Abstract

Do children inherit preferences from their parents? If they do, what implications does this have for markets? In this paper, we document a strong correlation in the automobile brands chosen by parents and their adult children. Our empirical challenge is to determine whether this correlation is driven by a causal transmission of brand preference across generations or a correlation of characteristics (like income) that determine brand choices. We present a variety of empirical specifications which lend support to the causal interpretation. We then develop a model of Bertrand competition among producers in the presence of consumer brand preference to demonstrate the importance of a causal link for firm strategy. We find that the intergenerational transmission of brand preferences lowers the equilibrium prices and profits of firms because preference transmission makes firms less able to capitalize on existing brand preference, as firms need to constantly boost market share as an investment in future brand loyalty.
1 Introduction

Economic models generally treat consumer preferences as exogenous and fixed. However, recent research on tastes for food (Birch 1999; Logan and Rhode 2010; Atkin 2011), female labor supply (Fernández, Fogli and Olivetti 2004), packaged goods (Bronnenberg, Dubé and Gentzkow Forthcoming), and preferences for redistribution (Luttmer and Singhal 2011) suggests that tastes and preferences may form endogenously through prior behavior, consumption, and experience. Such endogeneity has the potential to transform our view of market behavior and public policy by creating a dynamic link between consumption today and welfare tomorrow. For example, long-lived firms considering their pricing strategy today may think ahead to how market share, and consequent brand loyalty, will affect demand among future consumers.

The focus in economics on models of stable exogenous preferences is at least partially pragmatic. Models that allow for endogenous preference formation present technical and empirical challenges, and it is difficult to identify factors that influence preferences in most settings. One influence that is both plausibly important and potentially manageable is the family, which has proven to be fertile ground in prior literature (Fernández et al. 2004; Logan and Rhode 2010; Atkin 2011). Families may transmit preferences across generations, not only through immutable genetic endowments, but also through environment and experience. Thus, research on the intergenerational transmission of preferences may provide a better understanding of endogenous preference formation more generally.

In this paper, we empirically investigate the intergenerational transmission of preferences for automobile brands (e.g., Ford) and use these results to motivate a model of firm competition. Automobiles are particularly interesting because they are large, infrequent purchase for consumers and because they industry remains crucial to the manufacturing base on the United States. Brands are particularly interesting in that they represent a “soft” attribute where we might expect preferences to be especially malleable. That is, it is difficult to see why a consumer would inherently prefer a Ford over a GM for purely exogenous reasons (like genetics). Instead, it seems natural to expect such preferences to arise from experience and context.

To enable our investigation, we make use of the Panel Study of Income Dynamics (PSID), which is unique in that it follows multiple households within the same family over time. In particular, it surveys adult children who grew up in a PSID household but have since left and formed their own households. In several recent waves, the PSID has included questions about automobile ownership. Using these data, we find strong correlations in automobile choices across generations within a family. Specifically, a child whose mother has recently purchased
a given brand is 59% more likely to choose that brand (an 8.6 percentage-point increase on a base of 14.3%) than a demographically similar child whose mother did not choose that brand. To the best of our knowledge, we are the first to document this correlation in automobile brand choice across generations.

We define brand preference somewhat broadly, as representing a situation where a consumer prefers one automobile over another holding constant vehicle attributes (such as size and performance) and consumer characteristics (including demographics and geography). This definition allows brand preferences transmitted to a child from their parents to be the result of nostalgic feelings about a particular car brand, a developed taste for minor design details, or subjective beliefs and information about a vehicle’s performance and reliability. The intergenerational correlation in brand choice could be due either to the transmission of brand preference through these channels or to familial correlations of demographic or geographic factors that also determine brand choice. To better isolate the role of transmitted preferences, we demonstrate that controlling for the rich set of demographic factors available in the PSID has little effect on our estimated correlation. We further show that correlations remain strong when fine geographic controls, at the county or census tract level, are introduced nonparametrically.

We also repeat our analysis for a pair of firms (GM and Ford) that produce very similar models with common attributes, which limits the scope to which unobserved characteristics could be driving choice. That is, while there are many characteristics that might lead an individual to choose a BMW over a Ford, it is more difficult to imagine characteristics that might cause an individual to prefer a GM over a Ford, other than those that are included under our definition of brand preference. We find strong intergenerational correlations for Ford and GM buyers as well. Thus, while we cannot definitively rule out the possibility that these correlations are driven by unobserved household characteristics, the robustness of our results across a range of specifications argues in favor of a true brand preference.

After presenting our empirical evidence, we provide a heuristic model of the car market to show how the transmission of brand preferences from parent to child might influence the competitive behavior of automakers. In our model, consumers live for two periods, shopping for a car in a different market each period. For example, consumers might purchase an entry-level vehicle in the first period and then an upscale vehicle in the second. At the end of the second period, consumers have children, who may or may not inherit their parents’ brand preferences. Firms compete in both markets. When individuals carry brand preference into the second period based on their first-period choice, but brand preferences are not transmitted across generations, the game collapses to a two-period model, as in Klemperer

\footnote{The distinction between attributes and brand preference can be blurry, as we discuss below.}
In which firms “invest” in brand loyalty in the first period and “harvest” the rents in the second period. In this case, markups are low on entry-level vehicles but high on upscale vehicles.

When children inherit the brand preference of their parents, however, then firms are unable to harvest loyalty by raising prices for upscale vehicles because harvesting today shrinks the market for the next generation. In this case, the game can be characterized as an infinite period model, similar to the one analyzed by Dubé, Hitsch and Rossi (2009). For the magnitudes of brand loyalty we estimate in the PSID data, we find that the presence of brand loyalty lowers prices and profits, since the incentive to lower prices to invest in future profits outweighs the incentive to raise prices to increase current profits. In essence, automakers are continuously engaged in a price battle to invest in future loyal customers but are never able harvest this loyalty.

Our model also shows that, despite the result that brand loyalty ultimately results in lower prices and profits in equilibrium, competitive pressures provide firms with a strong unilateral incentive to encourage brand loyalty amongst their customers. Intuitively, a firm can increase its equilibrium market share and profitability if it can take actions (such as, for example, undertaking an aggressive advertising campaign or installing a distinctive, firm-specific trim on all its models) that more tightly tie its current customers to its brand. These benefits, however, come at the expense of the firms’ rivals, and when all firms behave in this way they collectively fare worse in equilibrium.

Our analysis relates to several existing literatures. First, as mentioned in the opening paragraph, our research relates to the nascent literature on endogenous preference formation. Much of that literature centers on preferences for food, which contrasts in many ways from automobiles.

Second, previous work in economics and marketing has studied brand loyalty in the automobile market (Train and Winston 2007; Mannering and Winston 1985, 1991). While these papers document within-household brand loyalty, the automobile literature has, to the best of our knowledge, never analyzed the intergenerational dimension of brand preference that we document here.

Third, recent work on brand preferences in consumer packaged goods has demonstrated that brand loyalty is responsible for much of the observed persistence in brand choices for individual consumers and the observed persistence in market shares within specific geographic areas (Bronnenberg, Dhar and Dubé 2009; Bronnenberg et al. Forthcoming). As compared to the products studied in that literature, automobiles are much larger expenses, they are purchased less frequently, and the product offerings are more heterogeneous. Brand loyalty in the automobile sector typically involves individuals purchasing quite different products.
that share a brand label, whereas the literature on packaged goods is better characterized as repeat purchases of the same item. For small purchases, brand loyalty may better be understood as a heuristic to aid in quick decision-making, which is likely quite different from the role brands play in purchasing an automobile.

Fourth, there is a considerable literature on the intergenerational transmission of earnings and education, much of which utilizes the PSID, as well as datasets from other countries that link outcomes of parents and children across generations.\footnote{See Solon (1992) for a seminal contribution and Solon (1999) and Black and Devereux (2011) for recent reviews.} Closely related literatures study the intergenerational transmission of IQ, occupations, welfare status, health, attitudes, social behavior, consumption, and wealth, nearly always finding a strong correlation between the outcomes of parents and their children (see Black and Devereux 2011).

Finally, our work has parallels in the extensive peer-effects and social interactions literatures (see Manski 1993, 2000). Whereas much of this literature studies how individuals are influenced by the aggregate behavior and characteristics of a reference group, we focus on how parents and children are influenced by the behavior and choices of a small number of individual family members.

The balance of the paper is structured as follows. In section 2 we provide a framework for interpreting interhousehold correlations in brand choices. We then describe our data in section 3, and we report our empirical results regarding the correlation in brand choice across generations in section 4. Section 5 lays out a simple theoretical framework that shows the implications of intergenerational brand preference for automakers’ prices and profits in equilibrium. Section 6 concludes.

## 2 Conceptual model of intergenerational vehicle choice

We begin by presenting a simple model of household vehicle choice that clarifies possible mechanisms by which choices may be correlated across families and the empirical challenges of separately identifying them. Consider a household $i$ in family $f$ that purchases vehicle $j$ at time $t$. Let the utility that household $i$ derives from this purchase be denoted by:

$$U_{ifjt} = f(D_{ift}, X_j; \beta) + \theta_{ifjt},$$

where $D_{ift}$ denotes a vector of observed and unobserved demographic and location-specific characteristics of household $i$, such as income, education, climate, and terrain. These characteristics interact with $X_j$, which denotes the attributes (including brand) of vehicle $j$,
through function $f(\cdot)$ and parameter vector $\beta$. This interaction allows observable and unobservable characteristics of households and their locations to influence vehicle choice in a variety of ways. For example, rural households may tend to choose pickup trucks, wealthy households may tend to purchase large SUVs, pro-union households may tend to purchase U.S. brands, and households living close to a Ford dealership may tend to purchase Fords. Finally, $\theta_{ijt}$ denotes a preference for vehicle $j$ that is unrelated to demographic or location-specific factors. We focus on influences from other family members as determinants of $\theta_{ijt}$, but other factors may exist, such as exposure to advertisements, prior driving experiences, idiosyncratic tastes (e.g., for a particular color or trim), or vehicle and gasoline market conditions at the time of purchase.

If parents’ preferences and choices for vehicles have a direct impact on their children’s preferences, this is expressed in our model as a correlation in $\theta_{ijt}$ across households within families, which leads to correlation in vehicle choices. Such preference correlation could be the result of past experiences. Suppose, for example, that a household had a strong preference for GM vehicles. Children growing up in the household may develop a preference for GM through several mechanisms. First, driving a GM as an adult might conjure up nostalgic feelings, so that children experience driving a GM differently than driving a Ford with similar attributes. Or, they may have developed a taste for the unique features of GM’s design, like interior styling, the feel of the seats, or the layout of the instrument panel. Alternatively, they may feel that they have significant experience with a GM, so that they are confident that they know what the GM’s quality and reliability will be. If individuals within a family have correlated preferences for any of these reasons, it will lead to correlation in the vehicle choices we observe, and we will categorize this as endogenous preference formation.

However, correlations in households’ vehicle choices may also arise through cross-household correlations in $D_{ijt}$. It is natural to expect such correlations to exist; Solon (1992), for example, documents strong intergenerational transmission of income. If households with high incomes are more likely to purchase SUVs and European luxury brands, then this correlation in income across generations will lead to correlations in vehicle choices across generations. Thus, a fundamental empirical challenge of our work is to identify vehicle choice correlations that arise from preference transmission separately from choice correlations that arise from similarities in demographic and geographic characteristics. This separate identification is important because it is only the preference transmission channel that is relevant for automakers’ strategies.

We employ several strategies to separately identify “true” transmission of vehicle preferences across households within the same family. First, we leverage the wealth of demographic and location information within the PSID dataset to control directly for potential confound-
ing factors. Despite being able to use a rich set of covariates (including census tract fixed effects), one might nonetheless be concerned that influential unobserved factors remain. For instance, if a family is unobservably pro-union, all of that family’s households might have a preference for U.S. brands. Thus, we also investigate subsets of the data for which unobserved factors are unlikely to be important.

Finally, we note that the distinction between brands and attributes is blurry. It is tempting to define a brand as something that is independent of all vehicle attributes, as if, for instance, Ford and GM vehicles were identical apart from the logo stamped on the grill. In practice, vehicles of different brands will differ in “minor” features, including trim style, dashboard layouts, and perceived reliability, even for cars that share identical observable characteristics, such as size, power, and cargo space. We define a brand in a way that encompasses these “minor” characteristics so that a brand preference might be derived from, for example, a preference to have the dashboard controls laid out in a particular way. In contrast, when we speak of preferences for attributes, we refer specifically to major vehicle characteristics, such as class, horsepower, size, and fuel economy. We believe that making this distinction between attributes and brands, thusly defined, is useful because the transmission of preferences for brands has very different implications than the transmission of preferences for attributes. The former is primarily relevant for automakers’ pricing, marketing, and product line strategies, while the latter is primarily relevant for public policies addressing the externalities of vehicle use, which we are exploring in separate research.

3 Data

Our data on vehicle ownership come from the Panel Study of Income Dynamics (PSID). In 1968, the PSID selected a nationally representative sample of households to survey, and since then it has asked them a battery of economic and demographic questions every year until 1997 and then every two years thereafter. The PSID collects information on everyone who lives in a PSID household, but it also follows members of the original PSID sample households and their children whenever they join or create a new household. As a result, the survey now collects information on many households that are members of the same extended family.

The PSID began collecting information on vehicles in 1999. Respondents report the total number of vehicles that they own or lease and additional detailed information on up to three vehicles, including vehicle make, model, and vintage, as well as the date of purchase, purchase price, and whether the vehicle was a gift. These data are available from surveys conducted in 1999, 2001, 2003, 2005, and 2007. These data allow us to examine how vehicle
Table 1: Variable means and sample sizes in PSID

<table>
<thead>
<tr>
<th></th>
<th>All heads and wives with mothers</th>
<th>Final sample of heads and wives</th>
<th>Mothers in final sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>33.6</td>
<td>35.8</td>
<td>59.3</td>
</tr>
<tr>
<td>Education</td>
<td>13.2</td>
<td>13.6</td>
<td>12.5</td>
</tr>
<tr>
<td>Annual family income</td>
<td>48,514</td>
<td>73,281</td>
<td>62,527</td>
</tr>
<tr>
<td>Number of kids</td>
<td>0.9</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Household family size</td>
<td>2.7</td>
<td>3.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Number of vehicles</td>
<td>1.5</td>
<td>2.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Number of unique individuals</td>
<td>6,798</td>
<td>4,044</td>
<td>2,213</td>
</tr>
<tr>
<td>Number of individual-years</td>
<td>26,659</td>
<td>10,032</td>
<td>6,280</td>
</tr>
</tbody>
</table>

Columns report means for (1) all household heads and wives whose mothers are in the PSID, (2) those that own a vehicle and whose mother mothers own a vehicle, and (3) the mothers of this subsample.

choices by individual households evolve over time as well as how the vehicle choices of one household relate to the vehicle choices of other households linked by family relationships. To the best of our knowledge, the PSID is unique in providing such information for families in the United States.

Below, we focus on the relationship between an individual’s brand choice and the brand holdings of his or her parents. To do this, we limit the PSID sample to individuals who own a vehicle and whose mother is also in the PSID and is also a vehicle owner. We link individuals to their mothers’ households because we were able to match more individuals consistently with their mothers than with their fathers.3 Consistent with PSID terminology, we refer to males and single females as household heads and female spouses (including cohabiting significant others) as wives.

Table 1 shows sample means for several variables for the full sample of individuals with mothers in the PSID, for the individuals who remain after limiting the sample to those with vehicles, and for the mothers themselves. There are 6,798 heads or wives whose mothers are present in the data. Of these, 4,044 are vehicle owners and have mothers who own a vehicle. Compared to all household heads and wives with mothers present in the data, these households are slightly older, are slightly more educated, and have higher income. Because many of these individuals are siblings, there are only 2,213 unique mothers in the data. Mothers are obviously older, with a mean age of 59 compared to 36 for their children. Heads and wives have larger households, have more kids living at home, and own slightly more vehicles.

3In preliminary analysis, we found results that were statistically indistinguishable when using data on fathers instead of mothers. We have also experimented with specifications that use data from both mother and father separately, which is identified from situations where the parents live in separate households. When both are used, we find that the effect of each correlation is roughly half of the correlation when we use data form only one parent.
vehicles than their mothers.

4 Empirical evidence of intergenerational brand preference transmission

In this section, we develop a linear probability model for the brand choice of children and demonstrate how children's brand choices are related to their parents' brand choices, using a variety of specifications that try to distinguish correlated brand preference from more mundane causes such as correlated demographics. We opt for a linear probability model over a structural discrete choice model, which is often used in studies of automobile demand. A discrete choice model has the advantage of allowing estimated coefficients to be interpreted directly as parameters of a utility function, but the linear probability model can establish the qualitative strength of intra-family correlation in brand choices and has several advantages in our context. The linear probability model is computationally simpler, particularly given the large number of fixed effects in many of our specifications. With most of the fixed effects considered here, such as brand-by-year or brand-by-state dummy variables, the only concern with a discrete choice model is computational time. With the brand-by-individual fixed effect specification, however, the discrete choice model will deliver inconsistent estimates due to the incidental parameters problem.

Finally, consumers are often able to choose from among multiple different vehicles with very similar observable attributes offered by different brands, such as a Ford F150, Chevy Silverado, and Dodge Ram pickup, or a Honda Civic, Toyota Corolla, or Hyundai Elantra compact sedan. Thus, a structural discrete choice model's unique ability to handle collinearity among particular bundles of attributes (such as size and horsepower among small sedans) is much less important in a study of brands than it is in most automobile demand estimation.

To operationalize our brand data, we categorize all vehicle choices as being one of seven "brands": GM, Ford, Chrysler, Toyota, Honda, Other Asian, and European. Grouping smaller Asian automakers and European manufacturers together ensures that each brand is chosen frequently enough to yield meaningful estimates in a linear probability framework. In particular, these brand definitions imply that their choice probabilities lie in the 3%-20% range in the raw data.\(^4\) For each vehicle purchase by every individual in our data, we expand the original data sample to include seven lines of data. The first is for the brand that was

\(^4\)In order to test whether the correlation across generations is coming from a correlated preference for brand (e.g., Ford) or sub-brand (e.g., Ford, Lincoln, or Mercury), we have run subsets of our regressions with 41 sub-brands instead of the 7 brands, interacting our control variables with all 41 sub-brands. In general, we find that both the overall brand and the sub-brand of the mother have a statistically significant correlation with the sub-brand chosen by the adult child.
chosen by the individual, and this line has the dependent variable coded as one. The other
six are observations with a zero dependent variable, one for each of the six brands not chosen.

This leads us to the following estimation equation:

\[ b_{ijt} = \gamma_1 \cdot 1(b_{mfjt} = b_{ijt}) + \gamma_2 \cdot 1(b_{mfj,t-1} = b_{ijt}) + \gamma_3 \cdot 1(b_{mfj,t-2} = b_{ijt}) 
+ \sum_{j=1}^{J} (X_{ift} \cdot \beta_j) + \sum_{j=1}^{J} (X_{mft} \cdot \delta_j) + \alpha_{jt} + \epsilon_{ijt}, \]  

where the dependent variable, \( b_{ijt} \), is a dummy coded as 1 if child \( i \) of family \( f \) chose brand \( j \) in choice \( t \). The independent variables of interest are dummy variables that indicate whether
the mother’s most recent prior purchase is of that same brand \( 1(b_{mfjt} = b_{ijt}) \), and likewise
for two additional lagged purchases of the mother \( 1(b_{mfj,t-1} = b_{ijt}) \) and \( 1(b_{mfj,t-2} = b_{ijt}) \).\(^5\)

Our hypothesis is that the \( \gamma \) coefficients will be positive—that is, children are more likely
to purchase a given brand if their parents have purchased that brand in the past. We control
for both child characteristics \( X_{fit} \) and mother’s characteristics \( X_{mft} \), interacted with brand
dummies. Finally, we allow for brand-by-year fixed effects, \( \alpha_{jt} \) to capture overall market
shares, leaving \( \epsilon_{ijt} \) as the error term.

This setup expands each observed brand choice into seven observations. To avoid this
expansion of the data set unduly shrinking our standard error estimates, we cluster all
standard error calculations at the level of the 1968 PSID family. This clustering accounts
for the mechanical correlation between the seven observations that represent a single choice,
the correlation in the individual’s choices across choice situations, and the correlation across
siblings or cousins.

We code the third mother’s brand dummy variable as zero for all brands when we do not
observe three choices for the mother. We do likewise for the second variable when we observe
only one choice for the mother. This should bias our results towards zero (a bias against
our expected finding). Our qualitative findings are robust to specifications that use only one
variable for the mother’s choice, and to estimation on the subsample of child choices where
the mother has three available choices.

We do not allow for an outside good, which would be interpreted as the option not
to purchase a vehicle at all. Inclusion of an outside good is standard in discrete choice
modeling, but here we are interested in knowing whether or not a child, conditional on

\(^5\)We have experimented with a variety of ways of characterizing the mother’s choice given that mothers
may own multiple vehicles. We have used the share of mother’s vehicles of a specific brand, and we have
done one-to-one vehicle matching across mothers and children using the order in which vehicles are listed in
the survey. In all cases, our qualitative results are quite similar. We prefer the dummy variable specification
for ease of interpretation and it accords with the causal model we have in mind.
purchasing a vehicle, decides to buy a brand that is the same as the one owned by members of his or her family. Inclusion of an outside good would mix together correlations in choice that determine whether or not individuals purchase vehicles with correlations in the brand chosen when purchasing a vehicle, which are distinct phenomena.

4.1 Baseline results

We begin by showing simple correlations in order to demonstrate the strength of the intrafamily relationship. We then demonstrate the impact that controlling for observable characteristics has on the results. Table 2 displays our results. Column 1 reports coefficients from a regression that includes only year-by-brand fixed effects, which control for the overall share of each brand during each period, and thus represent the raw intergenerational correlation in brand choice. The coefficients on all three variables that represent the mother’s brand choices are positive, statistically significant, and economically large. The coefficient estimate on the most recent choice of the mother is 0.085. There are seven brands in our choice set, so the probability that the average brand is selected is .143. Our estimate therefore indicates that a consumer’s mother purchasing a brand increases the likelihood that the consumer purchases the brand by 60%, on average. This effect will be even larger if the mother has consistently chosen that brand in the past; a child whose mother has chosen the same brand in all of the last three purchases is 140% more likely to choose that particular brand on average.

Does this correlation imply that preferences are transmitted across generations, or is merely the product of correlations in characteristics across households within a family? As we discuss in section 2, we wish to distinguish between correlations in choice that are driven by familial correlations in demographic and location-specific factors—which may cause related households to demand similar attributes in vehicles, in turn causing a correlation in brand choice—from those driven by a transmission of brand preference, that is, demand for a brand not driven by “major” attributes.

Key to this distinction is controlling for demographic or geographic features that might drive demand for attributes. In columns 2 through 7 of table 2, we introduce progressively richer controls and examine how the coefficient estimates change. In column 2 we add demographic controls for the child and his or her household, including family income, an urban versus rural dummy, age, sex, education, number of kids in the household, household size, and the gasoline price when the child purchased the vehicle. Each of these characteristics is interacted with a dummy for each brand, which is a flexible analog to the traditional approach in the automobile demand literature of interacting vehicle attributes with buyer
Table 2: Correlations between child brand choice and parental brand choice

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s brand</td>
<td>0.085</td>
<td>0.080</td>
<td>0.079</td>
<td>0.071</td>
<td>0.071</td>
<td>0.057</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Mother’s previous brand</td>
<td>0.061</td>
<td>0.059</td>
<td>0.060</td>
<td>0.053</td>
<td>0.054</td>
<td>0.052</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Mother’s second lag</td>
<td>0.053</td>
<td>0.049</td>
<td>0.051</td>
<td>0.045</td>
<td>0.044</td>
<td>0.036</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.008)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Child’s demographics</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother’s demographics</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>State fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother’s state fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Census tract fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of choices</td>
<td>13,645</td>
<td>13,645</td>
<td>13,645</td>
<td>13,645</td>
<td>13,645</td>
<td>13,645</td>
<td>13,645</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.092</td>
<td>0.101</td>
<td>0.102</td>
<td>0.116</td>
<td>0.122</td>
<td>0.208</td>
<td>0.469</td>
</tr>
</tbody>
</table>

Standard errors clustered by 1968 PSID family are in parentheses. Each column is a linear probability model where each individual-year-vehicle choice enters the data 7 times, once for each brand. The brands include: GM, Ford, Chrysler, Toyota, Honda, Other Asian, and European. Child’s and mother’s demographics include age, education, income, urban dummy, gender, number of children in household, and family size.

characteristics. The addition of these controls lowers the coefficients, but by a very small amount.

In column 3, we introduce a matching set of demographic controls for the mother and her household. These controls reflect the fact that the mother’s attributes might influence the child’s optimal choice of vehicle; for example, if the mother is elderly, the child might prefer a vehicle that is easy to enter and exit (because the mother might sometimes ride in the child’s car). These controls have very little effect.

In column 4 we add state-by-brand fixed effects, which allow the average market share of each brand to differ for each state. The purpose of these controls is to capture location-specific factors (like weather, which drives attribute demand, or supply factors for each brand) in a nonparametric fashion. These fixed effects cause the coefficient to fall, but again by a small amount. We add fixed effects for the mother’s state in column 5, which again has little impact. Comparing the coefficient on the first variable for the mother’s brand across columns 1 and 5, we see that the addition of these controls lowers the estimated coefficient by only about 16%.

In column 6 we add fixed effects for the child’s county of residence. This lowers the point estimates by a more significant amount, but all three coefficients remain statistically
significant and economically large. We interpret the reduction in the magnitude as evidence that some important location-specific factors determine brand choice and are correlated across family members. We have two main location-specific factors in mind: geography and brand supply. Weather, terrain, urbanization and culture are important determinants of the demand for attributes, which are different on average across brands. Even conditional on demand, there may be a different availability of brands across geographic areas due to the location of dealerships. In our view, most of these differences should be captured by county-level fixed effects. The change in the magnitude of the coefficients from column 5 to 6 suggests that some of the intergenerational correlation in brand choice is due to such factors, but only a modest portion.

The original PSID sample design drew stratified samples from particular geographic areas. The legacy of that original sample design is that PSID households are still more geographically clustered than would be the case for a random sample of households. As a result, despite having a modest sample size, we are able to control for even finer geographic fixed effects and still have statistical power. In column 7, we add census tract fixed effects, which identifies geographic areas that typically have between 2,500 and 8,000 people. Census-tract fixed effects are fine enough to control for factors like local repair shops, mechanics, and other network effects. And, they are fine enough to control for correlations in taste or characteristics of people who choose to locate in the same neighborhood with a city.

The inclusion of census-tract fixed effects drives the $R^2$ of our regression up to 0.47 (from an initial value of .09 in column 1), and it drives our coefficient estimates down further. The coefficients on the first and second mother variables are still statistically significant and economically meaningful, but the third variable becomes statistically indistinguishable from zero (both because the standard error rises and the coefficient falls). The coefficient of .034 on the mother’s most recent purchase implies that a child whose mother purchased a brand recently has a 24% greater chance of buying that brand than the average consumer. This is about two-fifths the size of the raw correlation, but it is still economically important.

While these regressions cannot completely rule out the possibility that unobservable demographic and location-specific factors may drive intergenerational correlations, we believe that the limited sensitivity of intergenerational brand correlations to rich demographic controls, and the resilience of our qualitative result to fine geographic fixed effects, is important evidence that they are driven by brand preferences rather than confounders. Additional evidence is provided in section 4.2, in which we restrict our attention to brands offering vehicle fleets with similar attributes.
4.2 Similar Brands

Our principle concern is that demographic or locational characteristics of children and mothers will be correlated and that these characteristics drive demand for vehicle attributes that are correlated with brand. For example, individuals who live in rural areas, work in construction jobs, or live in areas that receive heavy snowfall may be more likely to prefer light trucks to passenger cars. Because GM’s fleet is more heavily tilted towards light trucks than Toyota’s, such people will be more likely to buy a GM, even in the absence of any brand preference. Above, we showed that controlling for many observable characteristics had limited impact on the coefficients, but concerns about unobserved factors remain.

Here, we use a different strategy, isolating the choice set to brands that are very similar. Ford and GM are both full-line automakers that compete directly in every vehicle segment. Because their vehicle lineups are very similar, we would expect intrafamily brand choice correlations to be quite weak in the absence of intrafamily brand preference transmission when we limit our sample to children who choose either a GM or a Ford.6

Table 3 repeats the specifications in table 2 for a subset of choices limited to Ford and GM. Specifically, we keep all instances in which a child chose either a Ford or GM, which accounts for around 56% of our original sample, and we code the mother’s choice as before. There are three key things to note about the results in table 3. First, the results are all positive, statistical significant, and economically meaningful. This corroborates our baseline results and casts further doubt on the possibility that the correlation in brand choice across households is due entirely to confounders.

Second, the magnitudes of the coefficients are very similar across the full sample in table 2 and the subsample in table 3. This similarity of coefficient implies that the brand preference correlation has a smaller percentage effect on choice probabilities, because the baseline choice probabilities are higher. In the full sample, the market share for Ford is 23%, and the share is 33% for GM. In the subsample, this translates to a market share of 41% for Ford and 59% for GM. Thus, the coefficient of 0.085 in column 1 of table 3 implies that a child whose mother’s most recent prior purchase was the same brand boosts the probability of purchase by 21% for Ford and 14% for GM, whereas the same coefficient represents a 37% effect for Ford and 26% for GM in the full sample.

This difference is intuitive given that Ford and GM are generally close substitutes, and it does suggest that correlations in observable household characteristics that influence demand for vehicle attributes may have contributed to the brand correlations in table 2. However,

---

6Toyota and Honda also both produce a full range of high-quality cars as well as fuel efficient SUVs and trucks. In preliminary results, we find estimates for a Toyota and Honda subsample that are similar to what we find here for Ford and GM.
Table 3: Correlations between new vehicle brand and parental brand choice among those owning a Ford or GM

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s brand</td>
<td>0.086</td>
<td>0.087</td>
<td>0.087</td>
<td>0.077</td>
<td>0.075</td>
<td>0.061</td>
<td>0.055</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.014)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Mother’s previous brand</td>
<td>0.075</td>
<td>0.076</td>
<td>0.077</td>
<td>0.067</td>
<td>0.066</td>
<td>0.069</td>
<td>0.054</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.013)</td>
<td>(0.014)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Mother’s second lag</td>
<td>0.060</td>
<td>0.060</td>
<td>0.063</td>
<td>0.057</td>
<td>0.059</td>
<td>0.044</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.016)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Child’s demographics</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother’s demographics</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>State fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother’s state fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>County fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Census tract fixed effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of choices</td>
<td>7.611</td>
<td>7.611</td>
<td>7.611</td>
<td>7.611</td>
<td>7.611</td>
<td>7.611</td>
<td>7.611</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.064</td>
<td>0.066</td>
<td>0.067</td>
<td>0.087</td>
<td>0.101</td>
<td>0.136</td>
<td>0.537</td>
</tr>
</tbody>
</table>

Standard errors clustered by 1968 PSID family are in parentheses. Sample is limited to the cases where the child chose Ford or GM and the mother owns a Ford or GM. Each column is a linear probability model where each individual-year-vehicle choice enters the data twice, once for each brand. Child’s and mother’s demographics include age, education, income, urban dummy, gender, number of children in household, and family size.

A strong intrafamily brand correlation remains, even after limiting the sample to similar automakers.

Third, the coefficient estimates change less in magnitude when additional controls are added for the Ford and GM subsample than they did in the full sample. Magnitudes do decline as controls are added, and the third variable is small and statistically insignificant in the census tract regression. But the first two coefficients in column 7, which includes census-tract fixed effects, are greater than 60% of the same point estimates in column 1.

4.3 Additional specifications

The results in tables 2 and 3 are robust across specifications, with the most significant difference coming from the inclusion of census-tract fixed effects. To further explore the role that census tract controls might play, we present results that separately estimate coefficients for the roughly 20% of children who live in the same tract as their mother, and the 80% who do not, in table 4. The table presents only specifications that include census tract fixed effects, and columns 1 to 3 show the full sample, with columns 4 to 6 including only Ford and GM purchases. The table shows that brand preference correlations for children who live
Table 4: Correlations between new vehicle brand and parental brand choice for children who do or do not live in the same census tract as their parents

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>All brands Same tract</th>
<th>Different tract</th>
<th>Ford and GM Same tract</th>
<th>Different tract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s brand</td>
<td>0.034 (0.009)</td>
<td>0.052 (0.018)</td>
<td>0.040 (0.012)</td>
<td>0.050 (0.021)</td>
</tr>
<tr>
<td>Mother’s previous brand</td>
<td>0.037 (0.010)</td>
<td>0.061 (0.023)</td>
<td>0.038 (0.012)</td>
<td>0.054 (0.022)</td>
</tr>
<tr>
<td>Mother’s second lag</td>
<td>0.018 (0.011)</td>
<td>0.001 (0.022)</td>
<td>0.033 (0.014)</td>
<td>-0.040 (0.024)</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Child’s demographics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother’s demographics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother’s state fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Census tract fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of choices</td>
<td>13,645 2.550 11,995</td>
<td>13,645 2.550 11,995</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.469 0.417 0.511</td>
<td>0.537 0.438 0.609</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Standard errors clustered by 1968 PSID family are in parentheses. Sample is limited in columns as indicated by headers. Each column is a linear probability model where each individual-year-vehicle choice enters the data twice, once for each brand. Child’s and mother’s demographics include age, education, income, urban dummy, gender, number of children in household, and family size.

In different tracts than their parents (columns 3 and 6) are strong. Thus, it is not the case that co-residence in the same tract is driving our results.

4.4 Mechanisms for intergenerational brand preference transmission

There are several mechanisms through which a preference for particular brands could be transmitted from one generation to the next, all of which could give rise to the correlations documented above. Parents could be just a single, albeit particularly important, node in an information network that transmits contemporaneous information about automobiles. If so, then instantaneous changes in parental brand choice could influence child choices.

Alternatively, it may be crucial that children experience a brand directly while they remain part of their parents’ household, and that these preferences are a long-term evolution. In the extreme version of this experience mechanism, when parents purchase vehicles after their children have left the home, it should have no influence on the children’s choices.

Ideally, we’d like to separate long-run experiential formation from information transmis-
sion by having a complete vehicle ownership history of each family, and testing whether or not vehicles purchased at particular times in the child’s lifecycle, when they lived outside their parents home and after they left, are more or less influential. However, because vehicle ownership data are only available in the PSID from 1999 to 2007, we only observe a subsample of young adults while they are both in their parents home and on their own. And, we lack a complete history of vehicles owned throughout the child’s life, so when we observe a parent switch into a new brand, we are unable to determine whether the family had a prior history with that brand before the data were collected.

Nevertheless, we are able marshall additional suggestive evidence on both mechanisms. First, to examine the effect of vehicles owned by a parent while the child was still in the home, we limit our sample to children whom we observe living in their parents’ household in one year and observe living in their own household in a later year. We restrict this sample further to include individuals who did not form their own household until they were at least 18 years old and were not living with their parents beyond age 23. For these individuals, we then identify the brand ownership of their parents at the last time we observe them living in their parents’ household.  

Table 5 reports linear probability model regressions that predict the child’s brand choice (once they have established their own household) using a dummy variable for whether or not any of the parents’ vehicles at the time the child left the household were of a given brand. To avoid counting vehicles that children took with them from their parents’ home, we drop all children who reported that any of the vehicles in their fleet had been received as a gift. Our results in prior tables are insensitive to dropping these vehicles, which are quite rare, from the estimation sample.

The difference in the independent variable in these regressions relative to those discussed above means that we cannot directly compare the estimated coefficients to our previous estimates. However, the results from this analysis are qualitatively similar. Child brand choice is positively correlated with parental ownership of a brand when the child was most recently in the mother’s household. This relationship is statistically significant and economically large in all specifications.

This specification does not perfectly distinguish long-run preference formation from short-run information transmission, but these results do suggest a link between brand experience

---

7We use the term “parent” here, but we also include children whom we observe living in and moving out of a non-parent guardian’s household. In those cases, we use brand and demographic information from the guardian.

8Our results in prior tables are insensitive to dropping these vehicles, which are quite rare, from the estimation sample.
Table 5: Correlations between new vehicle brand and parental ownership at time when child lived with parents

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>All brands</th>
<th>Ford and GM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Parent Owned Brand</td>
<td>0.093</td>
<td>0.086</td>
</tr>
<tr>
<td>Brand fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Child’s demographics</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Parent’s demographics</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>State fixed effects</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Census tract fixed effects</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>4,298</td>
<td>4,298</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.094</td>
<td>0.146</td>
</tr>
</tbody>
</table>

Standard errors clustered by 1968 PSID family are in parentheses. Each column is a linear probability model where each individual-year-vehicle enters the data 7 times, once for each brand. The data are restricted to children who were observed as a dependent in a household in the sample when he or she was under 23 and then as the head (or wife) of a household later in the sample. Child’s and parent’s demographics include age, education, income, urban dummy, gender, number of children in household and family size.

During adolescence and brand choice in adulthood, suggestive of long-run endogenous brand preference formation.

To better isolate short-run information transmission, we can also estimate models that include individual fixed effects. These models are identified only from changes in parental brand ownership over time, across observations of multiple car purchases by the same child. Thus, if only long-run preference formation is at work, we would not expect changes in current parental ownership to affect child choice.

Column 1 of table 6 restates regression results from column 3 of table 2, and column 2 adds individual fixed effects. The same specifications are shown in columns 3 and 4 for the Ford and GM only sample. The inclusion of individual fixed effects significantly weakens the estimated effects, and it raises the standard errors. Nevertheless, the three coefficient estimates are jointly significant according to a standard F-test, in both columns 2 and 4. The inclusion of individual fixed effects changes the interpretation of the coefficient—it captures a short-run brand transmission. Thus, long-run brand preference transmission could be substantial and the coefficient in the individual fixed effects regressions could still be zero if short-run transmission is weak or nonexistent. The fact that we find statistically significant effects here suggests that there is at least some role for short-term information transmission, which we hypothesized would be weaker than the long-run effects.

Neither of these mechanism tests is as sharp as would be ideal because of limitations of
Table 6: Correlations between new vehicle brand and parental brand choice with individual fixed effects

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>All brands (1)</th>
<th>Ford and GM (2)</th>
<th>All brands (3)</th>
<th>Ford and GM (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother's brand</td>
<td>0.079</td>
<td>0.011</td>
<td>0.087</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
<td>(0.011)</td>
<td>(0.014)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Mother's previous brand</td>
<td>0.060</td>
<td>0.020</td>
<td>0.077</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.010)</td>
<td>(0.013)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>Mother's second lag</td>
<td>0.051</td>
<td>0.006</td>
<td>0.063</td>
<td>-0.010</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.013)</td>
<td>(0.015)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Child's demographics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mother's demographics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Household fixed effects</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of choices</td>
<td>13,645</td>
<td>13,645</td>
<td>7,611</td>
<td>7,611</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.102</td>
<td>0.465</td>
<td>0.067</td>
<td>0.583</td>
</tr>
</tbody>
</table>

Standard errors clustered by 1968 PSID family are in parentheses. Sample is limited in columns as indicated by headers. Each column is a linear probability model where each individual-year-vehicle choice enters the data twice, once for each brand. Child’s and mother’s demographics include age, education, income, urban dummy, gender, number of children in household, and family size.

The data. However, we believe that they suggest there is a causal mechanism both through long-run preference formation and short-run information transmission. Having provided this considerable evidence regarding the empirical correlation between child and parent brand choice, we now move to a discussion of the theoretical implications of intergenerational transmission of brand preferences by developing a model of the auto market.

5 Theoretical implications of brand preferences for the vehicle market

What might the persistence of brand preferences imply for market outcomes in the automobile industry? We begin to address this question by considering the implications of brand preferences for automakers’ pricing strategies. We study a simple, symmetric model in which two firms compete in two different product markets and consumers live two periods, purchasing once in each market. Our modeling approach follows the tradition of the switching costs and brand loyalty literature—particularly Klemperer (1987) and Dubé et al. (2009)—by focusing on whether brand loyalty increases or decreases prices in equilibrium. We follow
this analysis by studying a model in which consumers may be loyal to one firm but not the other, motivating a discussion of automakers’ incentives to encourage brand loyalty amongst their customers.

We forego a richer model that would more closely match the current automobile industry—a model with more than two major firms, many products per firm, and richly differentiated consumer preferences—for several reasons. First, the simultaneous estimation of the parameters needed to simulate the model (those governing households’ preference heterogeneity, households’ brand preference transmission, and firms’ marginal costs) would be a substantial undertaking that is beyond the scope of this paper and likely beyond the power of our data.\footnote{Dubé et al. (2009) and Dubé, Hitsch and Rossi (2010) are able to simultaneously estimate preference heterogeneity and within-household brand loyalty because they observe both a large number of repeat purchases per customer and rich price variation in their dataset on orange juice and margarine purchases. While our PSID dataset is well-suited for estimating intergenerational brand preference transmission, the limited number of purchases observed for each household and weak price data make it poorly suited for characterizing heterogeneous preferences for attributes or prices.} Second, the computational challenges of simulating such a model would be immense. Finally, the simple model we present is close in spirit to most of the brand loyalty literature and provides clear, intuitive results that we believe would generalize qualitatively to a more complex model.\footnote{We are encouraged here by the fact that Dubé et al. (2009) find qualitatively similar predictions from the simple and complex versions of their model.}

5.1 A simple model of automobile pricing under brand loyalty

A substantial literature, dating back to Klemperer (1987), studies the effect of brand preferences on firms’ prices in equilibrium. This literature commonly uses the term “switching costs” to refer to a reduction in utility experienced by a consumer who switches from one brand to another in different periods of a model, which is identical to how we operationalize what we call brand preference here.\footnote{Some papers model switching costs as an increase in utility from purchasing the same brand as that purchased last period (our approach), while others model switching costs as a decrease in utility from purchasing a different brand. Dubé et al. (2009) examines both models and finds that they produce identical predictions in the absence of an outside good. In the presence of an outside good, the second formulation yields lower prices in equilibrium, as switching costs make the outside good relatively more appealing.} Our approach is closest in spirit to that of Dubé et al. (2009), hereafter DHR, in that we model an infinite-horizon game in which brand preferences are of a sufficiently modest magnitude that some households do switch brands in equilibrium. Our primary difference from DHR and the preceding literature is that we model firms as having two products that cater to two types of consumers: the young and the old. We model multi-product firms to relate the model more closely to the automobile market, in which nearly all manufacturers produce a range of models tailored to consumers in different stages...
of their lifecycle, and to highlight the role that intergenerational preference transmission can play in determining automobile prices in equilibrium.

In our model, there are two symmetric firms, denoted $j$ and $k$, that compete in a differentiated Bertrand pricing game. We adopt an infinite horizon overlapping generation (OLG) framework in which households live for two periods. In each period, there are unit masses of two types of households: young (type $A$) and old (type $B$). All consumers are born as type $A$, become type $B$ in the second period of their lives, and then die, creating a new type $A$ consumer (offspring) upon death. A key feature of the model is that the type $A$ and type $B$ consumers purchase different kinds of cars. Both firms are aware of this fact, and both sell two vehicle models catering to the two types. Thus, there are four vehicles in the market: $jA$, $jB$, $kA$, and $kB$. $A$ and $B$ cars can be thought of as cars preferred by younger versus older consumers, or entry level versus upscale, or single-person versus family vehicles.

For both brevity and clarity, we will focus on the case in which type $A$ households only consider vehicles $jA$ and $kA$ and type $B$ households only consider vehicles $jB$ and $kB$. Clearly this is an abstraction, as there will be some substitution across any of the markets we described. Thus, this paper’s appendix (to be added) will discuss how relaxing this assumption affects our findings.\(^{12}\) Still, in a survey of over 22,000 consumers by a market research firm described in Langer (2011), the Cadillac Deville and Lincoln Town Car had more than 100 purchasers over the age of 60 and none under the age of 40, while the Scion tC had more than 100 purchasers under 40 and only 6 over 60. Similarly, only 5% of consumers who say they purchased a Buick are under the age of 40. Clearly there are vehicles that appeal strongly to specific age groups.

Let the utility of a particular consumer $i$ of type $B$ that purchases vehicle $jB$ be given by:

$$U_{ijB} = V - \alpha P_{jB} + \mu_B 1\{b_{iA} = j\} + \epsilon_{ijB},$$

where $V$ is a baseline utility that is common across the two brands, $P_{jB}$ is the price of vehicle $jB$, and $1\{b_{iA} = j\}$ is an indicator for whether consumer $i$ purchased brand $j$ when he/she was a type $A$ last period. $\mu_B$ denotes the strength of within-consumer persistence of brand

\(^{12}\)In brief, allowing for some cross-age substitution has essentially no impact on models in which intergenerational brand preference transmission is as strong as within-household transmission. In models in which intergenerational transmission is relatively weak, cross-age substitution reduces the gap between the type $A$ and type $B$ vehicle prices (and does so in a qualitatively symmetric way). The result that brand preferences (of a magnitude corresponding to our estimates above) reduce equilibrium prices continue to hold. This is true even in the extreme case in which there is no intergenerational brand preference and consumers have no systematic preference for their own type of vehicle. This last model is similar to that of Doganoglu (2010) in which consumers live for two periods and the (single product) firms cannot distinguish between young and old.
preferences. The utility from purchasing vehicle $kB$ is given similarly. All type $B$ households purchase exactly one vehicle, and there is no outside good.

The utility of a consumer $i$ of type $A$ that purchases vehicle $jA$ is similarly given by:

$$U_{ijA} = V - \alpha P_{jA} + \mu_A 1\{b_iB = j\} + \varepsilon_{ijA}. $$

Here, $1\{b_iB = j\}$ is an indicator for whether the parents of consumer $i$ purchased brand $j$ when they were type $B$ last period. $\mu_A$ denotes the strength of intergenerational brand preferences. In accordance with our estimates above, we will model $\mu_A$ as less than or equal to $\mu_B$. The random utility components $\varepsilon_{ijB}$ and $\varepsilon_{ijA}$ are assumed to be i.i.d. type I extreme value over individuals $i$, brands $j$ and $k$, and types $A$ and $B$.

For now, we assume that type $A$ consumers are not forward-looking when deciding whether to purchase vehicle $jA$ or $kA$; we will relax this assumption in future work.\footnote{Per the intuition of Somaini and Einav (2011), we expect that allowing for forward-looking behavior by the type $A$ consumers will result in higher prices for the type $A$ vehicles and lower prices for the type $B$ vehicles in equilibrium.} We also assume that type $B$ consumers are not forward looking in the sense that they do not consider the implications of the brand preferences they transmit to their children.

Let $\phi_A$ and $\phi_B$ denote the fraction of consumers loyal to brand $j$ in the $A$ and $B$ markets, respectively. Given the price of each vehicle and $\phi_A$ and $\phi_B$, the demand for each vehicle will be given by a weighted sum of standard logit choice probabilities. For example, the demand for vehicle $jA$ is given by:

$$D_{jA} = \phi_A \frac{\exp(V - \alpha P_{jA} + \mu_A)}{\exp(V - \alpha P_{jA} + \mu_A) + \exp(V - \alpha P_{kA})} + (1 - \phi_A) \frac{\exp(V - \alpha P_{jA})}{\exp(V - \alpha P_{jA}) + \exp(V - \alpha P_{kA} + \mu_A)}. $$

We model the marginal cost of all four vehicles in the market as a constant, denoted by $c$. Firm $j$’s per-period profits are then given by:

$$\pi_j(P_{jA}, P_{kA}, P_{jB}, P_{kB}, \phi_A, \phi_B) = (P_{jA} - c) \cdot D_{jA}(P_{jA}, P_{kA}, \phi_A) + (P_{jB} - c) \cdot D_{jB}(P_{jB}, P_{kB}, \phi_B). $$

In the infinitely repeated game, the firms’ state variables are the brand loyalty shares $\phi_A$ and $\phi_B$ of the consumers of each type. The states evolve so that next period’s loyalty of the type $A$ consumers is given by the current period’s demand of the type $B$ consumers for vehicle $jB$: $\phi_A' = D_{jB}(P_{jB}, P_{kB}, \phi_B)$. Similarly, $\phi_B' = D_{jA}(P_{jA}, P_{kA}, \phi_A)$. We restrict the firms to Markov strategies so that, with a discount factor $\delta$ that is shared by the two firms,
firm $j$’s Bellman equation is given by:

$$V_j(\phi_A, \phi_B) = \max_{P_jA, P_jB} \{\pi_j(P_jA, P_kA, P_jB, P_kB, \phi_A, \phi_B) + \delta V_j(\phi'_A, \phi'_B)\}$$

Firm $k$’s Bellman equation is defined similarly. These equations capture the tradeoff the firms face as the parameters $\mu_A$ and $\mu_B$, which govern the strength of brand loyalty, vary. The incentive to increase current-period profits by increasing prices is weighed against the incentive to increase future profits by lowering prices to boost the share of future loyal consumers.

For a given set of model parameters, the Markov Perfect Equilibrium (MPE) of the firms’ dynamic Bertrand pricing game can be solved computationally (details to be provided in a future appendix).

In the simulations presented below, we fix $\delta = 0.9$, $V = 1$, $\alpha = 8$, and $c = 1$. The choice of $V$ is immaterial in the absence of an outside good. The price preference $\alpha$ and marginal cost $c$ parameters together yield, in the absence of any brand preferences, an equilibrium price for all vehicles of 1.25 and equilibrium own-price elasticities of -5. This markup and elasticity roughly correspond to typical markups and elasticities found by Berry, Levinsohn and Pakes (1995).

The range of brand loyalty parameters $\mu_A$ and $\mu_B$ that we consider spans zero to one. Values of zero collapse the model to a standard static Bertrand problem, for which the equilibrium price is 1.25. Values of within-household brand preference, $\mu_B$, between 0.4 and 0.6 most closely correspond to the linear probability model estimates discussed above. These estimates also suggest that $\mu_A$ is roughly $1/2$ to $3/4$ the value of $\mu_B$.

### 5.2 Optimal prices in a model with symmetric firms

We explore the impact of brand preferences on firms’ equilibrium pricing strategies by increasing the brand preference parameters $\mu_A$ and $\mu_B$ from zero and examining the change in firms’ equilibrium steady state prices. These prices are sufficient statistics for steady state profits, since in steady state the two firms always evenly share both the $A$ and $B$ markets (due to the symmetry of the firms’ demand and cost parameters).

Figure 1 presents steady state equilibrium prices, over a range of brand loyalty strengths, for three cases. For all cases, the prices of firms $j$ and $k$ are equal within each of the markets $A$ and $B$ due to symmetry. In the first case, given by the solid lines, intergenerational brand transmission is turned off by holding $\mu_A = 0$ while the strength of within-household brand preferences $\mu_B$ is varied.

Without intergenerational brand loyalty ($\mu_A = 0$), the model reverts to a standard two-period game (akin to that of Klemperer (1987)) that can be solved for analytically, though the results presented below were nonetheless generated numerically.
Figure 1: Steady state prices with two symmetric firms

Note: Steady state equilibrium prices shown are from the model described in section 5.1 in which $\delta = 0.9$, $V = 1$, $\alpha = 8$, and $c = 1$. At steady state, the demand for each of the four cars $jA$, $jB$, $kA$, and $kB$ is equal to 0.5. The solid line denotes the case in which there is no intergenerational brand loyalty, the dashed line denotes the case in which intergenerational brand loyalty is half the strength of within-household brand loyalty, and the dotted line denotes the case in which intergenerational and within-household brand loyalty are equal.

Preference is varied by letting $\mu_B$ range from 0 to 1. In this case, we find that increasing $\mu_B$ raises the prices of the type $B$ cars while lowering the prices of the type $A$ cars. That is, when households develop brand loyalty but do not pass this loyalty to their children, then in equilibrium the prices for vehicles intended for older consumers will be high relative to prices for vehicles intended for younger consumers. The intuition for this result follows directly from Klemperer (1987): if first period choices determine brand loyalty in the second period, then firms will “invest” in customers in the first period by charging lower prices and “harvest” the consumer loyalty in the second period. Over the range of $\mu_B$ parameters plotted, the “investment” effect in the $A$ market outweighs the “harvesting” effect in the $B$ market in that the average vehicle price is less than the no-loyalty baseline price of 1.25.\textsuperscript{15}

When intergenerational brand loyalty is equal to within-household brand loyalty—the
case denoted by the dotted line in figure 1—the A and B markets behave identically to one another so that the prices for all four vehicles are equal in steady state, and the model collapses to that of DHR. Relative to the case with no intergenerational brand loyalty, type B consumers benefit and type A consumers lose as the firms no longer price their type B cars higher than their type A cars. In particular, firms can no longer “harvest” brand loyalty through high mark ups in the B market because doing so reduces future demand and profits.

Across the full range of brand loyalty parameters plotted, steady state equilibrium prices are lower than in the case of no brand loyalty. The dashed line plots an intermediate case in which intergenerational brand preference transmission, $\mu_A$, is one-half that of within-household transmission, $\mu_B$. This case lies between the two other cases.

Given that the values of $\mu_A$ and $\mu_B$ that apply to the automobile industry almost certainly lie within the plotted range, these results suggest that the transmission of automobile brand preferences within and across households reduces automakers’ prices and profits in equilibrium. Similar to DHR, we find that prices do increase with brand loyalty at the high end of the range. However, the point at which prices are actually higher than in the no-loyalty case—values of $\mu_A$ and $\mu_B$ of approximately 1.2—seems implausible given our estimates above.\(^{16}\) The intuition for why moderate levels of brand loyalty reduce prices in equilibrium is given by Cabral (2009), which discusses why the “investment” incentive to lower prices is first-order while the “harvesting” incentive to raise prices is second-order.

Figure 2 displays equilibrium prices and demand out of steady state for the “intermediate” model given by the dashed line in figure 1. Figure 2 fixes the brand preference transmission parameters at $\mu_B = 0.5$ and $\mu_A = 0.25$, which roughly corresponds to our empirical results above regarding intergenerational transmission of preferences and auxiliary results (not presented) on the strength of brand preference within the same household over time. The plot shows that, as the share of consumers loyal to firm j in both the A and B markets increases from zero to one, firm j’s prices and demands in both markets increase. The market B price is more sensitive to the initial level of brand loyalty because the relative weakness of intergenerational brand preferences means that the “harvesting” incentive is relatively strong in this market. That is, if firm j finds itself with a large number of loyal type B consumers, it has a strong incentive to raise the price of vehicle jB in equilibrium to profit from these consumers. Figure 2 also demonstrates that, starting from any initial state, the price and demand dynamics will drive the market to the 50/50 steady state.

We believe that the results of our analysis speak to the automobile industry’s apparent

\(^{16}\)A value of $\mu_B = 1.2$ implies that a household loyal to brand j facing equal prices for vehicles jB and kB would choose jB with a probability of 0.769. Such a choice probability would imply a coefficient of 0.537 in a linear probability model with two firms; this value far exceeds the magnitudes of the brand persistence we observe in the data.
Figure 2: Equilibrium non-steady state behavior; model with two symmetric firms

Note: Equilibrium prices shown are from the model described in section 5.1 in which $\delta = 0.9$, $V = 1$, $\alpha = 8$, and $c = 1$. $\mu_B$, which governs the strength of within-household brand preference transmission, is 0.5, and $\mu_A$, which governs intergenerational transmission, is 0.25. As one moves from zero to one on the horizontal axis, the state variables $\phi_A$ and $\phi_B$ denoting the shares of consumers loyal to firm $j$ in the $A$ and $B$ markets both move from zero to one.

focus on sales volumes to the potential neglect of current profits. The industry media is filled with stories about market share, sales volumes, and conquest rates. Anecdotally, automakers are said to focus on hitting quarterly sales targets, which frequently leads them to discount vehicles and even dump some at a loss in fleet sales. It is natural for an economist to view such prioritization of sales volumes over profitability as a mistake. When brand preferences are present, however, firms must make trade-offs between current profits and future profits, justifying a focus on volume. When brand preferences are transmitted across generations, the importance of brand preference is enhanced. In particular, intergenerational transmission sharply limits automakers’ ability to harvest brand preference later in consumers’ lifecycle, as harvesting jeopardizes the loyalty of future generations. Overall, automakers face strong pressure to cut prices today to compete on market share; however, it is difficult for them to ever reap the rewards of this customer loyalty.
5.3 Firms’ incentives for encouraging brand loyalty

One of the main results from the analysis above is that the presence of brand loyalty likely reduces automakers’ equilibrium prices and profits. This result begs the question of why, then, automakers appear to frequently encourage brand loyalty amongst their customers. For example, firms in this industry typically offer products that are vertically differentiated but nonetheless have similar brand-specific attributes (such as the location of the radio dials or the front grill styling), often focus their marketing and advertising efforts on their overall brand rather than on individual products, usually have dealers that sell their full range of vehicles, and occasionally even place advertisements that explicitly appeal to nostalgia.

Clearly, however, the industry would be better off if its consumers did not develop brand preferences. To address this issue, we now explore firms’ unilateral incentives to develop loyal consumers by studying a game in which the strength of brand preferences can vary across firms.

We begin with the model from the section above and, for simplicity, focus on the case in which intergenerational and within-household brand preferences are of the same magnitude. Thus, the $A$ and $B$ market prices will be equal in steady state. We create an asymmetry across the two firms by eliminating any brand preference for firm $j$. Mechanically, we do so by breaking the original brand loyalty parameters $\mu_A$ and $\mu_B$ into four parameters: $\mu_{jA}$, $\mu_{jB}$, $\mu_{kA}$, and $\mu_{kB}$. $\mu_{jA}$ and $\mu_{jB}$ apply if the consumer (or the consumer’s parents) purchased brand $j$ last period, while $\mu_{kA}$ and $\mu_{kB}$ if brand $k$ was purchased. We set $\mu_{jA}$ and $\mu_{jB}$ equal to zero and vary $\mu_{kA}$ and $\mu_{kB}$ to examine how firm $k$ is affected when consumers can be loyal to it but not to firm $j$.

The results of our analysis are presented in figure 3. This plot demonstrates that as $\mu_{kA}$ and $\mu_{kB}$ increase, firm $k$ modestly decreases its prices to invest in brand loyalty, but firm $j$ must substantially decrease its price in order to be competitive in the absence of any brand preference for its vehicles. Despite this price decrease, firm $j$’s steady state market share still declines with $\mu_{kA}$ and $\mu_{kB}$.

Because of these equilibrium pricing strategies, firm $k$’s profits increase with $\mu_{kA}$ and $\mu_{kB}$ while firm $j$’s profits decrease, as shown in figure 3. Intuitively, firm $k$’s ability to build brand loyalty as it shuttles consumers through different vehicles over their lifecycle gives it a strong competitive advantage over firm $j$.

The fact that firm $k$’s profits increase with $\mu_{kA}$ and $\mu_{kB}$ additionally implies that it has a unilateral incentive to encourage brand loyalty amongst its customers. Firm $j$ also has this incentive as its profits are lower in this case than in the case from section 5.2 when

\[17\] For example, see two recent television advertisements for the Toyota Camry and Chevy Silverado at http://www.youtube.com/watch?v=46pmd-qq_6o and http://www.youtube.com/watch?v=Mrl-mm-7WM8.
Figure 3: Prices and profits when only firm k has loyal consumers

Note: Steady state equilibrium prices shown are from the model described in sections 5.1 and 5.3 in which $\delta = 0.9$, $V = 1$, $\alpha = 8$, $c = 1$, and brand preferences for firm $j$ ($\mu_{jA}$ and $\mu_{jB}$) are set to zero. For firm $k$, intergenerational brand preference parameter $\mu_{kA}$ is set to equal the within-household preference parameter $\mu_{jB}$.

it has loyal consumers as well. Thus, in an equilibrium in which firms have some control over the extent to which consumers develop brand preferences, firms will encourage brand preferences even though the resulting equilibrium leaves them worse off. That is, absent collusion, competitive forces push firms to compete not only in prices but also in the degree of loyalty of their consumers, further reducing their profits. This outcome has parallels in the literature on advertising in oligopoly markets, in which the equilibrium level of advertising can exceed that which would maximize industry profits (see, for instance, Dixit and Norman (1978) and Grossman and Shapiro (1984)).

6 Conclusion

Our analysis of the PSID suggests that automobile brand preferences may be passed through the generations in ways that are important to the strategy of automobile producers. The strength of brand preferences for automobiles may be surprising, as compared to brand per-
sistence in other goods. After housing, automobiles are the largest purchases that most households make, which means that a reliance on brand as a convenient heuristic for simplifying choice seem an unlikely explanation for brand persistence. Our work documents strong correlation across generations in brand choice, which suggests a strong influence of brand preference in the market. Our results suggest that both endogenous taste formation (perhaps based on nostalgia) and information sharing are at work in explaining the transmission of brand preference.

Using a model that captures firms’ dynamic pricing incentives, we show that the transmission of brand preferences are likely to depress automakers’ prices and profits in equilibrium. Intuitively, intergenerational brand preference transmission forces firms to reduce prices of upscale vehicles intended for older consumers. This outcome occurs despite firms’ strong unilateral incentive to increase profits by encouraging their customers to stay loyal to their brand.

We conclude by noting that brand preferences are likely relevant to the broader question of why most major automakers carry a wide range of vertically differentiated products. There are, of course, many reasons for this strategy apart from its relationship to brand preferences: for instance, production economies of scope and the value of covering the wide range of consumers’ attribute preferences are surely important. That said, it seems likely that giving consumers an opportunity to stay within a brand over the lifecycle, thereby allowing them to develop a brand preference, can substantially enhance the value of carrying a broadly differentiated vehicle fleet. It is intuitive to expect that brand preferences give producers an incentive to develop entry-level offerings that will “lead” consumers to their profitable upscale goods. The intergenerational link that we establish further implies that discount automakers will have an incentive to develop upscale product lines in order to “lead” future generations to their entry product. This link may, for instance, help explain the relatively slow growth of firms, such as Toyota and Honda in the 1980s, and Hyundai today, that offer only entry-level vehicles, but do so at a low price given their high quality.

The product line question also harkens back to the debate over product strategies that shaped the initial competition between Ford and GM. Early in the twentieth century, Ford’s strategy was to create a single vehicle that was affordable to all, driving down costs through economies of scale. There was no interest in vertical product lines, and Henry Ford famously quipped that “people can have a Model T in any color—so long as it is black.” On the other hand, GM’s strategic plan was to build a variety of cars that fit people at different life stages and income levels, embodied by the famous quote from Alfred Sloan that GM would sell “a car for every purse and purpose.” Brand preference transmission within and across generations may be helpful in explaining why GM’s strategy succeeded and why
Ford ultimately deviated from its initial strategy and became a full-line automaker. Future research into brand preferences and firms’ product line choices would be valuable in shedding light onto both these historic developments and more recent industry dynamics.

References


