Branding and the Ravages of Time:
The effect of time on the brand premiums of automobiles

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Abstract

As more durable goods offer higher proportions of intangible benefits, understanding how these benefits change over time is crucial for firms' developing successful marketplace strategies. We take advantage of the phenomenon of twin cars – pairs of car models that are nearly identical from a structural and mechanical standpoint, but are sold under differing brand names – to disentangle the effects of physical wear-and-tear, which should impact both the premium brand and the corresponding standard brand similarly; in contrast to time depreciation, which should affect each brand differently. This phenomenon enables us to test how intangible benefits hold (or decrease) over time.

We use data on prices of new and used cars (for each year and mileage) that include the car's age; its usage in term of distance driven; its external condition, and its status (premium vs. standard) for 21 twin car pairs, for an average observation period of nine years, to estimate the deprecation in car values depending on condition and age.

The main result is that a premium car's depreciation age is much higher than that of the standard car (controlling for their respective mileages and initial prices). Age depreciation captures the decay in the intangible benefits provided by the car over time. This result, which confirms our analytical model, demonstrates that the true cost of owning a premium car is not just its initial high price, but the faster depreciation of the car's intangible value over its lifetime, as compared to the standard version of that same premium brand.

1. Introduction

Porsche Cayenne and iPhone7 are examples of luxury durable goods that represent status symbols for some segments of the population. Expensive houses, luxury cars and fashion items have been a symbol of wealth and success for generations (Solomon, 1983). Consumers may use expensive and trendy electronic items as a signal for wealth and refined taste. Owners of such goods receive tangible benefits from the quality of these products, as well as intangible benefits from the ownership of a luxury, high-status brand. Many durable goods, however, lose value over time, as their tangible benefits decrease and their performance deteriorates. Cars, for example, incur more wear and tear the older they are and the more they are driven, while smartphones become obsolete as newer versions with better technologies appear and the supply of application declines as developers focus on the new technology. Thus, an iPhone5, launched at a price of $399 for the 64GB version in 2012 is worth less today and could be purchased for $149.99 at Amazon. The decline in the price of a new iPhone 5 price may be attributed to relatively lower performance compared to newer models, as well as signaling lower status relative to its introduction year. While it is clear that the tangible benefits of durable goods decrease over time, it is less clear whether the owner of an older iPhone still derives the same *intangible* benefits as compared to the day it was launched or purchased[1]. Furthermore, the rate of depreciation of the intangible benefits of status products has not yet been quantified.

Understanding how these intangible benefits change over time is crucial for firms in order to develop successful marketplace strategies in general and pricing in particular. Previous studies that compared prices between stronger and weaker brands present a mixed picture. Sullivan (1998) found that stronger car brands retain higher value in the second-hand market over time.

[1] In this paper, we do not deal with cases wherein value may increase for some period of time, such as for example, the aging of wine, antiques, or classic cars.

However, Sullivan's measure of brand strength is based solely on tangible benefits. Thus, it remains unclear as to the effects of intangible brands benefits on the retention of value. Stahl et al. (2012) found a positive correlation between the esteem component of a car's brand equity and customers' retention of the brand. This is in contrast to Kurz and Li (2015) who show that the length of ownership of luxury cars is shorter than that of non-luxury cars.

In this paper, we seek to shed light on this question by investigating how cars' intangible benefits hold up over time in the used car market. We take advantage of the phenomenon of twin cars – different car models that are virtually the same from a structural standpoint, but are sold under differing brand names (Sullivan 1998) – to disentangle the effects of physical wear-and-tear – which should impact both the premium car brand and the standard-priced brand similarly – from the effect of time depreciation (on the value of the brand as a symbol), which should affect each brand differently. We first show analytically that as the perceived importance of status increases, the price of the used car should be lower compared to the price of the new car. We then use data on prices of new and used cars (for each year and mileage) that include the car's age; its usage in term of distance driven; its external condition, and its status (premium vs. standard) for 21 twin car pairs, to estimate the deprecation in car values depending on their conditions and ages.

The main result is that, as the theory suggests, the age depreciation of a premium car is much faster than that of a standard car (controlling for their mileage depreciation and for their initial prices). Age depreciation captures the decay in the intangible benefits provided by the car over time. This result demonstrates that the true cost of owning a premium car is not just its high initial price, but also the faster depreciation of its intangible value over its lifetime, as compared to the standard version of that same premium brand.

2. Theory

Material possessions play a central role in the creation of self-image (Belk 2013). The value material possessions impart to consumers' self-image, self-identity, and social image changes over time (Richins and Bloch 1991) and the change depends upon consumers' characteristics (Ball and Tasaki 1992). Dinnin (2009) demonstrated that the benefit of newness declines overtime, while Ball and Tasaki (1992) showed that for older consumers, attachment to possessions is characterized by an inverted U shape over the period of ownership. Several mechanisms are used to explain the decrease in value of possessions as the time of purchase recedes. As owners become accustomed to their possessions, they undergo a process of hedonic adaptation, i.e., the level of enduring involvement with the product declines (Richins and Bloch 1986). A second mechanism explaining decrease in value is that as the excitement of the purchase declines, so does the appeal of the new product (Higgins 2006). These mechanisms are hypothesized to operate for all brands (Strahilevitz and Loewenstein 1998). In other words, decline in hedonic value is expected to be experienced regardless of the strength of the brand. Yet although the underlying psychological mechanism operates the same way across brands, in the aggregate, it may cause a greater drop in value over time for higher-status brands because such brands have a larger component on status value that might lead to higher excitement at the time of purchase that will decrease faster overtime.

The psychological literature thus suggests that products with large components of intangible value may exhibit fast decrease in value over time, and this can manifest itself in fast decrease in the price of these products overtime. However, the equilibrium price in the market is not affected only by the valuation of consumers. For example, if consumers are forward-looking, they will take into account the decrease in value overtime at the time of purchase, which means that they will be willing to pay less for the product to begin with. This may mean that we will not observe the fast decline in prices overtime, rather the overall price level might be lower to begin with. Another factor impacting prices of used products is the supply of used units in the market which might also be affected by the changes in valuation overtime. Thus, the expected decrease in value overtime is not sufficient to determine that equilibrium prices will decrease over time.

In order to see if the decrease in value of the intangible benefits leads to fast decline in the equilibrium price of used products, we construct a simple model of the equilibrium price in a market of a durable good (specifically cars) that takes into account the effect of forward looking consumers and the supply of products in a dynamic framework. This model demonstrates that indeed if intangible benefits depreciate faster, products that offer a larger component of them will exhibit larger drops in equilibrium price overtime.

We extend the common durable goods models (see, e.g., Desai and Purohit 1999; Purohit 1997) so as to include the possibility of status consciousness on the part of some consumers. In adding status consciousness, we assume that status concerns are unrelated to the tangible benefits a consumer derives from the car, i.e., a consumer can be status conscious even if s/he does not derive much tangible benefit from the car (s/he keeps it in the garage and rarely uses it); or conversely, a consumer may have no status concerns and still derive tangible benefits from driving the car. Although a used car delivers fewer benefits, while tangible benefits may depreciate relatively slowly, status benefits deteriorate rapidly. Without loss of generality, we assume that a used car does not provide any status benefits.

In the model, a monopolist manufacturer markets a car that lasts for two periods: In the first, only new cars are available in the market, while in the second period, new cars as well as used ones from the first period are available in the market. A car provides tangible benefits such as transportation and a comfortable ride, and intangible ones that we summarize as “status”. Used cars are differentiated from new ones: They have depreciated with age and therefore provide fewer tangible benefits, for example, the ride may become less smooth; neither do used cars confer status on their owners. Consumers are heterogeneous in their valuations of the use of the car wherein only a portion cares about status. All consumers care about the functional use of the car, and the per-period valuations is distributed uniformly.

Our main interest is in how status affects the relative prices of used cars versus new cars in equilibrium. Here we only report the result of the model. Detailed analysis of the model is provided in Web Appendix A. Looking at the ratio of the price of the used car to the price of the new car in the second period we find that:[2]

> **Result 1:** The ratio of used car price to new car price is declining with an increase in status.

As the effect or importance of status increases, the equilibrium price of the used car decreases compared to the price of the new car. This decrease comes from two sources: First, there is a direct effect of status on the valuation of the car, and as status decreases more rapidly, the prices of cars with more status or more status-conscious consumers drop more. Second, there is an indirect effect of status depreciation on used car prices through its effect on the supply of used cars. The greater the supply of used cars, the lower their prices and it is straightforward to show that the portion of cars offered for sale on the used car market increases with status (see Web Appendix A).

[2] Results are the same if we use the difference in prices as the measure instead of the ratio.

3. Empirical analysis

The previous section showed that the depreciation of an automobile should correlated with its status, i.e., the equilibrium price of cars for which there is a higher status value and/or that attract more status-conscious consumers, should deteriorate over time faster. Premium cars have a larger portion of status value than do standard cars, and more status-conscious consumers, therefore premium cars' prices are predicted to depreciate faster than those of standard cars.

In practice, many other factors influence a car's rate of depreciation besides its status value. In order to control for these factors, we turn to an investigation of twin cars, utilizing a method that can be conceived of as a natural experiment to investigate the effects of standard and premium brands' effects on prices and demand (see for example Sullivan 1998). The idea is that status is attached to the brand name, while the other factors that might affect depreciation are attached to the physical car. As physical aspects are very similar for twin cars, differences in depreciation can be largely attributed to the differences in status between them. One of the key distinguishing factors in cars' deprecation is that we can measure their decline in terms of three distinct factors: (a) the car's age; b) its usage in term of distance driven; and c) its external condition. While most durable goods' depreciations also depend on age, usage, and condition, we can think of no other durable good in which all three factors are measured and published.

Twin cars provide a good test case of whether higher-status brands lose value faster due to depreciation in their hedonic value. Twin cars are functionally equivalent cars that bear differing brand names (Sullivan 1998; Esteban-Bravo and Lado 2011). The automobile industry, which is characterized by economies of scale in production (Friedlaender, Winston, & Wang, 1983; Stigler, 1958), and growing competition (Economist, 2011; Pauwels et.al. 2004) adapted joint production as a mean to reduce the cost of production. Smaller car brands may choose to assemble their cars using parts and systems that are manufactured by the larger brands. Twin cars are basically technically and mechanically the same cars that are sold under different brands (Sullivan, 1998). The cost savings from using the same mechanical parts may come with a loss of product differentiation associated with the physical characteristics of the car. This forces the stronger brand to differentiate itself on the non-functional attributes such as brand's image and its contribution the consumer's identity.

As the quality of twin cars' functional attributes is expected to be similar, the difference in consumers' evaluations is not likely to manifest in differences in perceived quality, but rather can be attributed to higher image of the more premium brand. For twin cars, the rate of depreciation of the functional attributes is similar for both versions of the car. Therefore, a change in the price gap between the two twin car brands can be attributed to the differential depreciation rates of the two brands' respective images.

The hypothesis that the price differences between twin cars can be attributed to the benefits of possessing the brand itself (Erdem et al., 1999; Swait, Erdem, Louviere, & Dubelaar, 1993) was empirically tested by Sullivan (1998) and Esteban-Bravo and Lado (2011). Their papers show that consumers are willing to pay more for new cars of the higher-status brand than for its lower-status twin. While these papers show that the differences in prices can be attributed to differences in status, they did not analyze how price differences change over time and their relationship to changes in the values of cars' functional and hedonic attributes over time. In this paper, we look at how the status affects price overtime. Our findings show that while status has a main effect of pushing a car's price up, it also has a negative (second-order) effect on price: Status depreciates quickly, causing faster and larger declines in the used-car price of high-status brands. As rational consumers take into account the price at which they will be able to sell their cars, status depreciation causes a decrease in their willingness to pay, and therefore the price of car does not reflect fully its status value in consumers' eyes.

3.1 Data

In order to create a list of twin cars, we began with a 2009 article from Edmunds, a leading online resource for automotive information (Edmunds.com 2009). The article defines twinned vehicles, and contains a list of twin vehicles including cars, SUVs, minivans, and trucks. Its definition is as follows:

> ***Twin Cars*****:** "Twinned vehicles are basically the same under the skin, but are sold under different brand names and marketed as unique vehicles. Manufacturers see this as a way of killing two birds with one stone: expanding their reach in various market segments while avoiding the higher costs of engineering a new vehicle. This practice is also referred to as "badge engineering," since an automaker can create the illusion of an "all-new" model simply by changing the badges, the grille and other superficial styling details. Twinned vehicles are built on the same chassis and share most of their under-hood and interior components, but often have different sheet metal, amenities and interior design. This idea extends as well to "triplet" and "quadruplet" vehicles, as in the case of the Buick Enclave/GMC Acadia/Saturn Outlook/Chevrolet Traverse quads."

For each pair of twins, we determined the period of time in which both specific twin vehicles were for sale, which in some cases restricted the available period. For example, while the GMC Acadia was available from 2007, its twin, the Buick Enclave, was available from 2008; and their twin, the Chevrolet Traverse, only from 2009. Thus the final period that appears in our dataset for this pair is 2009-2013 (see row 6, Table 1).

We dropped all discontinued vehicle brands, mostly General Motors' divisions, as a discontinued brand might have significant effects on its own price without a corresponding effect on the twin. We eliminated the following GM brands that were all discontinued in 2010: Pontiac, Hummer, Saturn, and Saab (the latter was sold in 2010 and declared bankruptcy in 2011). We also eliminated Mercury, a Ford division that was discontinued in 2011, as well as other discontinued models such as the Cadillac XLR, which was last manufactured in 2009.

Table 1: List of twin vehicles*

	Vehicle Type	Brand and Model	Observation Period
1	Cars	Chrysler 300/Dodge Charger	2006-2013
2		Hyundai Accent/Kia Rio	2005-2013
3		Lexus ES350/Toyota Camry	1993-2013
4		Lincoln MKS/Ford Taurus	2009-2013
5		Lincoln MKZ/Ford Fusion	2007-2012
6**	SUVs	Buick Enclave/GMC Acadia/Chevrolet Traverse	2009-2013
7**		Cadillac Escalade/GMC Yukon/Chevrolet Tahoe	2002-2012
8		Ford Escape/Mazda Tribute	2001-2011
9		Hyundai Tucson/Kia Sportage	2005-2013
10		Infiniti QX56/Nissan Armada	2005-2010
11		Jeep Compass/Jeep Patriot	2007-2013
12		Lexus LX570/Toyota Land Cruiser	2008-2011
13		Lincoln Navigator /Ford Expedition	1998-2013
14		Lincoln MKX/Ford Edge	2007-2013
15	Minivans	Chrysler Town & Country/Dodge Grand Caravan	1993-2013
16	Trucks	GMC Canyon/Chevrolet Colorado	2004-2012
17		GMC Sierra/Chevrolet Silverado	1999-2012

* Source: Edmunds.com
** Rows 6 and 7 include 3 vehicles each, thus the number of paired twins is 21, while the number of vehicles is 36.

We also eliminated the two twins: Chevrolet Impala/Buick Lacrosse and Dodge Avenger/Chrysler Sebring, as they shared a platform for only three and four years respectively. The final list appears in Table 1 and contains 36 cars and 21 pairs of twin vehicles (note that the two "triplets" we have contain three cars each).

For all the cars included in the final list, we used the Kelley Blue Book to determine the new and used car prices of each model. Kelley Blue Book provides the price of a used car according to the type of seller (private party or dealer), the year of production, the make and model, the mileage the particular car has been driven, some optional equipment, and the car's condition, ranging from “excellent” condition to “fair”. In order to insure consistency across all 36 vehicles and 21 pairs in our domain, for each year in our dataset, we downloaded the price for a private party (rather than a dealer) for 10 mileage groups (10,000 to 100,000 distance), standard equipment, and the four conditions of the vehicle (Web Appendix B provides the Kelley Blue Book used car guide description of the four conditions).

Using the Kelley Blue Book prices provides some attractive properties for the analysis. First, these prices are expert estimates of the equilibrium prices which are based on many sources of data. They take into account all that goes into an equilibrium price: the thinness of the market for some models; the average length of time a premium car is held by the original owner and the fact that it might differ from a standard car; the fact that premium and standard cars might differ with respect to the percent leased, etc. Second, the prices are provided for the same set of conditions for each car model (age, mileage, physical condition) thus facilitating comparison between the prices.

3.2 Pooled regression

As mentioned earlier, a key distinguishing factor in the deprecation of a vehicle is that publicly available data exist that quantify the decline in terms of three distinct factors: (a) the age of the car; b) its usage in term of distance driven; and c) the external condition of the car. To understand the effect of status on price we ran the following regression that explains the price of the car based on its condition, status, and the initial price (where *j* is the car model and *t* the year):

(1) $$price_{jt} = \alpha_0 + \alpha_1 Age_{jt} + \alpha_2 Mileage_{jt} + \alpha_3\, Condition_{jt} + \alpha_4 Status_j + \alpha_5 Status_j * Age_{jt} + \alpha_6 Status_j * Mileage_{jt} + \alpha_7\, Initial\ Price_j + \varepsilon$$

The “Status” variable is assigned the value of 1 for the premium vehicle and zero otherwise.[3] In addition, the status variable was interacted with age and mileage of the car.

In addition, as the purchase price of a new premium car is higher than that of a new standard one, the initial price might mediate the status effect of a new car. The initial price might also capture other factors or information that may indicate the quality of the car beyond the observables of brand name, etc. Thus, we included the (mean-centered) initial price as control variable. The idea behind using the mean-centered initial price is that the more deviation there is in the initial price from the population mean, the more some unobservable quality or value effects might bias the estimates, and in turn mitigate the effect.

The results are given in Table 2.

The models show that car prices decrease with cars’ ages, use (distance driven), and conditions. In addition, we see that if a car has a higher initial price, only slightly above 50% of this higher price holds up over time (50.2% in Model 1 and 53.2% in Model 2). The interesting effects are that of status: First, status pushes the initial price of the car up by more than $8,000, which is about 27% of the car’s initial price. Second, higher-status cars have higher depreciation for age (by $601 per year), and for mileage (by $203 per 10,000 miles). As the average mileage driven per year in the US is about 13,500 miles (in 2016[4]), we see that the effect of status on age depreciation is higher than that on mileage depreciation. This finding is consistent with the notion that status perceptions are mostly affected by the newness of the car.

[3] GMC brands are categorized as status brands. See Section 4 (Robustness checks) for a discussion.
[4] Reported by the US Department of Transportation: https://www.fhwa.dot.gov/ohim/onh00/bar8.htm

Table 2: Age/Mileage multipliers of twin vehicles: Pooled regression*

	Model 1	**Model 2**
Intercept	26,429 (115)	21,900 (142)
Initial Price (mean-centered) **	0.502 (.003)	0.532 (.003)
Age (years)	-1,147 (8)	-840 (10)
Mileage (10,000 miles)	-689 (13)	-583 (18)
Condition:* Very Good**	-472 (105)	-472 (98)
Good	-903 (105)	-903 (98)
Fair	-2,129 (105)	-2,129 (98)
Status (1 = premium)		8,172 (178)
Status*Age		-601 (14)
Status*Mileage		-203 (24)
Ratio of Age/Mileage Multipliers (Premium/Standard)		1.27
Adjusted R-Square	79.5%	82.2%

* Standard error in parenthesis; All coefficients are significant at the 99% level.

** In Model 1, the mean around which the initial price is centered is a single price of the average initial prices ($28,023), while in Model 2, it is $32,441 for premium brands and $23,086 for standard brands.

*** "Excellent Condition" is the benchmark category.

More importantly, comparing the ratio of age to mileage depreciations between standard and premium cars, we see that the ratio is higher for premium cars, as predicted by the model. The way to compute this ratio is as follows: Take a car that travels 10,000 miles[5]: A standard car depreciates by $840 and $583 because of age and mileage respectively. The age/mileage ratio is thus 1.44. A premium brand depreciates by $1,442 (=840+601, rounded) because of age and by $786 (=583+203) because of mileage, resulting in age/mileage ratio of 1.83. In order to find out

[5] While the intermediate calculations depend on the miles travelled, the ratio does not

how larger is the age/mileage depreciation of a premium car over and above a standard one, we divide both ratios to arrive at the 1.27 number. We can thus summarize these findings as follows:

> **Result 2:** On average, when taking into account a car's premium status, as well as its initial price, a premium car's age depreciation is 27% larger than that of a standard car (controlling for their mileage depreciation).

3.3 Individual regressions

The advantage of the pooled regression is that the effect of status could be directly measured while controlling for mileage driven, the condition of the car, as well as the initial price of the car. The obvious limitation is that we pool all observations and it's not clear if the main result hold for all or most of individual vehicles. We thus run individual regressions in which for each price was estimated as a function of age, mileage, and condition (see table 3):

(2) $$price_t = \alpha_0 + \alpha_1\ Age_t + \alpha_2\ Mileage_t + \alpha_3\ Condition_t + \varepsilon$$

Table 3: Individual regressions results*

Vehicle	**Intercept** (base-price)	**Age** (year)	**Mileage** (10,000)	**Condition**			**Adj. R-Squared**
				V. Good	**Good**	**Fair**	
Chrysler 300	30,977	-2,056	-810	-574	-1,067	-2,698	87.9%
Dodge Charger	21,223	-778	-686	-488	-904	-2,191	95.2%
Hyundai Accent	12,493	-593	-353	-354	-586	-1,478	94.5%
Kia Rio	11,945	-837	-295	-331[x]	-534	-1,300	86.3%
Lexus ES350	29,637	-1,191	-627	-418	-772	-1,990	93.3%
Toyota Camry	17,106	-643	-378	-293[x]	-528	-1,383	91.7%
Lincoln MKS	31,635	-1,569	-1,015	-670	-1,310	-3,360	94.6%
Ford Taurus	20,779	-1,068	-699	-510	-970	-2,445	93.1%
Lincoln MKZ	23,532	-1,289	-725	-529	-962	-2,454	97.9%
Ford Fusion	15,261	-708	-498	-404	-729	-1,825	96.3%
Buick Enclave	36,074	-2,537	-1,149	-720	-1,640	-3,680	90.4%
GMC Acadia	30,867	-1,601	-1,006	-621	-1,287	-3,311	94.1%
Chevrolet Traverse	26,096	-1,516	-837	-590	-1,140	-2,880	93.2%
Cadillac Escalade	56,248	-3,520	-1,301	-723	-1,506	-3,484	93.9%
GMC Yukon	54,287	-3,300	-1,291	-703	-1,508	-3,363	94.9%

Vehicle	Intercept	Age	Mileage	Condition			Adj. R-
Chevrolet Tahoe	33,529	-1,771	-850	-535	-1,027	-2,543	94.6%
Ford Escape	19,161	-1,175	-459	-364	-613	-1,402	96.7%
Mazda Tribute	13,307	-768	-327	-297[x]	-488	-1,110	91.4%
Hyundai Tucson	22,447	-1,469	-570	-458	-803	-1,842	96.6%
Kia Sportage	19,968	-983	-566	-436	-778	-1,789	94.0%
Infiniti QX56	42,894	-2,634	-1,197	-658	-1,383	-3,208	96.7%
Nissan Armada	29,125	-1,544	-867	-550	-1,052	-2,404	96.8%
Jeep Compass	20,272	-997	-633	-464	-861	-2,007	96.1%
Jeep Patriot	16,391	-423	-592	-468	-832	-1,904	93.0%
Lexus LX570	72,513	-2,007	-2,624	-1,250	-2,800	-6,700	99.2%
Toyota Land Cruiser	63,827	-1,033	-2,388	-1,175	-2,675	-6,225	97.8%
Lincoln Navigator	45,140	-2,667	-806	-526[NS]	-1,034	-2,434	94.8%
Ford Expedition	31,579	-1,806	-585	-428[NS]	-786	-1,867	94.8%
Lincoln MKX	35,040	-1,754	-1,060	-663	-1,376	-3,221	96.6%
Ford Edge	21,517	-756	-726	-492	-952	-2,210	97.9%
Chrysler T&C	18,967	-836	-368	-303[NS]	-532[NS]	-1,256	74.1%
Dodge Grand Caravan	14,671	-524	-318	-299[NS]	-493	-1,135	78.0%
GMC Canyon	22,826	-619	-731	-511	-950	-2,177	96.5%
Chevrolet Colorado	22,561	-609	-729	-483	-1,275	-2,139	85.4%
GMC Sierra	18,068	-586	-499	-404	-659	-1,516	88.1%
Chevrolet Silverado	17,475	-560	-490	-375	-634	-1,447	87.7%

*All coefficients are significant at the 99% level- except 95% (marked with x) and non-significant (NS).

In Table 4, the second and third columns depict the standardized age and mileage coefficients of each car, that is, α_1 and α_2 of Equation (2). The fourth column presents the ratio of the age coefficient divided by the mileage coefficient, i.e., α_1/α_2. Our claim is that this ratio should be larger in premium vehicles in their standard twins. Indeed, the fifth column of the table depicts the ratio of age/mileage coefficient for premium cars divided by standard ones. If our hypothesis is correct, this ratio should be greater than one: Indeed, for 19 out of the 21 pairs, the ratio of age/mileage coefficients is greater for the premium vehicles than for their twins.

Table 4: Age/Mileage (standardized) multipliers of twin vehicles: Individual regressions

Vehicle Model	Age coefficient	Mileage coefficient	Age/Mileage multiplier	Ratio of Multipliers*
Chrysler 300	-0.83	-0.41	2.03	
Dodge Charger	-0.63	-0.69	0.90	2.24
Hyundai Accent	-0.78	-0.52	1.51	
Kia Rio	-0.85	-0.33	2.56	0.59
Lexus ES350	-0.93	-0.23	4.00	
Toyota Camry	-0.92	-0.26	3.59	1.12
Lincoln MKS	-0.59	-0.73	0.80	
Ford Taurus	-0.55	-0.73	0.75	1.07
Lincoln MKZ	-0.69	-0.65	1.06	
Ford Fusion	-0.60	-0.71	0.84	1.25
Buick Enclave	-0.67	-0.62	1.09	
GMC Acadia	-0.57	-0.72	0.78	1.39
Buick Enclave	-0.67	-0.62	1.09	
Chevrolet Traverse	-0.61	-0.68	0.89	1.22
GMC Acadia	-0.57	-0.72	0.78	
Chevrolet Traverse	-0.61	-0.68	0.89	0.88
Cadillac Escalade	-0.91	-0.31	2.98	
GMC Yukon	-0.91	-0.32	2.81	1.06
Cadillac Escalade	-0.91	-0.31	2.98	
Chevrolet Tahoe	-0.88	-0.38	2.29	1.30
GMC Yukon	-0.91	-0.32	2.81	
Chevrolet Tahoe	-0.88	-0.38	2.29	1.23
Ford Escape	-0.92	-0.33	2.82	
Mazda Tribute	-0.89	-0.33	2.67	1.06
Hyundai Tucson	-0.89	-0.38	2.32	
Kia Sportage	-0.80	-0.51	1.56	1.49
Infiniti QX56	-0.76	-0.58	1.31	
Nissan Armada	-0.69	-0.66	1.06	1.23
Jeep Compass	-0.70	-0.64	1.10	
Jeep Patriot	-0.40	-0.81	0.50	2.21
Lexus LX570	-0.27	-0.91	0.30	
Toyota Land Cruiser	-0.16	-0.93	0.17	1.77
Lincoln Navigator	-0.96	-0.18	5.31	
Ford Expedition	-0.95	-0.19	4.96	1.07
Lincoln MKX	-0.72	-0.62	1.15	
Ford Edge	-0.54	-0.76	0.71	1.62
Chrysler Town & Country	-0.84	-0.18	4.79	
Dodge Grand Caravan	-0.84	-0.24	3.48	1.38

Vehicle Model	Age coefficient	Mileage coefficient	Age/Mileage multiplier	Ratio of Multipliers*
GMC Canyon	-0.57	-0.75	0.76	
Chevrolet Colorado	-0.53	-0.71	0.75	1.02
GMC Sierra	-0.79	-0.48	1.65	
Chevrolet Silverado	-0.78	-0.49	1.60	1.03
Average	**-0.72**	**-0.53**	**1.89**	**1.29**

* Ratio (of premium to standard multipliers) larger than 1 implies that the age/mileage depreciation multiplier is larger for premium brands.

Result 3: For most of the twin cars in our sample (19 out of 21), the ratio of age/mileage depreciation is higher for premium cars than it is for their standard twins. Thus a premium car's age depreciation is on average 29% greater than that of a standard car (controlling for their mileage depreciation).

3.4. Robustness checks

We have three "triplets" in our data: Buick Enclave/GMC Acadia/Chevrolet Traverse, and Cadillac Escalade/GMC Yukon/Chevrolet Tahoe. In our main pooled regression, reported in Table 2, both the GMC Acadia and the Yukon were categorized as premium brands. We thus ran the pooled regression when the GMC Acadia and the Yukon were categorized as standard brands, and a pooled regression without the GMC brand. The main results remain the same: When taking into account a car's premium status, as well as its initial price, its age depreciation of a premium car is 31% and 29% larger than that of a standard car, for GMC as a standard brand and without GMC brands, respectively. The results demonstrate the robustness of our model to differing categorization of the two brands[6].

The vehicles in our dataset are divided into the following categories: Cars, SUVs, minivans, and trucks. One might raise the question of our results' robustness when broken down to the category level. We thus ran the pooled regression for the larger two categories: cars and

[6] Similar results are obtained when we delete the pairs where the premium brand was determined solely on the basis of the initial price: Hyundai/Kia (two pairs) Jeep Compass/Patriot (one pair), and Ford/Mazda (one pair).

SUVs (minivans and trucks contains only one and two pairs, respectively). The regressions confirm our results in that these two categories – cars and SUVs – exhibit a similar pattern in which age depreciation of a premium car is larger – 1.5 and 1.13 respectively – than that of a standard car (controlling for mileage). Note that the effect is larger for cars as than it is with SUVs. This might be due to the fact that the price premium a consumer pays for a premium new car vs. standard new car is higher than that for an SUV (52% vs. 38%), which may indicate that the heterogeneity in cars' status perceptions is higher than for SUVs' status perceptions.

4. Conclusion

In this research, we study the decline of a durable good's intangible benefits compared to the decline in its tangible benefits. We show that as the importance of status increases, the price of the used car should decrease more compared to that of the new car. We use data on prices of new and used cars (for each year and mileage) that include the age of the car; its usage in term of distance driven; the external condition of the car, and its status (premium vs. standard) for 21 twin car pairs to test this empirically. We obtain the main result that a premium car's age depreciation is much greater than that of the standard car (controlling for their mileage depreciation and the car's initial price). This result, which confirms the theoretical prediction, demonstrates that the true cost of owning a premium car is not just its initial high price, but also the much faster depreciation of the car's value over its lifetime, as compared to the standard version of that same premium brand.

More generally, the results indicate that producers of durable goods need to think carefully how the deprecation in the product's status over time should impact their decisions regarding pricing, product line design and sales.

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Web Appendix A

In this Web Appendix, we present a two period model that shows that in equilibrium, the ratio (or the difference) of used car price to new car price is declining with status.

A monopolist manufacturer markets a car that lasts for two periods: In the first, only new cars are available in the market, while in the second period, new cars as well as used ones from the first period are available in the market. A car provides tangible benefits such as transportation and a comfortable ride, and intangible ones that we summarize as "status". Used cars are differentiated from new ones: They have depreciated with age and therefore provide fewer tangible benefits, for example, the ride may become less smooth; neither do used cars confer status on their owners.

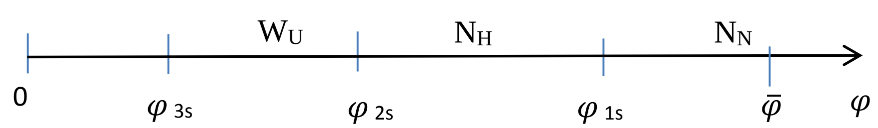
Consumers are heterogeneous in their valuations of the use of the car; only a portion r cares about status. All consumers care about the functional use of the car, and the per-period valuations are represented by φ that is distributed uniformly between 0 and $\bar{\varphi}$. Consumers' gross utility of the per-period value are:

(A1) $$utility = \begin{cases} \varphi + s & if\ car\ is\ new\ and\ consumer\ is\ status\ concious \\ \varphi & if car\ is\ new\ and\ consumer\ is\ not\ status\ concious \\ \delta\varphi & if\ car\ is\ a\ used\ car \end{cases}$$

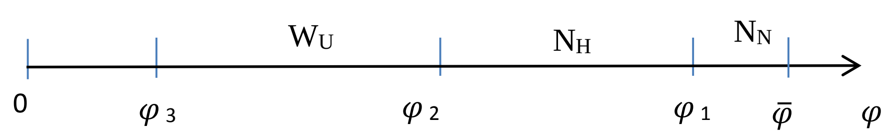
Consumer segments and behavior under this set of valuations are shown in Figure A1:

Figure A1: Consumer segments and behavior

Consumers who are status conscious



Consumers who are not status conscious



The top scale depicts the behavior of the status-conscious consumers, and the bottom scale the behavior of the non-status-conscious consumers. The consumers with the highest valuations elect to buy a new car in each period (N_N); at lower valuations, consumers buy a new car and hold it for two periods (N_H); and still lower-valuation consumers wait and then buy a used car (W_U). As can be seen in Figure A1, status-conscious consumers buy more new cars due to the value they place on the status of owning a new car. Let Q_{1n}, Q_{2n}, and Q_u be the quantity of new cars sold in Period 1, Period 2, and the quantity of used cars sold in Period 2 respectively. Note that $Q_u = Q_{2n}$, as only consumers who buy new cars in Period 2 offer their used cars for sale. This being a full information model, there is an interior solution and the market clears, i.e., the number of cars offered for sale in each period is equal to the number of cars sold in each period. Consider, for example, the quantity of new cars offered in Period 1, Q_{1n}, which is equal to the number of consumers who buy a new car in Period 1, which from Figure 1 is $r(\bar{\varphi} - \varphi_{2s})$ status seekers and $(1-r)(\bar{\varphi} - \varphi_2)$ non-status-seeker consumers. We get the following market-clearing condition: $Q_{1n} = r(\bar{\varphi} - \varphi_{2s}) + (1-r)(\bar{\varphi} - \varphi_2) = \bar{\varphi} - r\varphi_{2s} - (1-r)\varphi_2$. Similar considerations of market clearance in Period 2 lead to the complete set of conditions in the model:

(A2) $$Q_{1n} = r(\bar{\varphi} - \varphi_{2s}) + (1-r)(\bar{\varphi} - \varphi_2) = \bar{\varphi} - r\varphi_{2s} - (1-r)\varphi_2$$

(A3) $$Q_{2n} = r(\bar{\varphi} - \varphi_{1s}) + (1-r)(\bar{\varphi} - \varphi_1) = \bar{\varphi} - r\varphi_{1s} - (1-r)\varphi_1$$

(A4) $$Q_u = r(\varphi_{2s} - \varphi_{3s}) + (1-r)(\varphi_2 - \varphi_3)$$

If we denote the price of a used car by P_u, then the participation constraint of the marginal consumers who buy used cars in both segments implies that $P_u = \delta\varphi_3$. Noting that it must be the case that $\varphi_{3s} = \varphi_3$, and substituting for Q_{1n} and Q_{2n} from Equations (A2) and (A3), we find:

(A5) $$P_u = \delta(\bar{\varphi} - Q_{2n} - Q_{1n}).$$

From the incentive constraints of the consumers who are indifferent between buying a new car in the second period and keeping the old car, we find that:

(A6) $$P_{2n} = (1-\delta)\varphi_{1s} + s = (1-\delta)\varphi_1$$

Using Equations (A3) and (A6), we can express φ_{1s} as:

(A7) $$\varphi_{1s} = \bar{\varphi} - Q_{2n} - \frac{1-r}{1-\delta} s$$

(A8) $$P_{2n} = (1-\delta)(\bar{\varphi} - Q_{2n}) + rs$$

Similarly, from the incentive constraints of the consumers who are indifferent between buying a new car in Period 1 and waiting to buy a used car in Period 2, we find that:

(A9) $$P_{1n} = \varphi_{2s} + s + P_u = \varphi_2 + P_u$$

Using Equations (A2) and (A9), we can express φ_{2s} and P_{1n} as:

(A10) $$\varphi_{2s} = \bar{\varphi} - Q_{1n} - (1-r)s$$

(A11) $$P_{1n} = \bar{\varphi} - Q_{1n} + rs + P_u$$

Putting it all together, we obtain the following demand system:

(A12) $$P_u = \delta(\bar{\varphi} - Q_{2n} - Q_{1n})$$

(A13) $$P_{2n} = (1-\delta)(\bar{\varphi} - Q_{2n}) + rs + P_u$$

(A14) $$P_{1n} = \bar{\varphi} - Q_{1n} + rs + P_u$$

wherein the seller maximizes profit over the two periods. Solving for the subgame perfect decisions by the seller, we get the following results for the prices:

(A15) $$P_u = \frac{\delta[3\bar{\varphi}\delta + (c - rs)(4+\delta)]}{4+6\delta}$$

(A16) $$P_{2n} = \frac{4(c+rs+\bar{\varphi}) + 2(3c+rs+\bar{\varphi})\delta - (5c+rs+3\bar{\varphi})\delta^2}{2(2-\delta)(2+3\delta)}$$

(A17) $$P_{1n} = \frac{(4+\delta(\delta-2)^2)rs + c(4+\delta(4-\delta^2-2\delta)-4) + \bar{\varphi}(4+8\delta-3\delta^2)}{2(2-\delta)(2+3\delta)}$$

Our main interest is in how status (s) affects the relative prices of used cars versus new cars. Looking at the ratio of P_u to P_{2n}, we find that the ratio of used car price to new car price is declining with an increase in status, i.e., $\frac{\partial(P_u/P_{2n})}{\partial s} < 0$.

Thus as the effect or importance of status increases, the price of the used car decreases compared to the price of the new car, stemming from two sources: First, there is a direct effect of status on the valuation of the car, and as status decreases more rapidly, the prices of cars with more status or more status-conscious consumers drop more. The average consumer's valuation of a new car is $\frac{\bar{\varphi}}{2} + rs$, and the average consumer's valuation of a used car is $\delta\frac{\bar{\varphi}}{2}$. Clearly, the larger s is, the larger (faster) the drop in price. Second, there is an indirect effect of status depreciation on used car prices through its effect on the supply of used cars. The greater the supply of used cars, the lower their prices (see Equation A5 and note that $Q_u = Q_{2n}$). Consider the portion of cars purchased in Period 1 that are offered for sale used in Period 2, ${Q_u}/{Q_{1n}}$.

(A18) $$\frac{\partial(Q_u/Q_{1n})}{\partial s} = \frac{r\bar{\varphi}\delta(4+(4-3\delta)\delta)}{4\left(\bar{\varphi}+(rs-c)(1-\delta)\right)^2} > 0$$

The portion of cars offered for sale on the used car market increases with status.

Web Appendix B

Definition of vehicle conditions in Kelley Blue Book used cars guide (see KBB.com)

Excellent - 3% of all cars we value

Looks new and is in excellent mechanical condition

- Has never had any paint touch-ups and/or body work
- Does not need reconditioning
- The engine compartment is clean and free of leaks
- Is free of rust
- The body and interior are free of wear or visible defects
- Wheels are flawless
- All tires match and are like new
- Has a clean title history and will pass a safety and smog inspection
- Has complete and verifiable service records

Very Good - 23% of all cars we value

Has minor cosmetic defects and is in excellent mechanical condition

- Has had minor paint touch-up and/or body work
- Requires minimal reconditioning
- The engine compartment is clean and free of leaks
- Is free of rust
- The body and interior have minimal signs of wear or visible defects
- Wheels are flawless
- All tires match and have 75% or more of tread remaining
- Has a clean title history and will pass a safety and smog inspection
- Most service records are available

Good - 54% of all cars we value

Has some reparable cosmetic defects and is free of major mechanical problems

- May need some servicing
- The paint and body work may require minor touch-ups
- The engine compartment may have minor leaks
- Has only minor rust, if any
- The body may have minor scratches or dings
- The interior has minor blemishes characteristic of normal wear
- Wheels may have minor reparable scratches or scrapes
- All tires match and have at least 50% of tread remaining
- Though it may need some reconditioning, it has a clean title history and will pass a safety and smog inspection
- Some service records are available

Fair - 18% of all cars we value

Has some cosmetic defects that require repairing and/or replacing

- Requires some mechanical repairs
- The paint and body work may require refinishing and body repair
- The engine compartment has leaks and may require repairs
- May have some reparable rust damage
- The body has dents, chips, and/or scratches
- The interior has substantial wear, and may have small tears
- Wheels may be warped or bent, have major scratches, scrapes, or pitting; or require replacement
- The tires may not match and may need replacing
- Needs servicing, but is still in reasonable running condition with a clean title history
- A few service records are available

Poor - Kelley Blue Book does not provide prices for cars in poor condition.