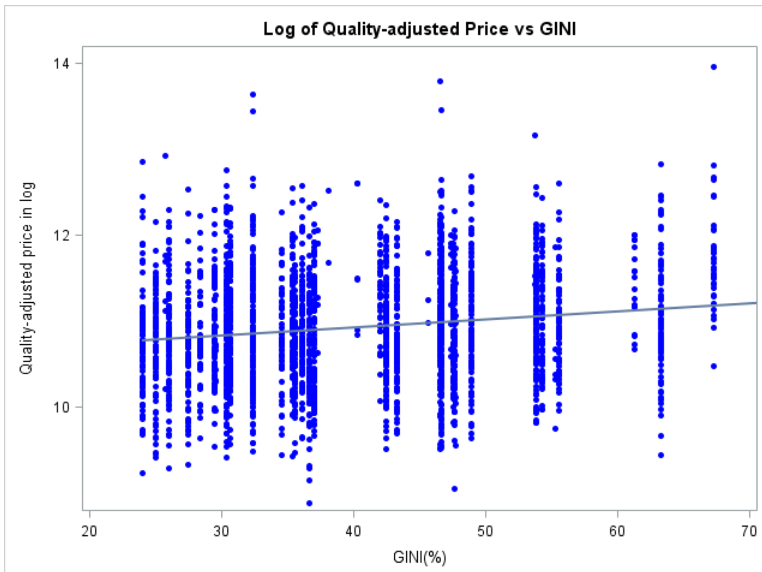
In order to emphasize on the key prediction in the model, the quality-adjusted price is generated by adjusting for automobile's hedonic features, population, JD Power, and GINI. The remainder of the price (the quality-adjusted price) is then plotted against GDP per capita (in logs). The result is presented in Figure 7. Two panels in the figure are the same figure but of difference y-axis scale. It shows that although there still exists substantial intra-country dispersion, the cross-country trend of the automobile price can be captured by per capita GDP and its quadratic term.

Figure 7: Quality-adjusted price of each model of automobile versus the GDP per capita (both in logs). The right-hand panel is the enlarged part of the left-hand panel.



Another key prediction of the model is that the income inequality increases the price of the automobile under the mean-preserving condition. Therefore, the quality-adjusted price is generated by adjusting cars' hedonic features, population, JD Power rating, and income, and is then plotted against GINI coefficient as shown in Figure 8. An upward trend of quality-adjusted price is observed when we plot it against the GINI coefficient.

Figure 8: Quality-adjusted price (in log) of each model of automobile versus the GINI coefficient.



In models (5) and (6) of Table 2, it is apparent that the pricing-to-market behavior is prevalent and significant in overall sample. However, these results do not answer the main question in this paper: Does the pricing-to-market strategy change in different quality levels. To answer this question, we group the sample by the productivity level and then run a similar regression in each subgroup. This time we will focus on the coefficient change in Income and Income^2 across different qualities. Table 3 shows these results.

Table 3: Coefficients of various regression models on price (in logarithm) of automobiles by JD Power rating.

Coefficients (standard deviations). Dependent variable-log of price†.

JD Power Rating	2	3	4	5
Manual	0.069*	-0.111*	0.013	0.026
	(0.023)	(0.031)	(0.029)	(0.048)
Horsepower††	0.3*	0.3*	0.68*	0.81*
	(0.0003)	(0.05)	(0.135)	(0.217)
Length	0.13*	0.031*	-0.0093	0.0151
	(0.007)	(0.005)	(0.0081)	(0.0134)
Width	0.21*	0.017*	0.0596	-0.0311
	(0.025)	(0.004)	(0.126)	(0.0197)
Weight ††	-0.0034	0.056*	0.079*	0.025*
	(0.0028)	(0.004)	(0.018)	(0.009)
Door Number	-0.1123*	-0.013	-0.0017	0.0182
	(0.0095)	(0.009)	(0.0011)	(0.0128)
Diesel Engine	0.204*	0.115*	0.108*	0.174 *
	(0.013)	(0.021)	(0.023)	(0.05)
Hybrid	0.053*	0.031*	0.123*	0.101
	(0.008)	(0.010)	(0.032)	(0.137)
Airbags	0.072*	0.082*	0.013	0.028*
	(0.012)	(0.021)	(0.011)	(0.009)
Stability	0.041*	0.21*	0.013	0.025
	(0.012)	(0.035)	(0.019)	(0.030)
Population†††	-0.042*	-0.021*	-0.011*	-0.022*
	(0.003)	(0.006)	(0.004)	(0.010)
Income†	0.214*	0.041*	0.150	-0.345
	(0.037)	(0.016)	(0.387)	(0.407)
Income^{2†}	-0.007*	-0.006*	-0.006	0.016
	(0.001)	(0.002)	(0.019)	(0.019)
GINI(%)	0.4*	0.21*	0.13*	0.22*
	(0.12)	(0.04)	(0.03)	(0.10)
adj. R^2	0.89	0.87	0.94	0.96
N	1751	1208	632	721

† in logarithm.†† in hundreds.††† in thousands.

* Significant at 95% confidence interval.

In Table 3 the automobile price analysis is broken down by productivity levels. The car models with JD Power rating of 2 is the majority in the sample, followed by the sample size of JD Power rating of 3. The highest JD Power ratings 4 or 5 have about the same size in the sample. The primary goal of generating Table 3 is to study the pricing-to-market strategy at different productivity, thus different quality level (equation (11)). The key coefficients in the table are the Income and Income^2 rows. The Income coefficient is positive and significant at the lowest two JD Power ratings of 2 and 3, while the Income^2 terms are both negative in these two ratings. These results suggest that low-quality models exercise pricing-to-market strategy across destinations. Namely, the same automobile model will be sold at higher price in higher income countries at a decreasing rate (Income^2 coefficient is negative). In contrast to the low-productivity pricing-to-market strategy, the two higher ratings (4 and 5) do not have the same strategy. The coefficients of Income and Income^2 are not significantly different from zero in ratings 4 and 5. This result of Income and Income^2 in ratings 4 and 5 suggests that the prices of high-productivity, high-quality automobile models are not systematically affected by destination country's income. These results support the findings in our model and are consistent with the stylized fact we started with.

Besides the key coefficients of Income and Income^2, we notice that some of the hedonic and country-specific coefficients become non-significant. Among all the hedonic features, only the Horsepower and Diesel Engine remain significantly positive in all quality levels. In the country-specific variables,the population and GINI coefficients remain significantly negative and significantly positive, respectively.

6. Extension: Production Cost and Transportation Cost

So far we have studied automobile companies' pricing strategies considering the marginal cost and the price markup parts. In the marginal cost part, it is implicitly assumed that the same automobile model with the same hedonic specifications has the same production cost due to the standardized production procedure regulated by each automobile company. However, one may argue that even for the same production technology, the cost of production may vary across countries due to reasons such as workers' wages. Hence in this section, we will consider the difference in cost of production from each producing country. Here the average wage of the production workers in each country of origin is used . However, because we do not have all the country of origin information in our data, this will substantially reduce our sample size. Among the 4312 observations in model (6) in Table 2, we only have the country of origin information for 2471 observations, a little more than half of it.

Table 4: Regression of price (in logarithm) of automobiles on variables, including the producing country's production wage (in logarithm) and the distance from the producing country to the destination country (in logarithm).

	Model (6)	Model (7)
Manual	-0.09*	0.03
	(0.0009)	(0.06)
Horsepower††	0.31*	0.35*
	(0.05)	(0.08)
Length	0.049*	0.057*
	(0.005)	(0.008)
Width	0.051*	0.041*
	(0.02)	(0.017)
Weight ††	0.017*	0.02*
	(0.0018)	(0.007)
Door Number	-0.06*	-0.04*
	(0.009)	(0.009)
Diesel Engine	0.11*	0.13*
	(0.018)	(0.03)
Hybrid	0.073*	0.052*
	(0.018)	(0.021)
Airbags	0.047*	0.037*
	(0.0049)	(0.004)
Stability	0.06*	0.07*
	(0.018)	(0.02)
AWD	0.002	0.01
	(0.05)	(0.05)
JD Power	0.14*	0.13*
	(0.037)	(0.024)
Population†††	-0.012*	-0.014*
	(0.004)	(0.003)
Income†	0.04*	0.03*
	(0.008)	(0.005)
Income†2	-0.01*	-0.02*
	(0.003)	(0.004)
GINI(%)	0.30*	0.32*
	(0.09)	(0.1)
production wage†		0.03
		(0.03)
distance†		0.09*
		(0.02)
adj. R^2	0.92	0.89
N	4312	2471

† in logarithm.†† in hundreds.††† in thousands.
* Significant at 95% confidence interval.

Besides the difference in production cost, the cost of transportation was not considered in the previous discussion due to the same reason that information of many countries of origin is not available. In this section, we will consider the effect of the production cost (measured by production labor's wage) and the transportation cost (the distance between two major cities of trade) on a smaller sample size. In Table 4, we add the wage of production workers in the producing country and the distance from the producing country to the destination country to capture these two aspects. Model (6) is repeated from Table 2 and listed here as a comparison.

Model (7) in Table 4 indicates that the wage of the production labor in the exporting country does not significantly affect automobile price. This means that in our sample, the exporting country's production wage does not systematically affect the automobile price. The coefficient of distance is significantly positive. This shows that the transportation cost systematically and positively affects the price of automobile.

Comparing model (7) with model (6), we notice that only the coefficient of the variable "Manual" turns from significantly negative to non-significantly positive. All the other coefficients remain at the same level of significance and sign, meaning that adding the wage of production worker and distance has limited effect on the existing coefficients.

7. Conclusion

This paper began by addressing an interesting but often overlooked feature: varying pricing-to-market behavior in quality dimension. We started by illustrating the stylized fact of prices versus GDP per capita in several automobile models. The data suggest that the pricing-to-market strategy is often exercised by low-quality firms but is not so by high-quality firms. Motivated by this interesting stylized fact, a model is built where firms face the distribution cost denominated by destination country's income. Both quality and price are determined simultaneously and it is concluded that the optimal price was a combination of marginal cost (product-specific) and price markup (destination country-specific). The model is highly tractable and it shows that firms with higher productivity produce higher quality good and charge more uniformly. Although price increases with destination country's income, the marginal effect dampens. Namely, there is no apparent pricing-to-market behavior in high-productivity, high-quality firms as in low-productivity, low-quality firm. This model reconciles the contrasting pricing strategies in high and low quality firms.

The second part of the model is dedicated to the study of how income inequality affects firm's pricing decision. This part is motivated by some irregularly high prices in some developing countries such as China. The argument is that firms can target the wealthier group of the consumers, or both the wealthy and the poor groups. It is then concluded that firm's prices will increase monotonically when the income inequality worsens (more uneven distribution of total income) in that country. This result shows when everything else is held equal, firms will set higher price in high income inequality country.

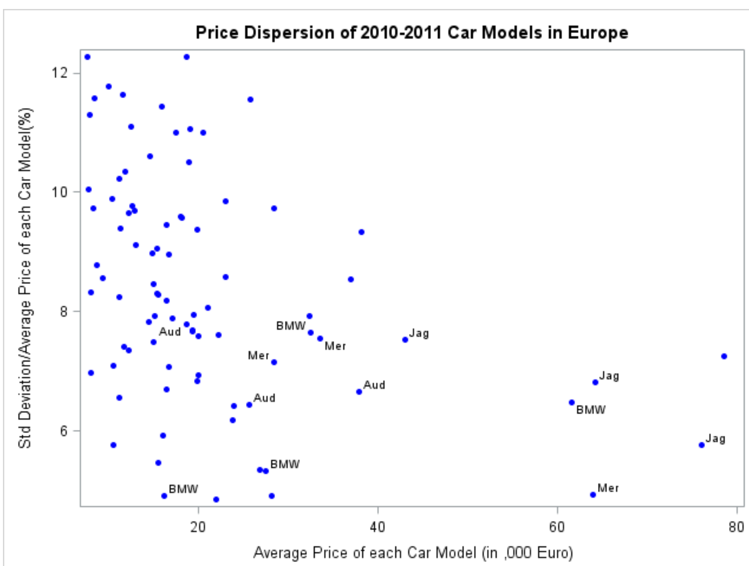
In the empirical part of the paper, the empirical model consistent with the theoretical model is constructed. Specifically, the hedonic features are used to capture the product-specific marginal cost part of the price; and the population, income, and GINI are used to capture the country-specific markup part of the price. Using the JD Power rating as the productivity proxy, it is concluded that low-productivity, low-quality automobile models exercise pricing-to-market strategy while high-productivity, high-quality automobile models do not exercise pricing-to-market strategy. Additionally, controlling for all hedonic features and other country-specific features, firms set higher prices in places with higher income inequality. These results support the theoretical model as well as the stylized facts coherently. The findings and results in this study contribute to current trade literature by providing a more comprehensive framework studying firm's choice of quality and pricing-to-market strategy.

Appendix

A. Car company's pricing-to-market behavior

Car companies offer a natural way to group the varieties of automobile models and avoid some cross-company variations. Within each company, the vertical differentiation of automobile models offers us a good way to rank the automobile models using unit-value quality proxy. Some automobile companies have a uniformed pricing-to-market strategy while others have different strategy for different model. Here we first show the stylized fact for the ones with uniformed pricing strategy. Four car companies (Audi, BMW, Jaguar, Mercedes) in the 2010-2011 panel of Figure 1 are labeled in Figure A.1. As shown in Figure A.1, some of the low-price, low-price-dispersion models are company-specific. These automobile companies do not seem to exercise pricing-to-market strategy disregard of the models they produce. For instance, the four models of BMW all appear to have low price dispersion across all countries. Similar case can be found in Jaguar, Mercedes, and Audi. This result suggests that sometimes pricing strategy may be company-specific and not model-specific.

Figure A.1: Standard Deviation/Average Price (%) and Average Price of four automobile companies in 2010-2011.



Note: Standard Deviation/Average Price (%) and Average Price of Audi (Aud), BMW, Jaguar (Jag), Mercedes (Mer) Models in 2010-2011.

In some other cases, models belonged to the same automobile companies have different pricing-to-market strategies. The pricing-to-market behaviors of the European automobiles are documented in in Figures 2 and 3, here we document the MSRP automobile information available online for 2012 automobile models and conduct similar analysis. It shows the difference in pricing strategy within each automobile company. We choose 3 automobile models from each automobile company with high, medium, and low prices representing high, medium, and low qualities. For each automobile model, we quote the price of the 2012 most basic line sold in all countries and convert to U.S. dollar using the exchange rate in August 2012. Here are the eight automobile companies: BMW, Ford, Honda, Toyota, Volkswagon, Mazda, Kia, and Hyundai. Keep in mind that we do not rank the quality between automobile companies as it calls for much subjective judgment.

Table A.1: Coefficients and standard deviations of Price on logarithm of GDP per capita for selected automobile models.

BMW 740i	BMW 535i	BMW 328i
-0.12 (0.17)	0.09 (0.12)	0.068 (0.072)
Ford Fusion	Ford Focus	Ford Fiesta
0.061 (0.17)	0.12 (0.089)	0.018 (0.10)
Honda Accord	Honda Civic	Honda Fit
0.54* (0.23)	0.49 (0.24)	0.30* (0.16)
Toyota Camry	Toyota Corolla	Toyora Yaris
-0.12 (0.60)	0.49* (0.24)	0.356* (0.169)
Volkswagon CC	Volkswagon Passat	Volkswagon Jetta
0.79 (0.51)	0.39 (0.35)	0.55* (0.27)
Mazda 6	Mazda 3	Mazda 2
0.176 (0.178)	0.13 (0.11)	0.055 (0.048)
Kia Optima	Kia Forte	Kia Rio
-0.41 (0.32)	0.013 (0.135)	0.10 (0.05)*
Hyundai Genesis	Hyundai Sonata	Hyundai Elantra
-0.022 (0.113)	-0.048 (0.23)	0.26 (0.13)*

$*$ denotes significant at 10% significance level.

We run the simple regression of $ln(P_{ijkl}) = \alpha_{ikl} + \beta_{ikl} \cdot ln(GDP_j) + \epsilon_{ijkl}$ where i, j, k, l denote exporting country, importing country, automobile company, and automobile model, respectively. Table A.1 lists the β_{ikl} coefficient for each automobile model (coefficients and standard deviations are reported in Table A.1 in the Appendix). Each row corresponds to a automobile company and the most expensive model (hence the highest quality according to unit-value quality proxy definition) is listed on the left.

The first thing we noticed is that among all eight top models (the left column), only half of the coefficients are positive and among the positive ones, only one has coefficients that is significantly positive. This result shows that for 7 out of 8 high-quality automobile models, the prices are not affected by destination country's GDP per capita systematically. For the 16 middle and low quality automobiles, 15 out of 16 models are positive and in the last column (the lowest quality automobile in each automobile company), five out of eight of them are significantly positive. This again supports the stylized fact in the introduction: firms practice price-to-market in low-quality models but not in high-quality models.

B. Apparel company's pricing-to-market behavior

Different from the automobile company, the apparel company is not usually characterized by vertical differentiation within each brand, the cross-company quality differentiation is usually more pronounced than it is in automobile industry. Hence we chose three internationally-known brands to represent high, medium, and low quality using the concept of unit-value quality proxy. The companies are Burberry, Mango, and H&M[9]. We chose six apparel items in each brand with similar design and fabrics: trench coat, skirt, women's jacket, trainer shoes, cardigan, and women's jeans. Similar to the previous automobile example, we run the same regression of $ln(P_{ijkl}) = \alpha_{ikl} + \beta_{ijkl} \cdot ln(GDP_j) + \epsilon_{ijkl}$ and list the coefficient and standard deviation of β_{ikl} in each item of clothing.

Table B.1: Coefficients and standard deviations of Price on logarithm of GDP per capita for selected clothing items carried by Burberry, Mango, and H&M.(β_{ikl} in the model: $ln(P_{ijkl}) = \alpha_{ikl} + \beta_{ijkl} \cdot ln(GDP_j) + \epsilon_{ijkl}$)

	Burberry	Mango	H&M
Trench Coat	0.089 (0.076)	0.015 (0.009)	0.006*(0.002)
Skirt	0.017 (0.018)	0.0019 (0.017)	0.002* (0.001)
Women's Jacket	0.07 (0.06)	0.011 (0.008)	0.001 (0.006)
Trainer Shoes	0.028 (0.018)	n.a.	0.089 (-0.13)
Cardigan	0.024 (0.025)	0.0025*(0.0009)	0.0012* (0.000072)
Women's Jeans	0.0006 (0.013)	0.0019 (0.0014)	0.001 (0.05)

$*$ denotes significant at 10% significance level.

[9]The average price of an apparel item is the highest for Burberry and lowest for H&M.

Although most coefficients in the left column of Table B are greater than 0, none is significant. This suggests that Burberry's pricing strategy is not significantly affected systematically by destination country's GDP per capita in any item. And in the middle and right column, some of the coefficients are significantly positive. This means that these items are affected by destination country's GDP systematically. In particular, the lowest-quality H&M appears to exercise price-to-market according to destination country's GDP per capita in many of their items. This again supports the stylized fact established in the introduction where high and low quality products appear to have different pricing strategies.

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