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UNCERTAINTY AND CONSUMER DURABLES ADJUSTMENT

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ABSTRACT

Uncertainty and Consumer Durables Adjustment*

We study infrequent durables stock adjustment by consumers who also derive utility from non-durable consumption flows, in the presence of idiosyncratic income uncertainty. We first characterize how the extent of uncertainty bears theoretically on the cross-sectional distribution of the durable/non durable ratio, the probability of costly adjustment, and the size of adjustment. Then, we bring such predictions to bear on a data set with extensive information on disaggregated durable goods and subjective measures of future income uncertainty. The data feature two conceptually distinct sources of variation: cross-sectional heterogeneity of the sampled households' dynamic problems, and history-dependent heterogeneity in their situation at the beginning of the observation period. We note that the latter should affect the likelihood but not the size of stock adjustment decisions, and find broad support for theoretical predictions in formal selection-controlled regressions based on this insight.

JEL Classification: D11, D12 and D91
Keywords: adjustment costs, Heckman exclusion restriction and optimal inaction

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1 Introduction

Over the last ten years a growing literature has focused on realistic models of intermittent adjustment at the microeconomic level. Infrequent large adjustments can be explained in an optimizing framework by first-order adjustment costs. These can justify very large deviations from frictionless optimum levels when such deviations are volatile and likely to be erased soon by exogenous developments rather than by costly action: in a more uncertain environment, the option of remaining inactive is more valuable, and even small costs can imply wide ranges of inaction. This theoretical perspective is applicable to many microeconomic adjustment decisions (including labor demand, investment, inventories, and cash balances) as well as to durable goods consumption, on which we focus in this paper. We review and extend the relevant theory's implications for the relationship between optimal dynamic adjustment policies and a variety of microeconomic features of an individual consumer's problem. Then, we bring them to bear on a data set featuring extensive information on durable purchases and on subjective measures of future income uncertainty.

Our empirical work aims at disentangling the conceptually different effects of uncertainty and other factors on the frequency and size of adjustment. In theory, higher uncertainty increases the likelihood of wide deviations from the preferred durables stock, but also widens the range of inaction. Hence, conditionally on the current state, higher uncertainty about the future evolution of the problem's forcing variables implies that immediate adjustment is less likely, and that adjustment is larger if it does occur. Theory offers similar *ceteris paribus* predictions regarding the comparative dynamics implications of the drift, adjustment cost, and taste parameters of the optimal adjustment problems. We account for such effects measuring the drift in expected durable consumption on the basis of optimality conditions on the durables/nondurables consumption margin, and approximating adjustment costs by measures of bureaucratic inefficiency. Econometric identification of our controlled regression estimates is based on a key distinction between two conceptually different sources of variation in the *intensity* and *size* of durables adjustment decisions. Cross-sectional heterogeneity of consumers' and goods' characteristics bears on both the frequency and size of optimal infrequent adjustment policies, but a consumer's decision to adjust during the observation period also depends importantly on the dynamic history that (for given parameters of the dynamic problem and optimal adjustment policy) brought him or her close to the boundaries of the inaction range. After controlling for the former (cross-sectional) variation by conditioning on relevant characteristics, the latter (dynamic) variation is summarized in cross-sectional data by the beginning-of-period value of the stock of durables in relation to nondurable consumption. This variable conveys information as to the consumer's position within the inaction band at the beginning of the observation period, hence the likelihood of adjustment. Conditionally on adjustment taking place, however, it is *not* expected to influence the size of durables stock adjustment, which should be based on forward-looking considerations and depend on uncertainty, adjustment costs, and other observable and unobservable characteristics, rather than on past history. Thus, an infrequent-adjustment perspective provides a theoretically sound exclusion restriction to standard selection-controlled estimation techniques.

Despite the realism of infrequent adjustment models and their potential importance for explaining aggregate phenomena, relatively few studies test and estimate such models on microeconomic data, and fewer still focus on the empirical role of uncertainty. Lam (1991) uses PSID data to estimate the parameters of a threshold adjustment model in an extended permanent income hypothesis model, and finds evidence for liquidity constraints and resale market imperfections. More recently, Attanasio (2000) estimates a semi-structural model of car purchases on a sample of U.S. households drawn from the CEX. His specification focuses on characterization of trigger and return points rather than on the role of structural parameters.

We are not aware of previous empirical studies of the joint effects of uncertainty and other microeconomic parameters on both the extensive and intensive margin of the durable adjustment decision. Eberly (1994) and Foote, Hurst, and Leahy (2000) are perhaps the closest antecedent to our work. Eberly (1994) studies car purchases using panel data from the Survey of Consumer Finances and finds that higher uncertainty increases the width of the inaction bands, but does not characterize its effects on the probability of adjustment. Her theoretical framework is based on the Grossman and Laroque (1990) model and, like that of Hassler (2001), does not allow for idiosyncratic labor income risk. Foote, Hurst, and Leahy (2000) instead neglect the size durable stock adjustment, and focus on its frequency (from CEX data). They find it to be negatively related to the imputed variance of household income obtained from regressions estimated with PSID data. That proxy, of course, may be contaminated by measurement error in income, and by prediction errors due to the smaller information set available to the econometrician. Our data offer a better measure of household-level uncertainty, based on the household's own information set, and also make it possible to control for nondurable consumption flows and durables stocks (rather than for the age of the car which, in Foote et al.'s regressions, may imperfectly proxy for those variables). And while earlier work had to rely on fairly arbitrary assumptions as to variables that predict the variance of income but have no effect on the adjustment decisions, clear-cut exclusion restrictions are offered to empirical analysis by our framework, which refines and extends those proposed by Grossman and Laroque (1990), Bertola and Caballero (1990), Caballero (1993). Furthermore, our framework allows us to explicitly (albeit approximately) account for nondiversifiable income uncertainty both theoretically and empirically.

Section 2 sets up the relevant theoretical framework, first characterizing frictionless intertemporal choice of optimal durables stock/nondurables flow ratios, then showing that in the presence of adjustment costs the solution can be approximated by action and return points in terms of (log) deviations of the durable/nondurable ratio from its no-adjustment-costs level. Section 3 introduces our data; discusses available observable counterparts for theoretical uncertainty, adjustment-cost, and drift parameters; and reviews theoretical predictions and empirical evidence on the relationship of such parameters to the shape of cross-sectional distributions of durable stocks and to the frequency and size of stock adjustment. Section 4 specifies semi-structural models for adjustment probabilities and selection-controlled adjustment sizes, tests theoretical predictions on estimated parameters, and computes aggregate measures of optimal adjustment's responsiveness to parameter changes. Section 5 concludes, summarizing our results and outlining directions for further research.

2 Theoretical framework

We consider the intertemporal optimization problem of a consumer whose period utility $u(C(\tau), X(\tau))$ is a function of the nondurable consumption flow, $C(t)$, and of the available durable goods stock $X(t)$. In continuous time, the consumer aims at maximizing the present discounted (at rate ρ) value of such utility flows, subject to a standard budget constraint: $r(t)$ is the rate of return on assets held (or debt owed) at time t which, together with a flow $y(t)$ of labor income, is used to finance nondurable and durable consumption expenditure. The price of durables in terms of nondurables, $p(\cdot)$, may vary exogenously over time, and the actual expenditure and/or utility flows also depend on the size and sign of durables stock changes, $\Delta X(\tau)$, which result from sales or purchases (adjustment) rather than from depreciation in use, which occurs continuously at rate δ.

If both durable and nondurable consumption yield utility and both income and asset returns are random, such an optimization program is analytically intractable and even numerical analysis must rely on drastic simplifications. The classic Grossman and Laroque

(1990) study of optimal durable consumption abstracts from nondurable goods and labor income, to obtain analytic and numerical results for the case where asset returns are described by Brownian increments, and utility has constant elasticity. Other researchers have chosen different simplifications and approximations (see Attanasio, 2000, and Padula, 2000, for references and discussions).

Empirical analysis of available data would not be able to detect and test detailed features of realistic models, even if a tractable specification were available. Since the data we analyze do contain information on labor-income expectations and uncertainty, we follow Bar-Ilan and Blinder (1992) and Bertola and Caballero (1990) in studying approximate durable consumption choices in the presence of labor income risk. And since detailed information is available on consumer characteristics and on more than one durable good stock, we pay particular attention to the implications of the resulting approximate characterization for the variation of stocks and of adjustment patterns across heterogeneous observations.

Defining the user cost of durable goods as $\upsilon(t) \equiv (r(t)+\delta)\, p(t) - E[dp(t)]/dt$,in the absence of adjustment costs the condition

$$\frac{\partial u(C(t),X(t))}{\partial C(t)}\upsilon(t) = \frac{\partial u(C(t),X(t))}{\partial X(t)} \tag{1}$$

is necessary and sufficient to ensure that the consumer could not obtain a larger utility flow from the purchasing power expended at each point in time. When $u(\cdot,\cdot)$ is homothetic, (1) implies that the optimal ratio of durable to nondurable consumption is a function $z(\cdot)$ of the user cost,

$$\frac{X(t)}{C(t)} = z(\upsilon(t)), \quad z'(\cdot) < 0. \tag{2}$$

As to dynamic optimality, perfect borrowing and lending opportunities at a constant rate of interest r implies the Euler condition

$$\frac{\partial u(C(t),X(t))}{\partial C(t)} = e^{(r-\rho)\tau} E_t \left\{ \frac{\partial u(C(t+\tau),X(t+\tau))}{\partial C(t+\tau)} \right\}, \tag{3}$$

so that discounted (by $e^{(r-\rho)\tau}$) marginal utility changes are unpredictable.

If γ denotes the elasticity of marginal utility and σ^2 denotes the conditional variance of consumption growth, the expected growth rate of consumption can be approximated by the expression

$$E_t \left\{ \Delta \log(C(t)) \right\} \approx \frac{r-\rho}{\gamma} + \frac{\gamma}{2}\sigma^2 \tag{4}$$

(see e.g. Carroll, 1997), and the stock of durables follows a similar process if, as is the case under homotheticity, it is proportional to the nondurable consumption level.

The solution of the intertemporal consumption problem exists under mild regularity conditions. In the absence of adjustment costs, it is fully determined by conditions (1) and (3) and by the relevant budget and accumulation constraints. An explicit solution is not available in general, but several characterization results are available. If utility flows are a constant-elasticity function of nondurable consumption flows and durables stocks, $u(\cdot) = (1-\beta)\log C + \beta \log X$, then $X(t)/C(t)$ is inversely proportional to $v(t)$ by (2), hence constant if the user cost of durables is constant. While the exact consumption function is nonlinear in the presence of precautionary savings, if (4) is a satisfactory approximation then future expected consumption is proportional to current consumption. Further, the expected-value version of the consumer's budget constraint implies that each of the durable and nondurable consumption levels should be approximately proportional to the consumer's total wealth (the coefficient of proportionality depending on the rates of return, of utility discount, and of expected marginal utility growth). Hence, the volatility of consumption should be increasing in lifetime wealth volatility, which is in turn positively related to the volatility of permanent and transitory labor income shocks for given rate of interest.[1]

2.1 Adjustment costs

In reality, second-hand markets generally price used goods at less than the seller's valuation from continued use, to imply that the unit price applicable to durable purchases is different from that applicable to durable sales, even after accounting for depreciation. Moreover, adjustment can entail lump-sum costs, independent of the size of adjustment, for example because purchasing a car requires visiting dealers and registration bureaus. Hence, the unit price of small net purchases of durables is large, and the policy of frequent purchases and sales that would allow the consumer's durables stock to remain aligned with nondurable consumption as in (1) cannot be optimal. If the utility function is differentiable, small misalignment of the durable/nondurable ratio cannot have a first-order impact on utility flows, and should not be corrected if adjustment entails first-order transaction costs. In formalizing these insights we follow closely the approach and methods of earlier theoretical studies but, to prepare the ground for our empirical application, we focus particularly

[1] Banks et al. (2001) show that the conditional variance of consumption growth is proportional to the conditional variance of income growth (the proportionality factor can be approximated by the square of previous period's income-consumption ratio).

on characterization results for optimal deviations from the frictionless durable/nondurable consumption ratio, i.e., that implied by (1) in the absence of adjustment costs.

Bertola and Caballero (1990) characterize the optimal timing and size of infrequent costly adjustment of durables (or other stock variables) towards a statically optimal level $X^*(t)$ when the deviations from that level follow a random walk with drift in continuous time, and entail quadratic flow losses. In our specification of the consumer's problem without adjustment costs, the consumer at each point in time allocates a flow M of purchasing power to expenditure on nondurable goods, C, and imputed durable user costs, υX. The problem

$$\max_X \{(1-\beta)\log(M-\upsilon X)+\beta\log(X)\},$$

selects $X^* = \beta M/\upsilon$ and achieves the optimal utility flow

$$(1-\beta)\log(M-\upsilon\beta\frac{M}{\upsilon})+\beta\log(\beta\frac{M}{\upsilon}) \equiv u^*(M).$$

Along the intertemporal dimension, the process followed by the "expenditure" flows $M(t)$ satisfies the budget constraint by definition and, since

$$C(t) = (1-\beta)M(t),$$

has the unpredictable-increment properties familiar from standard applications of Euler conditions in the form (3) or (4).

To obtain an approximate characterization of the problem in the presence of adjustment costs, we begin by noting that an arbitrary durables stocks process $X(t)$ yields smaller utility than $X^*(t) = \beta E(t)/\upsilon(t)$ for the same sequence of $M(t)$ flows. Log-approximating utility flows around the frictionless optimum, the first-order term vanishes by optimality and neglecting third-order and higher terms yields

$$(1-\beta)\log(M-\upsilon X)+\beta\log(X)-u^*(M) \approx -\frac{\beta}{(1-\beta)}\left[\log(X)-\log\left(\beta\frac{M}{\upsilon}\right)\right]^2.$$

The independent-increments sequence $M(t)$ of expenditures (on nondurable goods and durable goods user cost) satisfies the intertemporal budget constraint by definition in the absence of transaction costs. When transaction costs are present, it can serve as an approximation to its budget-constrained counterpart (whose level should, in an exact solution, be adjusted so as to finance goods-terms transaction costs). Hence, the utility flow accruing to a consumer who optimally allocates purchasing power over time, continuously adjusts the nondurable consumption flow $C(t)$, and uses a given durables stock $X(t)$ can be approximated as

$$-\frac{\beta}{(1-\beta)}\left(\log(X(t))-\log\left(\frac{\beta}{(1-\beta)}\frac{C(t)}{\upsilon(t)}\right)\right)^2=-\frac{b}{2}\ (x(t)-c(t)-\kappa(t))^2\,,\tag{5}$$

where $b \equiv 2\beta/(1-\beta)$ is the slope of marginal utility losses due to deviations from the optimal durable/nondurable ratio along the optimal intertemporal expenditure pattern; $x(t) \equiv \log X(t)$ is the log durables stock; $c(t) \equiv \log C(t)$ is the log nondurable consumption flow; and $\kappa(t) \equiv \log(\beta/(1-\beta)) - \log \upsilon(t)$ represents the $x(t)-c(t)$ log-ratio of durables to nondurables consumption that would be optimal in the absence of adjustment costs, given the consumer's preferences and user cost.

The derivations leading to the approximation (5) offer useful insights for our microeconometric study. In particular, the slope b of marginal utility flow losses is related to structural features of the consumer's problem, namely the ratio $\beta/(1-\beta)$ of the durable and nondurable weights (or budget shares) in a log-linear utility flow expression. Similar expressions can be derived if the consumer derives utility from more than one stock of durables, with possibly different budget shares. Hence, this representation of the consumer's problem lends itself naturally to a study of cross-sectional data with information about different durable goods and nondurable consumption flows.

Standard solution methods are applicable if we define

$$z(t) \equiv x(t) - c(t) - \kappa(t)\tag{6}$$

and proceed to study the optimization problem

$$V(z_t) \equiv -\min_{\{z_\tau\}} E_t \int_t^\infty e^{-\rho(\tau-t)}\left(\left(\frac{b}{2}z(\tau)^2\right)d\tau + [\text{adjustment costs}]\right)\tag{7}$$

where adjustment costs, expressed in terms of utility, have the "kinked" form studied in earlier work. While it would be straightforward to let adjustment entail both lump-sum and proportional (to transaction size) costs, our data are silent as to the possible relevance of the latter. Hence, we will suppose that adjusting the stock of durables by any non-zero amount entails the same lump-sum cost, denoted A, in terms of utility. This formalization can represent the consumer's opportunity cost of shopping for durable goods or—noting that for our logarithmic specification the utility price of wealth is inversely proportional to the intertemporally optimal expenditure flow—approximate adjustment costs in terms of goods that are proportional to the consumer's durables stock, or total wealth.

An explicit solution is available if $z(t)$ follows an arithmetic Brownian motion process at times when the consumer refrains from purchases or sales of durables, i.e., if

$$[\Delta X(t) = 0] \quad \Rightarrow \; dz(t) \equiv \vartheta dt + \sigma dW(t) \tag{8}$$

where ϑ and σ are the drift and the standard deviation of the process. The optimal adjustment policy is described by two durable/nondurable consumption ratios, L and U, that trigger adjustment to a return point s. The optimal L, s, U adjustment points for the state variable z solve a simple nonlinear system of equations. In our empirical exercise, we will analyze a set of cross-sectional observations, each of which may be interpreted as a draw from a history of infrequent adjustment by a single decision maker. In the absence of time-series information on individual behavior, we will find it insightful to interpret the cross-sectional information available in terms of the long-run distribution of the controlled variable, z, within the $[L, U]$ optimal inaction interval. The stable distribution and adjustment intensities of the controlled Brownian motion process of interest have the piecewise exponential form familiar from e.g., Bertola and Caballero (1990) and Eberly (1994). Appendix A reports the relevant formulae.

The dynamics postulated in (8) are approximately realistic, in light of the definition of $z(t)$ in (6), if the logarithm of the durables stock depreciates linearly and the user cost $v(t)$ is either constant, or influenced by geometric inflation of the durable's relative price. The drift parameter ϑ reflects both depreciation of the durables stock and the drift in nondurable consumption. For our analysis of different durables stocks and heterogeneous consumers, it will be useful to note that ϑ should be more negative for goods with fast depreciation and/or steeply declining relative price, and for consumers with more positive consumption drift.[2] In the next section, we illustrate graphically the implications of different parameters and confront them with simple empirical evidence.

3 Data and theoretical implications

A consensus has formed in the literature that attempts to estimate structural parameters of a realistic infrequent-adjustment model cannot be fruitful (see e.g. Attanasio, 2000). Our

[2]Along the intertemporally optimal path, the logarithm of nondurable consumption approximately follows an unpredictable-increments process with drift. While optimal consumption growth need not be independently and identically distributed over time, its variance is in general monotonically increasing in the variance of uninsurable future income, and this justifies use of the approximate solution's qualitative features in empirical analysis.

alternative strategy aims at assessing the qualitative implications of a semi-structural theoretical model on a microeconomic data set. We analyze household data drawn from the 1995 Survey of Households Income and Wealth (SHIW).[3] The SHIW collects data on income, durable and nondurable consumption expenditures, financial wealth, real estate wealth, and demographic variables for a representative sample of about 8,000 Italian households. Since 1989 the SHIW also features a rotating panel component whereby approximately half of the sample units are re-interviewed in the subsequent survey. Information is provided for three durable-goods categories: means of transport (for brevity "cars" or vehicles in what follows); furniture, furnishings, household appliances and sundry articles ("furniture"); precious objects including jewelry, antiques, old and gold coins ("jewelry"). Households report the value of the stock at the end of the year, and the value of any sales and purchases during the year. For furniture the value of sales is not available (in Italy, there is virtually no second-hand market for household items). To obtain an observable counterpart to the consumer's durable stock at the time of adjustment, we subtract purchases and add sales to the end-of-year stock reported. For households that do not adjust, we measure the durables/nondurables ratio at the end of the period. This is likely to be lower than the same ratio at times when decisions not to adjust were taken during the period, because of depreciation. It is not immediately obvious whether and how idiosyncratic variation in depreciation rates would bias the empirical findings, but the discrete-time observations available to us are arguably a better approximation to the relevant continuous-time variable than the beginning-of-year stock (used in other applied work), which also neglects depreciation during the year.

Availability of information on various categories of goods makes it possible to study infrequent adjustment of durables other than cars, the only case studied in the empirical literature. As we shall see, some features of the model are fairly robust across different categories of durable goods, but others appear more relevant to households' choice of vehicles rather than that of furniture or jewelry. Jewelry purchase patterns are particularly hard to interpret, perhaps not surprisingly since the homotheticity assumption is less convincing, and accounting for taste heterogeneity more difficult, for this particular type of durable.

The data also offer very useful information on each household's future outlook. In a

[3]See Appendix B for a detailed description of the survey contents, its sample design, interviewing procedure and response rates. The 1998 SHIW also features subjective uncertainty and durables information. However, in 1997-98 a subsidy program for early scrapping of cars and motorcycles (similar to the one set up in France, see Adda and Cooper, 2000) was in place. Since modelling the effect of scrapping incentives is beyond the scope of this paper, we focus on the 1995 SHIW.

special section of the SHIW survey, households are asked a set of questions designed to elicit the perceived probability of being employed over the twelve months following the interview and the variation in earnings if employed (see Appendix B for details). We use this information to construct measures of the first two moments of the distribution of future earnings following the methodology developed in Guiso, Jappelli and Pistaferri (2002). The relevant portion of the survey is administered randomly (according to year of birth) to only half of the 1995 SHIW households who neither are retired, nor plan to retire in the following year. After excluding households with missing values of the subjective expectations and durables variables, we have 1,877 valid observations.

Table 1 reports summary statistics for the sample used in this paper and for the whole 1995 sample.[4] Values for the two samples appear comparable and confirm the randomness of the sample selection. In the sample we will be using in estimation the average value of the stock of cars is little more than 6,000 euro, compared to about 10,000 euro for furniture and 3,000 euro for jewelry. The corresponding durables stock/nondurable flow ratios are 36, 59, and 18 percent, respectively. The fractions of households who report sales or purchases is 18 percent for cars, 30 percent for furniture, and 10 percent for jewelry. Average net family disposable income is about 25,000 euro, household heads are 43 years old and have 10 years of schooling on average; families have three members on average, and about a third of the sample lives in the South. Table 2 reports summary statistics for the sub-sample of households that adjust the stock of each durable good.

The data also provide useful information on the key parameters of the optimization problem introduced above. Tables 1 and 2 report summary statistics for variables that convey information on the drift and uncertainty of the consumers' income processes, on adjustment costs, and on depreciation rates. Separate subsections below discuss available proxies for the theoretical model's uncertainty, drift, and adjustment cost parameters (detailed definitions are listed in Appendix C). In each case, we outline theoretical insights and confront them with simple empirical information on the distribution of durable/nondurable consumption ratios. These exercises usefully connect theoretical insights with descriptive evidence, offer information on some interesting unconditional features of the data, and pave the way for formal controlled regressions in Section 4.

[4] The whole sample excludes the retired for comparison purposes with the sample used in the estimation below.

3.1 Controlling for heterogeneity

Before proceeding to study the problem's dynamic aspects, it is important to recognize that our dataset's cross-section of consumers is certainly heterogeneous along many dimensions that would bear on durable consumption patterns even in the absence of adjustment costs. The optimizing behavior characterized above is that of a hypothetical infinitely-lived consumer, but the data are drawn from a cross-section of demographically heterogeneous consumers with possibly different tastes for durables (Attanasio, 2000, finds strong evidence of demographic effects in his data).

The explicit approximation procedure outlined above indexes taste for durables by the budget share parameter β, and makes it possible to give a structural interpretation to demographic variation in our empirical work. Our theoretical framework also makes it possible to calibrate other parameters to represent adjustment problems for different durables. Figure 1 illustrates how several aspects of the dynamic problem's solution depend on β; the values chosen for the drift ϑ, the variance σ^2, and the slope of utility losses from misalignment of nondurable consumption flows and durables stocks are meant to be roughly realistic if a unit of time is a year. Adjustment cost parameters are in terms of utility units, or fractions of permanent income under the logarithmic utility approximation. Thus, the $A = 0.01$ lump sum cost in the figure supposes that direct and opportunity costs of shopping for the durable good amount to 1 percent of a year's utility flow.

Obviously, taste for durables is an important determinant of the average durables/nondurables ratio: in the top-left panel of Figure 1, a larger durables budget share β (on the horizontal axis) is associated with increasingly large trigger and return durable/nondurable log ratios (on the vertical axis). Less obviously, and importantly for our purposes, this parameter also affects the frequency and size of adjustments since, by the definition of the marginal cost slope b in equation (5) above, a larger β increases the cost of departing from the statically optimal consumption bundle. Hence, stronger taste for durables implies a narrower inaction range and smaller optimal adjustment sizes in the bottom-left panel of Figure 1. The long-run density of the consumer's deviation from the statically optimal durable/nondurable log ratio (in the top-right panel) is positive on a narrower domain when β is large; and, as the boundaries of a narrower inaction range are more likely to be reached frequently, the unconditional probability intensity of adjustment at the lower boundary of the inaction range is an increasing function of β (see the bottom-right panel: in this and the following figures, the drift is sufficiently negative to imply that downward adjustment occurs with negligible probability, as is realistic in the presence of strong depreciation).

In light of these theoretical results, it is important to account for taste heterogeneity when testing the model's empirical fit. Accordingly, we will condition on a variety of controls meant to capture differences in tastes across consumers. Using a procedure similar to that performed by Eberly (1994) on durable/wealth ratios, we first filter the data with a regression of the durables stock/nondurable consumption ratio on a set of demographic characteristics (a polynomial in age, dummies for gender, education, area of residence, marital status, family size and household composition). Then, we compute the empirical density of the residuals, using Gaussian kernel nonparametric smoothers evaluated at 25 points over the range of X/C.[5] Figure 2 plots the empirical density of the log-ratio unexplained by demographic heterogeneity for vehicles (top-left panel), furniture (top-right), and jewelry (bottom). In all cases, the empirical density of X/C is skewed, and qualitatively similar to the theoretical stable density plot in the previous figure. While such a shape could be spuriously generated by uncontrolled heterogeneity in raw data, its appearance in filtered data suggests that the optimal inaction model approximates the durable goods consumption problem well. We now turn to examining the effect of uncertainty, drift, and adjustment costs on the shape of the density of X/C.

3.2 Uncertainty

The four panels of Figure 3 illustrate theoretical effects of different levels of uncertainty, as summarized by σ (the standard deviation of innovations in the process, denoted $z(t)$ above, that represents deviations from the frictionless durable/nondurable consumption bundle in the absence of adjustment). The parameters are the same as in the previous and following illustrations of theoretical insights, with the exception of the drift ϑ of the $z(t)$ process: since this parameter and σ interact in fairly complicated ways, we set ϑ to a less negative value in order better to highlight the implications of higher variance in isolation.

Along the vertical axis of the top left panel, we see that the inaction range becomes wider as uncertainty increases, to imply that adjustment is larger when it does occur (see bottom-left panel). Intuitively, if the consumer knows that deviations from the optimal configuration of the durable/nondurable bundle are very volatile it is optimal not to bear

[5] The stock of durables is measured as of the end of the period, and observations in the lower and upper percentile of the distribution are excluded from the computation. The empirical X/C ratio is zero when a household owns no durables in a category. This is not literally consistent with our simple theoretical framework, where durables are infinitely divisible and preferences are homothetic. Attanasio's (2000) less structural model accounts for selection of observations into the zero-durables category.

adjustment costs in order to correct such large deviations, and rather wait and see whether random events will correct them costlessly. Note that for a given state z on the vertical axis, the inaction range is smaller for low than for high levels of uncertainty. Hence, theory implies that, *conditioning* on the beginning-of-period information summarized by z, higher levels of uncertainty about future developments should be associated with *lower* probabilities of adjustment action in the immediate future.

Regarding *unconditional* implications, a wider range of inaction obviously implies that larger values of σ are associated with wider dispersion of z deviations in steady state, as illustrated in the top-right panel of Figure 3. The negative drift imparts an asymmetric shape to the density, and the trigger and return points are offset in the opposite direction around the frictionless optimum: the consumer's infrequent-adjustment policy lets the durables/nondurable ratio fluctuate around that reference point, leaving its average value broadly unchanged for different levels of uncertainty (recall that, in contrast, different taste-for-durable parameters had sharp implications for the average bundle consumed). The bottom-right panel of the figure plots the long-run average frequency (or intensity) of adjustment, and shows that the probability of action tends to be an increasing function of σ. In fact, higher uncertainty makes inaction optimal in the face of larger z deviations, but also increases the likelihood of wider swings in that process's realizations, hence the probability that action be triggered by any given barrier. Since marginal utility losses are increasing in z, it is not optimal to expand the range of inaction so much as to imply an unchanged frequency of adjustment in the presence of more uncertainty: the consumer should trade smaller average flow losses against larger adjustment costs, and adjust more frequently when faced by a larger σ.[6]

Our data's uncertainty indicators offer a valuable opportunity for empirical testing of such theoretical implications. In Table 1, the sample average of the coefficient of variation of expected future earnings is 4 percent, hence much smaller than the 11 percent standard deviation estimated for the innovation to earnings growth from longitudinal data on Italian workers (Guiso, Pistaferri and Schivardi 2001). This is of course not surprising. Subjective uncertainty at the individual level is conditioned on more information than is available to econometricians, and is a more appropriate measure of risk than measures polluted by variability predictable at the household level (if not by the econometrician). Comparing

[6] The effect is not monotonic in the presence of nonzero drift, since drift and variance interact in determining the long-run density of the process in the neighborhood of the adjustment trigger, but the tendency of higher variance to imply more frequent adjustment is unambiguous when σ is large relative to ϑ.

Table 1 and Table 2, we see that uncertainty is lower in the sub-sample of those who adjust than in the whole sample (and so is the fraction of unemployed, of low educated, and of those living in the South).

Our approximate model and data provide less than fully structural guidance in interpreting these and other empirical relationships between subjective measures of uncertainty and durable adjustment choices. Qualitatively, the theoretically relevant measure of uncertainty (in the proportional growth rate of nondurable consumption growth) should be monotonically related to the available measure of subjective income uncertainty. Theory is silent on the functional shape of such a relationship, however, and especially on the possible role of expected income growth. In what follows, our main uncertainty measure is the standard deviation of the individual distribution of future earnings, but we also discuss empirical findings when using normalized uncertainty measures (such as the coefficient of variation of income growth) or controlling for expected income growth.

Viewing the available household-level measure of earnings uncertainty as a proxy for the variability of X/C in the absence of adjustment, it is interesting to see whether the cross-sectional distribution of X/C becomes more spread-out as the variance of the state variable facing the consumer increases. Figure 4 reports the empirical density of X/C for subsamples of households with low and high income uncertainty. We classify as high-income risk households with a standard deviation of future earnings above the 75^{th} percentile of the distribution. The empirical plots are qualitatively similar to the theoretical ones, and the density for high uncertainty households is below that for low uncertainty households everywhere but in the tails, for all durable types. Regarding theoretical predictions on the relationship between uncertainty and the unconditional frequency of adjustment, it may be interesting to note that the uncertainty measure is indeed positively associated with adjustment in simple probit regressions with no other conditioning variables. In what follows, however, we will be focusing on controlled regression results and, in particular, on the distinction between the effects of uncertainty on the frequency of adjustment conditionally on the beginning-of-period value of z, and that on the size of adjustment for those who adjust.

3.3 Drift

Theoretical implications of a larger drift are illustrated in Figure 5. As the consumer trades larger utility losses off the larger expected adjustment costs entailed by speedier travel between the boundaries of a given inaction band, more negative values of ϑ enlarge the inaction range in the top-left panel, have asymmetric effects on adjustment sizes in the bottom-left panel, yield an increasingly skewed steady-state distribution with wider support in the top-right panel, and increase the frequency of upward adjustment in the bottom-right panel.

Seeking empirical counterparts for these theoretical results, recall that the drift of the X/C ratio in the absence of adjustment should be larger in absolute value for goods with faster depreciation and faster decline in prices, and for consumers with a steeper nondurable consumption profile. It would be interesting to exploit differences in drift across types of durable goods with heterogeneous depreciation rates. However, the depreciation rate affects the frictionless optimum durables/nondurables basket through the user cost, as in equation (1), as well as the speed at which the actual basket traverses the consumer's state space. Furthermore, it is not obvious that focusing on depreciation as a source of drift heterogeneity would lead to the emergence of a clear ordering. In fact, our durable goods categories include different items with probably markedly different depreciation rates. For instance, what we call "furniture" includes fast-depreciating items, such as household appliances and sundry articles, as well as beds, chairs, and tables which do depreciate slowly. Thus, it is not obvious whether these goods overall depreciate faster or slower than vehicles.

While information on the depreciation rate of durable goods is not readily available to us, we can exploit variation in predictable household nondurable consumption growth which should, on the basis of the theory outlined in Section 2, be approximately proportional to ϑ if preferences are homothetic.[7]

To obtain an observable counterpart to consumption drift, we exploit the rotating panel component of the SHIW survey. The data set includes 851 households interviewed in both 1993 and 1995.[8] For these households, consumption growth in the 1993-1995 period is directly observable. For the remaining households, however, such information is missing.

[7] This relationship is noisy, of course, since depreciation and relative price inflation rates need not be the same for households with different characteristics and facing different economic environments. Interactions between financial market imperfections and transaction costs are potentially very complex, but desired durable and nondurable consumption should in principle remain proportional to each other in the presence of liquidity constraints and uninsurable consumption risk, which in general affect predictable consumption growth—as illustrated in equation (4)—but need not alter the consumer's within-period budget allocation (Meghir and Weber, 1996). Accordingly, when conditioning on the consumption drift, we need not presume that households are financially unconstrained (as in Eberly, 1994, who also discusses ways of detecting them in her sample from the theoretical perspective of Grossman and Laroque, 1990, where an integrated financial market prevents idiosyncratic precautionary saving motives from playing any role).

[8] We cannot use this panel for fixed-effect estimation because uncertainty data are not available in the 1993 survey. As mentioned in footnote 3, the later 1998 release of the survey is affected by a scrapping-subsidy program, hence the 1995-98 panel component of the SHIW is also problematic for fixed-effect estimation purposes.

Our strategy is, first, to estimate a consumption growth Euler equation for the 1991-93 panel households. We assume that heterogeneity of consumption growth, which averages 0.56 percent in this group, is a function of *changes* in demographics (number of children, number of earners, family size, and homeownership status), and other characteristics (education, a quadratic in age, gender).[9] The predicted value of this regression is an estimate of expected nondurable consumption for the panel households. We use a best-subset regression strategy to impute desired nondurable consumption growth to remaining households (the average is 0.71 percent in this group).[10] Then, a proxy for the unobservable drift ϑ of the durables/nondurables log ratio in the absence of adjustment is given by the estimated individual-specific consumption growth, with negative sign.

Some observable variability is also available as regards depreciation: for vehicles, we may use province-level measures of accident frequency (in Table 1, we see that about 1 percent of cars are involved in an accident during the year) and of dissatisfaction with the extent of traffic congestion.[11] Comparing Table 1 and Table 2, it is interesting to note that the individuals adjusting the stock of vehicle appear to be living in provinces with less frequent car accidents and lower dissatisfaction with quality of public transports and traffic congestion.

Theory predicts that a more negative drift should make the density of X/C more spread-out and more skewed to the left (see Figure 5, top-right panel). To check this, we plot the empirical density of the X/C ratio (after controlling for observable demographic characteristics) for households with different predictable consumption growth rates. In Figure 6, a household is allocated to the "high drift" group regime if the drift of the durable/nondurable basket is *ceteris paribus* more negative, i.e. if consumption growth is above the 75$^{\text{th}}$ percentile of the cross-sectional distribution. The empirical densities for vehicles conform to qualitative theoretical predictions. Evidence for the other two types of durables is hard to detect. Interestingly, however, the distribution of "jewelry" in this and all other empirical figures is noticeably more symmetric than that of the other two durable-good groups. This

[9] The drift in nondurable consumption growth is estimated on the basis of *changes* in demographics, while regressions for the size of adjustment below exploit cross-sectional variation in the *levels* of demographics.

[10] The variables that are used to impute missing values include dummies for employed, self employed, region of residence, marital status, gender, education, a quadratic in age, number of children in three age bands, family size, and the number of earners.

[11] The 1993 SHIW asked each head to report (on a 0-10 scale) their satisfaction with the quality of various public and private services in the province or neighborhood of residence (there are 105 provinces in Italy, usually centered around medium to large-sized cities). We construct the index reported in the text by taking a provincial average of households' responses. Standard errors of our estimates below are corrected for provincial clustering.

is consistent with the smaller drift (after accounting for nondurable consumption growth) implied by the fact that jewelry, antiques, and other items included in this category are likely to appreciate rather than depreciate over time.

3.4 Adjustment costs

Theoretical implications of larger adjustment costs (relative to the slope of marginal flow utility losses) are illustrated in Figure 7. Larger lump-sum costs imply a wider inaction range, lower intensity of adjustment, and larger adjustment steps. These intuitive effects deserve to be confronted with the admittedly limited information available to us on variation in adjustment costs across the data set. Adjustment costs for different durable goods are widely different in reality. In particular, cars and vehicles are likely to feature large adjustment costs because of the legal and administrative costs that the buyer incurs upon purchase. Adjusting the stock of such durable goods by selling the current car and buying a new one also implies large costs because *lemon* problems plague the second-hand market for vehicles while administrative costs are incurred upon purchase of the new car. In Table 2, the large size of vehicle stock adjustments suggests that the width of the inaction band is larger for cars than for the other durable goods categories, which is consistent with the plausible idea that buying a new car (or vehicle) entails various transaction costs which makes adjustment more costly for cars than for furniture and jewelry, which should thus have lower adjustment costs than cars. Furniture is likely to lie in between: like cars, household appliances face a *lemon* problem, but differently from cars and similarly to jewelry they entail little or no administrative costs upon purchase.

In practice, a comprehensive measure of adjustment costs is not available to us, and we rely on a proxy which applies mainly to cars: the efficiency of local public administration. Consider the process of buying a new car in Italy. In order to get a plate and a temporary registration, the buyer must provide the dealer with a certificate of residence and his/her social security number. Obtaining the former typically requires a visit to the local council office and a nominal fee. Within two months of the purchase cars must be registered with a public registry (PRA). Registration entails filling an application form (with notarized signatures of both buyer and seller) as well as paying a fee. The search, time, and psychic costs of dealing with the local bureaucracy and notary publics (or the monetary equivalent entailed by hiring the services of *We'll-do-it-for-you* agencies) certainly do vary across different parts of Italy, and the relevant variation is likely to be captured by the answers to the SHIW survey question on perceived efficiency of public council offices. Comparing

Tables 1 and 2, we see that dissatisfaction with the efficiency of the public administration is slightly lower among those who adjust the stock of cars (a mean difference test has a $|t|$-statistic of 6). We will proxy adjustment costs with province-level indicators of such dissatisfaction. Of course, this variable may capture province-specific effects other than transaction costs, especially as regards adjustment of durables other than cars, since the adjustment costs entailed by furniture or jewelry purchases are unlikely to be related to the efficiency of the local public administration.

In Figure 8, we plot the density of X/C (after controlling for demographic characteristics) for two groups of households with different adjustment costs. We allocate to the high-adjustment cost group all households living in a province with an index of dissatisfaction with the efficiency of public offices in excess of the 75^{th} percentile of the distribution. Since this index is likely to be a reasonable proxy of adjustment costs just for cars, we report the density function only for this type of durable. Figure 8 does not conform to the theoretical predictions illustrated in Figure 7. In particular, the distribution of the ratio of car-stock to nondurable consumption is more spread-out for households bearing smaller adjustment costs. There may be two reasons for this. First, our measure is a very crude indicator of transaction costs. Second, the same indicator may be correlated with characteristics that impart an opposite (and counteracting) effect on the shape of the cross-sectional density. We will account for such violations of the *ceteris paribus* requirement in the more formal regression analysis of the next section.

4 Regression analysis

The theoretical predictions reviewed above broadly agree with some simple descriptive evidence from our data set. The agreement between theory and data, however, is far from perfect, and this is not surprising since the evidence analyzed in the previous section is far from conforming to the *ceteris paribus* assumption of theoretical comparisons. To assess the impact of each parameter in isolation, all other characteristics that may affect the distribution of X/C should be held constant. Hence, we proceed to examine the validity of theoretical implications in a formal controlled regression framework.

Very few households downgrade the stock of vehicles (a little more than 1 percent of the whole sample) or that of jewelry (0.2 percent); as mentioned, no information is available on the value of furniture sales. Hence, we focus on regressions for the probability of upgrading the existing stock of durable goods, and for the net size of adjustment (the value of purchases, if any, minus that of sales. Separate specifications are run for vehicles, furniture, and jewelry, allowing for possible interactions among the three types of durable-adjustment decisions.

4.1 The probability of adjustment

We estimate a model for the probability that a household upgrades each durable stock, conditioning on observable characteristics. To allow for possible non-separabilities, we include all three durables/nondurable ratios in each of the equations. We let adjustment of the current stock of durables occur when a latent variable D_i^*,

$$D_i^* = W_i'\gamma + u_i,$$

is driven to be larger than zero in the period. The assumption that $u_i \sim N(0,1)$ yields the probit model

$$\Pr(D_i^* > 0) = \Phi\left(W_i'\gamma\right), \tag{9}$$

where $\Phi(W_i'\gamma)$ is the standard normal cumulative density function evaluated at $W_i'\gamma$. In our theoretical framework, such a latent variable is readily interpreted as the distance between the action point and the durable-non durable ratio. If continuous-time observations were available, theory would predict adjustment with certainty as soon as the deviation of X/C from the frictionless optimum equals (or exceeds) the boundaries of the optimal inaction band. Discrete-time data allow only imperfect control for the consumer's position within the band, and the probit equation's prediction error conceptually corresponds to income and other relevant shocks occurring (unobservably) within the observation period, as well as measurement error.

In the class of infrequent adjustment models we consider, observing a large value of X/C prior to adjustment makes subsequent upward adjustment less likely. In our empirical strategy, we treat both the frictionless optimum and the inaction band as systematically different across individuals and unobservable as such. We focus on how observable variables bear on these when interpreting the results of regressions conditional on the pre-adjustment X/C : this is essentially the variable displayed by the smoothed distribution functions of the empirical illustrations above, which—after controlling for observable characteristics—we want to interpret as the history-dependent component of the determinants of optimal adjustment decisions.

For example, and most crucially, consider the implications of higher uncertainty. The model predicts that adjustment is less likely to be observed, for a given X/C, when a more uncertain outlook implies a wider (unobservable) band. The implications of the current X/C depend on the position of the frictionless optimum as well as on the width of the band, but the former (controlled by, e.g., demographics) is not affected by variance in the linear-quadratic approximation. With appropriate measures of drift and adjustment costs, one can test the additional implications that stronger drift (a higher depreciation rate) increases the probability of adjustment, while larger adjustment costs make adjustment less frequent. To account for the fact that the standard deviation of future earnings is not dimension free, we include as an additional regressor the value of expected earnings.[12] The drift is measured by expected household nondurable consumption growth, obtained by the imputation procedure discussed above.

As pointed out in Section 3.1, individuals who are relatively more inclined to consume durable goods should tend to remain closer to the frictionless X/C ratio, and therefore adjust more frequently and by smaller amounts. We proxy for taste heterogeneity inserting in all our regressions a vector of demographic variables (education, age, family size, the number of children in three age bands, the number of earners, and dummy indicators for region of residence and city size). Finally, and most interestingly, we insert a set of variables intended to capture depreciation (the frequency of car accidents and the dissatisfaction with the extent of traffic congestion in the province where the household lives), adjustment costs (the dissatisfaction with the efficiency of the local public administration), and the opportunities to obtain an equivalent flow of services if no adjustment is undertaken (an index of dissatisfaction with the quality of public transports in the household province). The quality of public transports may have an impact on the frequency of adjustment since for individuals living in areas with highly inefficient public transports the benefits from more frequent adjustment are larger than for households that can rely, if no adjustment is undertaken, on high quality public transport. These variables are expected to be most relevant for the vehicles regressions. Since they only vary at the province level, we correct standard errors for clustering.

Table 3 reports marginal effect estimates from probit regressions for the upgrading of the stock of vehicles, jewelry, and furniture, respectively. In the first column, the probability of

[12] We have also obtained qualitatively similar results using the coefficient of variation as an indicator of uncertainty. Such a normalized measure appears unduly restrictive, however, since it forces expected future income to have a negative impact on the probability of adjustment.

upgrading decreases with the initial value of the ratio of the stock of vehicles to nondurable consumption, as predicted by the theoretical model. The coefficient is highly statistically significant and economically important: a 10 percent decline in the durable-nondurable ratio would increase the probability of adjusting by about 7 percent on average. The stocks of the other two durable goods (scaled by nondurable consumption) are statistically insignificant. Hence, the data do not reject separability in preferences and adjustment costs across the three durable goods considered.

As predicted by the theory, a higher level of uncertainty reduces the probability of adjusting (a p-value of 1.7 percent) after controlling for expected earnings (whose coefficient is statistically significant but economically small). A 10 percent increase in the standard deviation of future earnings decreases the probability of adjustment by about 1 percent on average.

Our main control for the drift (expected household nondurable consumption growth) is statistically significant and displays a sign that is in agreement with the model's prediction: households with faster growing nondurable consumption adjust more frequently than those with a flatter profile; if the drift in consumption is increased by 10 percent, the probability of adjusting the stock of vehicles rises by little less than 0.4 percent. The alternative control for the drift (traffic congestion) is instead poorly measured. Despite the admittedly less than ideal character of these controls, this evidence suggests that expected changes have a strong effect on the probability of adjustment.[13]

The index of inefficiency of the public administration has a negative, statistically significant impact on the probability of adjustment, as predicted by optimal inaction models if this variable measures adjustment costs for vehicles. This effect was far from apparent in the simple descriptive evidence of Section 3.4, but is precisely estimated and quite large by the controlled regression approach. A 10 percent increase in the efficiency of the local public administration increases the probability of adjustment by about 16 percent. Bringing all provinces to the level of efficiency of the most efficient province (a very extreme experiment) would increase the probability of adjustment by almost 10 percentage points.

In addition, those living in provinces with bad public transport are more likely to upgrade and those living in provinces with a high frequency of car accidents less likely (al-

[13]If our imputed drift measure is removed, the results are very similar: the point estimate of the income uncertainty effect is -0.0210 with a standard error of 0.0092. If we focus only on the original panel households, again we obtain similar results (although less precisely measured due to a reduced sample size). In particular, the point estimate of the income uncertainty effect is -0.0187 with a standard error of 0.0155. The point estimate of the drift is 0.5581 with a standard error of 0.1576. Thus it appears that our imputation procedure for the drift is not driving the results.

though the estimate has a somewhat large standard error). The first effect is consistent with the idea that if a good substitute for private transport is available, the pressure to adjust when the stock of vehicles depletes is lessened leading to less frequent upgrading. One explanation for the second effect is that a high probability of car accident not only raises the drift but also increases uncertainty about the X/C ratio and the two have opposite effects on the probability of adjustment.

Overall, the estimated effects on the probability of adjustment of the main variables that theory predicts should affect the adjustment decision (the initial stock, the value of uncertainty, drift, and adjustment cost) lend considerable support to the model in the case of vehicles.

Demographic variables also appear relevant to the likelihood of adjusting, which declines with age, is lower for residents in the South, and higher for families with high education, multiple earners, and many members. Theory suggests that adjustment should be more likely for individuals whose preferences attach a larger weight to durables, and most of the effects are at least superficially consistent with this interpretation. For instance, cars are likely to be more important for large households than for the elderly, leading the former to adjust more frequently than the latter.

In the second and third columns we report the results of probit regressions for the decision of upgrading the stock of furniture and that of jewelry, respectively. Uncertainty reduces the likelihood of upgrading, though standard errors are higher than in the case of vehicles (p-values of 15 percent and 12 percent, respectively for furniture and jewelry). Expected earnings are statistically significant for both furniture and jewelry. The drift term is correctly signed and significant. The index of inefficiency of the local public administration is insignificant, and not surprisingly so since this variable is a poor adjustment-cost proxy for durable goods other than vehicles. The own durables stock-nondurable consumption ratio is statistically significant in both equations, but while it is plausibly negative for furniture, it carries a positive sign for jewelry. This indicates that our theoretical and empirical approach cannot capture crucial features of jewelry consumption, which is likely to depend on unobservable taste heterogeneity in ways that are poorly controlled by demographic variables: if at the household level idiosyncratic taste for jewelry increases both the likelihood of adjustment and the initial jewelry stock, the coefficient of the latter is biased upwards in estimation, and this can explain our result. To the extent that the specification can be relied upon to capture other effects, there is evidence of complementarity between furniture and jewelry purchases, and of demographic effects: education increases and age decreases the probability of upgrading, family size does not affect the probability of buying furniture but decreases the probability of buying jewelry, the number of earners increases the probability of both, and furniture adjustment is less likely in the South.

4.2 The size of adjustment

Theory also delivers qualitatively sensible sign predictions and exclusion restrictions for the size of the adjustment conditional on adjusting (or, equivalently, for the width of the inaction band). Formally,

$$E\left(A_i \,|Z_i, D_i^* > 0\right) = Z_i'\beta + E\left(\varepsilon_i \,|Z_i, D_i^* > 0\right) \tag{10}$$

where A_i is individual i's optimal adjustment size, Z_i a vector of explanatory variables, and $\varepsilon_i \sim N\left(0, \sigma_\varepsilon^2\right)$ a Gaussian error term capturing measurement error and unobserved heterogeneity. Theory predicts that higher uncertainty and adjustment costs both *increase* the size of adjustment, while a higher drift reduces it.

In the equation for the size of the adjustment, however, the disturbance depends upon unobserved heterogeneity as well as measurement error. Hence, $E\left(\varepsilon_i \,|Z_i, D_i^* > 0\right)$ is not zero in general, and simple OLS regressions conducted on the sample of those who adjust will provide inconsistent estimates of the parameters of interest. This is a standard problem in microeconometrics, which we treat in what follows with Heckman-selectivity corrections in regressions for the size of adjustment. This approach is most suitable in our setting. First, since unobserved heterogeneity in the two margins is likely to exist along a variety of dimensions (tastes for durables, transaction costs, etc.) that obviously affect both the likelihood of observation in the neighborhood of trigger points and the width of the adjustment bands, the relevant self-selection mechanism implies that unobservable heterogeneity in the extensive margin is correlated with unobserved heterogeneity in the intensive margin (i.e., $\operatorname{cov}\left(u_i, \varepsilon_i\right) \neq 0$), thus precluding use of a Cragg (1971) model (see Lee and Maddala, 1985). And theory suggests that the decision to adjust does not depend on the same variables affecting the decision about how much to adjust. Hence, a simple Tobit model would not be appropriate, and suitable identifying restrictions are available for a Heckman correction procedure.

As mentioned, theory predicts that the value of X/C at the beginning of the period (i.e., prior to adjustment) affects the likelihood of adjusting but not the size of the adjustment if it occurs. This is an important exclusion restriction, and the evidence presented below suggests that it is powerful enough for identification purposes. The results of the second stage of the Heckman selectivity regressions are reported in Table 4. In the first column we see that income uncertainty increases the size of vehicles adjustment, as predicted by the theoretical model. The effect is strongly significant (a p-value of 1.1 percent) and economically sizable (see below). The effect of expected earnings is positive but poorly measured, and the negative effect of drift has similarly small significance. Among demographic variables, only city size dummies and the number of teen-age family members are significant (people living in metropolitan areas buy smaller cars, and the size of adjustment is also smaller for families with teen-age members). There is evidence of self-selection: the Wald test for independent equations has a p-value below 1 percent, and strongly supports our specification allowance for unobserved taste factors. The estimate of ρ (which measures the correlation between the error term of the adjustment size equation, ε_i, and the error term of the selection equation, u_i) is negative and statistically significant, indicating that the unobserved heterogeneity that leads a household to adjust the stock of durables is negatively correlated with the unobserved heterogeneity that affects the size of adjustment. The availability of efficient public transports increases the size of adjustment. Our index for the inefficiency of the public administration does not have statistically significant effects on the size of automobile purchase.[14]

For furniture,where adjustment is measured on the basis of purchases, results are broadly in line with theoretical predictions. More uncertainty increases the size of the adjustment (but the p-value is high, 13 percent). The drift has the expected sign but is not significant, while expected income increases the value of the purchase. The elderly and households with young children adjust by smaller amounts, while households living in the South and in provinces with good public transports make larger purchases. We again find evidence for selection and negative correlation between unobservables in the adjustment equation and the selection equation.

For jewelry, results are less in agreement with the theory, or poorly measured. For instance, our measure of income uncertainty has the wrong sign and displays a large standard error. Expected income increases the size of the adjustment. The drift has the predicted sign and is statistically well measured. Among the demographics, age and residence in the South increase the size of adjustment. Residence in small town decreases it. Finally, we find

[14]If we focus only on the original panel households, we obtain similar results. In particular, the point estimate of the income uncertainty effect is 1.57 and it is marginally significant (a standard error of 0.97). The point estimate of the drift is 8.72 with a large standard error of 12. The estimate of ρ is -0.58 (0.09). Also in this case, as in the probit case, point estimates of the main effects in the sub-sample of panel households are comparable to those obtained in the whole sample, just less precisely measured due to a smaller sample size. Removing the imputed drift measure from the regression has virtually no effect.

again that the estimate of ρ is negative and statistically significantly different from zero.

In summary, our regression evidence shows that the model seems to be appropriate for modelling the behavior of car adjustment and, to some extent, furniture, but evidence for the jewelry is more mixed.

It is particularly interesting, from our theoretical perspective, to find that variables which positively affect the probability of adjustment also tend to have a negative effect on the size of the adjustment, and vice versa. This is quite consistent with the infrequent-adjustment perspective of our theoretical approach: the likelihood of adjustment (conditional on the initial durables/nondurable consumption ratio) is lower for wider inaction bands, which in turn imply larger adjustment sizes. Hence, sources of heterogeneity that make action less likely should indeed also imply larger adjustment upon action. From the viewpoint of the approximate model outlined in Section 2, it is particularly intriguing and quite interesting to find that not only the effects of observable variables, but also those of unobservable heterogeneity are negatively related in the selection and outcome equations. Consider individuals with similar target levels but different unobserved tastes for vehicles. Individuals whose utility attaches more weight to vehicles face steeper flow utility losses when deviating from the frictionless optimal stock, hence have narrower inaction bands (see Figure 1) and adjust more frequently and by smaller amounts than individuals with weaker tastes for vehicles. Thus, unobserved heterogeneity in the intensive margin equation should indeed be negatively correlated with unobserved heterogeneity in the extensive margin equation.

4.3 Unconditional effects

Much recent theoretical and empirical work has focused on aggregate implications of infrequent adjustment at the microeconomic level. In the dynamic aggregation studies proposed by Bertola and Caballero (1990), Eberly (1993), and Caballero (1993), a crucial role is played by the aggregate component of individual uncertainty, whose empirical relevance is analyzed by Attanasio (2000) and Hassler (2001) but cannot be analyzed in the context of our essentially cross-sectional empirical work. Since at any given point in time aggregate *per capita* durable purchases are given by the product of the fraction of adjusting households and the size of adjustment for those adjusting, however, our separate estimation of the effects of uncertainty on the two margins is of considerable interest, and our estimates offer useful information regarding the role of uncertainty (and of other variables) in shaping the dynamics of aggregate *per capita* durable purchases.

This issue can be evaluated considering the expression for average household durable expenditure in the whole sample:

$$\begin{aligned} E(A_i) &= E(A_i \,|D_i^* > 0) \Pr(D_i^* > 0) + E(A_i \,|D_i^* \leq 0) \Pr(D_i^* \leq 0) \\ &= E(A_i \,|D_i^* > 0) \Pr(D_i^* > 0), \end{aligned}$$

where $E(A_i \,|D_i^* > 0)$ is average expenditure in the subsample of those who adjust, $\Pr(D_i^* > 0)$ the probability of adjusting, and the second equality follows from the fact that $A_i \,|D_i^* \leq 0 \equiv 0$ (individuals who do not adjust make no purchase). The marginal effect of a given variable x_{ik} (affecting both the size of adjustment and the probability of adjustment) on average household expenditure is then:

$$\frac{\partial E(A_i)}{\partial x_{ik}} = \frac{\partial E(A_i \,|D_i^* > 0)}{\partial x_{ik}} \Pr(D_i^* > 0) + \frac{\partial \Pr(D_i^* > 0)}{\partial x_{ik}} E(A_i \,|D_i^* > 0).$$

Intuitively, the marginal effect is given by the sum of two components. The first is the change in buyers' purchases induced by a change in x_{ik}. The second is the change in purchases of those who change buying decision (from buying to non-buying or vice versa) because of a shift in x_{ik}. Using (9) and (10), it follows that the marginal effect of x_{ik} on average expenditure (for those who adjust and for those who don't) is given by the expression:

$$\frac{\partial E(A_i)}{\partial x_{ik}} = \beta_k \Phi\left(W_i'\gamma\right) + \gamma_k \phi\left(W_i'\gamma\right)\left[Z_i'\beta - \rho\sigma_\varepsilon W_i'\gamma\right]$$

We calculate this marginal effect (and the breakdown in intensive and extensive margin effects) and the corresponding elasticity $\frac{\partial E(A_i)}{\partial x_{ik}} \frac{x_{ik}}{A_i}$ (evaluated at the mean of the variables).[15] The results are reported in Table 5 for the case of vehicles.[16]

We find that the aggregate effects of uncertainty are quite small, because its impacts on the frequency and size of adjustment have opposite signs and largely offset each other. The net effect is positive, but a 10 percent increase in the standard deviation of future earnings increases household car expenditure only by 0.2 percent on average. Estimation-based measures of aggregate effects of marginal uncertainty changes arguably offer a better

[15] The elasticity is estimated at the mean values using the formula

$$\left\{\widehat{\beta}_k \overline{\Phi} + \widehat{\gamma}_k \overline{\phi}\left[\overline{Z}'\widehat{\beta} - \widehat{\rho}\widehat{\sigma}_\varepsilon \overline{W}'\widehat{\gamma}\right]\right\} \overline{x}_k / \overline{A},$$

where $\overline{\Phi}$ is the average of the individual $\Phi(W_i'\widehat{\gamma})$ and $\overline{\phi}$ is the average of the individual $\phi(W_i'\widehat{\gamma})$.

[16] Results for the other two durables categories, not reported, are available on request. Since the calculated marginal effect and elasticity estimated lack standard errors, they do not have a rigorous statistical interpretation but provide useful information on the aggregate effects of interest.

indication than Hassler's (2001) numerical experiments, based on large, infrequent switches in uncertainty. Further work may fruitfully take an explicitly dynamic perspective on such phenomena, recognizing in particular that rational optimal-adjustment policies would not in general remain invariant in the face of dynamic (rather than comparative-static) uncertainty variation.

The effect of a larger drift is similarly quite small, and has an overall negative impact. A 10 percent increase in the drift decreases average household expenditure by 0.3 percent. The inefficiency of the local public administration (which we interpret as a measure of the extent of adjustment costs faced in the adjustment process) has instead a quite sizable negative effect. A 10 percent decline in inefficiency (or a 10 percent increase in efficiency, corresponding to lower adjustment costs) brings about an increase in average household expenditure of approximately the same magnitude. More inefficient alternative public transports increase expenditure: a 10 percent decline in inefficiency of public transports decreases expenditure by almost 8 percent.

5 Concluding remarks

This paper has outlined and tested a set of theoretical predictions concerning optimal infrequent adjustment of durable good stocks. First, we have derived the approximate behavior of the durables stock/nondurable flow ratio for consumers who adopt infrequent-adjustment optimal policies in the presence of first-order adjustment costs, and examined how the ergodic distribution of this ratio changes in response to changes in uncertainty, the level of the durable drift, adjustment costs, and tastes for durable relatively to nondurable goods. Second, we have examined the effect of the same variables on the intensity of adjustment (i.e., the probability of making a transaction), and on the size of the adjustment (given that a transaction is observed), two margins of the adjustment policy that depend on structural features of the consumers' problem in conceptually distinct ways.

We have studied empirically the relationship between the relevant indicators in our data and the probability and size of adjustment of three categories of durable goods, focusing in particular on the implications of different degrees of uncertainty across consumers. Our detailed theoretical framework makes it possible to explore relatively subtle features of the data. In particular, we have emphasized a conceptual distinction between, on the one hand, permanent cross-sectional heterogeneity of the sampled households' dynamic problem, controlled by a battery of demographic and geographic control variables; and, on the other hand, history-dependent heterogeneity of their situation at the beginning of the observation period, captured in the data by variation in their durables/nondurable ratio that is orthogonal to those control variables. The different theoretical implications of these distinct sources of empirical variation support a structural exclusion restriction in selection-controlled regression analysis. The results show that theoretical predictions are broadly supported by the data.

Much, of course, remains to be done. In particular, our data and empirical approach did not allow us to characterize the effects of adjustment costs proportional to transaction size which, unlike per-adjustment lump sum costs, can in principle allow the width of the inaction band and the size of transactions to vary independently from each other across individuals. We note, however, that the significant negative correlation between the (observable and unobservable) determinants of the likelihood and size of adjustment suggest that lump-sum adjustment costs are the predominant source of "optimal inaction" in our data set. In principle, the data make it possible to study durable goods other than cars, on which the literature has focused thus far, and to exploit differences in depreciation rates and access to second-hand market across goods to test some additional implications of our model. In practice, the empirical results are uniformly favorable for cars, while empirical support is more mixed for furniture and (especially) jewelry. This is far from surprising, because our theoretical framework's auxiliary assumptions (such as homotheticity of demand) and our empirical approach (based on demographic controls for taste heterogeneity) are less likely to be suitable for the analysis of jewelry. Hence, lack of uniform support may indicate that the results are not driven by spurious mechanisms, and strengthens our confidence in the explanatory power of the theory when applied to suitable microeconomic problems and data.

A Solution technique

During periods when inaction is optimal and the $\{z_t\}$ process follows a Brownian motion process with drift ϑ and standard deviation σ, the expected present discounted value $V(z)$ of quadratic flow losses must satisfy the differential equation

$$\frac{1}{2}V''(z)\sigma^2 + V'(z)\vartheta - \rho V(z) - \frac{bz^2}{2} = 0,$$

with solution

$$V(z_t) = -\frac{b}{2}\left(\frac{z_t^2}{\rho} + \frac{\sigma^2 + 2z_t\vartheta}{\rho^2} + \frac{\vartheta^2}{\rho^3}\right) + K_1 e^{\alpha_1 z_t} + K_2 e^{\alpha_2 z_t}$$

where α_1, α_2 are solutions of the characteristic equation $\alpha\vartheta + \frac{1}{2}\alpha^2\sigma^2 - \rho = 0$ and K_1, K_2 are constants of integration.

The constants of integration in $V(.)$ and (L, s, U) must be such as to imply that $V'(x)$ equals the marginal cost of action whenever action is in fact undertaken ("smooth pasting"), and that the value function at the trigger and return points differ by the total cost of adjusting between the two points ("value matching"):

$$\begin{aligned} V(s) - V(L) &= V(s) - V(U) = C, \\ V'(L) &= V'(s) = V'(U) = 0. \end{aligned}$$

Inserting the functional form (8) in these conditions forms a system of equation to be solved for the constants of integration and the action and return points.

A.1 Stable distribution

Our empirical exercise analyzes a set of cross-sectional observations, each of which may be interpreted as a draw from a history of infrequent adjustment similar to that characterized above for a single decision maker. In the absence of time-series information on individual behavior, the cross-sectional information available can be interpreted in terms of the long-run distribution of the controlled variable, z, within the $[L, U]$ optimal inaction interval.

The Kolmogorov equation for the steady-state density reads

$$\frac{\sigma^2}{2}f''(z) = \vartheta f'(z),$$

and is solved by a piecewise linear function if $\vartheta = 0$, a piecewise exponential function otherwise:

$$f(z) = \begin{cases} Az + B & \text{if } \vartheta = 0, \\ Ae^{\frac{2\vartheta}{\sigma^2}z} + B & \text{otherwise.} \end{cases}$$

The constants of integration A and B applicable to each of the state-space segments are determined by continuity of the stable density at the trigger and return points, and by the adding-up constraint $\int_L^U f(z)\,dz = 1$.

In the long run, the rate at which adjustment events occur is the same as the rate of probability outflow from the lower trigger point, L, towards the return point s. The same derivations that lead to the stable density—outlined in the Appendix of Bertola and Caballero (1990), and discussed more formally in their references—establish that the relevant probability flow is given by

$$\frac{\sigma^2}{2} f'_{(+)}(L) = \frac{\sigma^2}{2} \frac{d}{dz} \left(A_l e^{\frac{2\vartheta}{\sigma^2} z} + B_l \right)_{z=L} = A_l \vartheta e^{\frac{2\vartheta}{\sigma^2} L},$$

where A_l is the constant of integration determined by the stable distribution's boundary conditions. The probability (intensity) of adjustment events at the upper boundary of the inaction range has a similar form, and also corresponds to the product of the infinitesimal likelihood of finding the process in the immediate neighborhood of the trigger point, $f'_{(-)}(U)$, and of the intensity of Brownian movements that may push the process towards that point, $\sigma^2/2$.

B Data: the SHIW

The Bank of Italy Survey of Household Income and Wealth (SHIW) collects detailed data on demographics, households' consumption, income and balance sheet items. The survey was first run in the mid-60s but has been available on tape only since 1984. Over time, it has gone through a number of changes in sample size and design, sampling methodology and questionnaire. However, sampling methodology, sample size and the broad contents of the information collected have been unchanged since 1989. Each wave surveys a representative sample of the Italian resident population and covers about 8,000 households, - although at times specific parts of the questionnaire are asked to only a random sub-sample. Sampling occurs in two stages, first at municipality level and then at household level. Municipalities are divided into 51 strata defined by 17 regions and 3 classes of population size (more than 40,000, 20,000 to 40,000, less than 20,000). Households are randomly selected from registry office records. They are defined as groups of individuals related by blood, marriage or adoption and sharing the same dwelling. The head of the household is conventionally identified with the husband, if present. If instead the person who would usually be considered the head of the household works abroad or was absent at the time of the interview, the head of the household is taken to be the person responsible for managing the household's resources. The net response rate (ratio of responses to households contacted net of ineligible units) was 57 percent in the 1995 wave. Brandolini and Cannari (1994) present a detailed discussion of sample design, attrition, and other measurement issues and compare the SHIW variables with the corresponding aggregate quantities.

C Definitions of the variables

All demographic variables refer to the household head.

Nondurable consumption: the sum of the expenditure on food, entertainment, education, clothing, medical expenses, housing repairs and additions, and imputed rents.

Durables flows: expenditures and revenues from sales on three categories separately. "Means of transport" (includes cars, motorbikes, caravans, motor boats, boats, bicycles); "Furniture, furnishing, household appliances and sundry articles" (includes furniture, furnishing, carpets, lamps, household appliances, washing machines, dishwashers, TVs, PCs, Hi-Fi, CDs etc.); "precious objects" (including jewelry, old and gold coins, works of arts, antiques and antiques furniture).

Durable stock: Value of end of period stock of durables for each of the three categories. The beginning of period value is computed subtracting purchases and adding sales to the end of period stock.

Education of the household head is coded as follows: no education (0); completed elementary school (5 years); completed junior high school (8 years); completed high school (13 years); completed university (18 years); post-graduate education (more than 20 years).

Quality of life indicators: All household heads are asked to assign a score between 1 (worst) and 10 (best) to various quality of life indicators, including: the functioning of public transports, health services, kindergartens, primary and secondary schools, Universities, public council offices, the availability of rentals, job opportunities, shopping facilities, leisure and public park facilities, the extent of traffic congestion, air and water quality, crime control and street safety, street cleanliness and noise pollution.

City size is coded as follows: 0-20,000 inhabitants (small town); 20,000-40,000 inhabitants (medium town); 40,000-500,000 inhabitants (large town); and more than 500,000 inhabitants (metropolitan area).

Indicators of earnings uncertainty: We use the standard deviation of expected earnings at the individual level. This is computed directly from survey questions asking the employed and job seekers to report: (a) on a scale from 0 to 100, their chances of keeping their job or finding one in the next twelve months; (b) the minimum and the maximum income expected conditional on being employed; and (c) the probability that future earnings will be less than the mid-point of the subjective distribution of future earnings. After making some assumptions on the shape of the on-the-job probability distribution of earnings (triangular distribution) and on the value of the unemployment compensation to each individual in the sample, Guiso, Jappelli, and Pistaferri (2002) use this information to recover measures of expected earnings and their dispersion.

References

[1] Adda, Jerôme, and Russell Cooper (2000), "Balladurette and Juppette: A discrete analysis of scrapping subsidies," *Journal of Political Economy* **108**(4), 778-806.

[2] Attanasio, Orazio (2000) "Consumer durables and inertial behaviour: Estimation and aggregation of (S,s) rules for automobile purchases," *Review of Economic Studies* **67**, 667-96.

[3] Banks, James, Richard Blundell, and Agar Brugiavini (2001), "Risk Pooling, Precautionary Saving and Consumption Growth ", *Review of Economic Studies* 68, 757-79.

[4] Bar-Ilan, Avner and Alan Blinder (1992), "Consumer durables: Evidence on the optimality of usually doing nothing," *Journal of Money, Credit, and Banking* **24**, 258-72.

[5] Beaulieu, Joseph (1993), "Optimal durable and nondurable consumption with transaction costs," Finance and Economics Discussion Papers, Federal Reserve Board.

[6] Bertola, Giuseppe and Ricardo Caballero (1990) "Kinked adjustment costs and aggregate dynamics," *NBER Macroeconomics Annual*, 237-88.

[7] Brandolini, Andrea, and Luigi Cannari (1994) "Methodological Appendix: The Bank of Italy Survey of Household Income and Wealth," in *Saving and the Accumulation of Wealth: Essays on Italian Households and Government Behavior*, A. Ando, L. Guiso, and I. Visco (eds.), Cambridge: Cambridge University Press.

[8] Caballero, Ricardo (1993) "Durable Goods: An Explanation for their Slow Adjustment," *Journal of Political Economy* 101(2), 351-384

[9] Caplin, Andrew and John Leahy (1994), "Business as usual, market crashes, and wisdom after the fact," *American Economic Review* **84**, 548-65.

[10] Carroll, Christopher D. (1997), "Buffer-stock saving and the lifecycle/permanent income hypothesis," *Quarterly Journal of Economics* **112**, 1-55.

[11] Cragg, John (1971), "Some statistical models for limited dependent variables with application to the demand for durable goods," *Econometrica* **39**, 829-44.

[12] Eberly, Janice (1994), "Adjustment of consumers' durables stocks: Evidence from automobile purchases," *Journal of Political Economy* **102**, 403-36.

[13] Foote, Christopher, Erik Hurst, and John V. Leahy (2000), "Testing the (S,s) Model," *American Economic Review Papers and Proceedings* **90**, 116-19.

[14] Grossman, Sanford and Guy Laroque (1990), "Asset pricing and optimal portfolio choice in the presence of illiquid durable consumption goods," *Econometrica* **58**, 25-51.

[15] Guiso, Luigi, Tullio Jappelli, and Luigi Pistaferri (2002), "An empirical analysis of earnings and employment risk," *Journal of Business and Economic Statistics,* forthcoming.

[16] Guiso, Luigi, Luigi Pistaferri, and Fabiano Schivardi (2001), "Insurance within the firm," CEPR Discussion Paper 2793.

[17] Hassler, John (1996), "Variations in risk and fluctuations in demand: A theoretical model," *Journal of Economic Dynamics and Control* **20**, 1115-43.

[18] Hassler, John (2001) "Uncertainty and the Timing of Automobile Purchases," *Scandinavian Journal of Economics*, 103(2), 2001.

[19] House, Christopher L., and John V. Leahy (2000), "An (S,s) model with adverse selection," NBER Working Paper 8030.

[20] Lam, Pok-Sang (1991), "Permanent income, liquidity, and adjustment of automobile stocks: Evidence from panel data," *Quarterly Journal of Economics* **106**, 203-30.

[21] Lee, Lung-Fei, and G.S. Maddala (1985), "The common structure of tests for selectivity bias, serial correlation, heteroskedasticity and non-normality in the Tobit model," *International Economic Review* **26**, 1-20.

[22] Leahy, John and Joseph Zeira (2000), "The timing of purchases and aggregate fluctuations," NBER Working Paper 7672.

[23] Meghir, Costas, and Guglielmo Weber (1996), "Intertemporal non-separability or borrowing restrictions? A disaggregate analysis using a US consumption panel", Econometrica 64, 1151-82.

[24] Padula, Mario (2000), "Durable goods and intertemporal choices: A survey," *Giornale degli Economisti ed Annali di Economia* **60**, 245-69

Table 1
Summary statistics for the whole sample

The table shows summary statistics for the selected sample of households reporting the information on the subjective probability distribution of future earnings. All figures are in euro and weighted by sample weights. An adjustment is defined as an action: upgrade, downgrade or both. For furniture, only upgrade is available. The value of purchase is calculated only for buyers. Standard deviations are reported in parenthesis. The 1995 sample excludes the retired for comparison with the values of our sample. 'Public transports', 'Local council offices', and 'Traffic congestion' are 1-10 indexes of dissatisfaction with the efficiency of public transports, public offices, and the extent of traffic congestion at the province level, respectively (10 corresponds to the highest level of dissatisfaction).

		Our sample	1995 sample
Value of stock	Vehicles	6,324 (6,476)	5,936 (6,436)
	Furniture	9,967 (9,584)	9,439 (9,577)
	Jewelry	3,225 (7,050)	3,214 (10,274)
X/C	Vehicles	0.3572 (0.3887)	0.3405 (0.3651)
	Furniture	0.5924 (0.5578)	0.5766 (0.5768)
	Jewelry	0.1798 (0.4438)	0.1700 (0.4681)
Frequency of adjustment	Vehicles	0.1785 (0.3831)	0.1762 (0.3810)
	Furniture	0.3033 (0.4598)	0.2936 (0.4555)
	Jewelry	0.0996 (0.2996)	0.0994 (0.2992)
Value of purchase	Vehicles	7,536 (6,882)	7,206 (6,575)
	Furniture	2,168 (3,717)	2,514 (5,031)
	Jewelry	1,259 (2,139)	1,081 (1,795)
Family income		24,907 (17,425)	24,125 (18,098)
Age		42.66 (9.10)	43.94 (9.79)
Earnings uncertainty		0.0398 (0.0425)	-.-
Accidents per 1,000 cars		11.04 (2.55)	11.04 (2.58)
Years of schooling		9.99 (4.09)	9.44 (4.20)
Family size		3.46 (1.23)	3.35 (1.24)
South		0.3472 (0.4762)	0.3485 (0.4765)
Public transports		5.66 (1.00)	5.31 (1.05)
Local council offices		5.48 (1.00)	5.51 (1.00)
Traffic congestion		6.91 (0.96)	4.06 (0.97)
Number of observations		1,877	4,782

Table 2
Summary statistics for the sample of those who adjust

The table shows summary statistics for the selected sample of households reporting the information on the subjective probability distribution of future earnings and adjusting the stock of durables. Standard deviations are reported in parenthesis.

		Adjust vehicles	Adjust furniture	Adjust jewelry
Value of stock	Vehicles	10,811 (8,036)	7,224 (6,905)	9,011 (8,028)
	Furniture	11,079 (9,492)	11,120 (9,540)	13,904 (12,148)
	Jewelry	3,586 (6,055)	3,967 (8,058)	6,593 (11,333)
X/C	Vehicles	0.5257 (0.3589)	0.3733 (0.3308)	0.4388 (0.3664)
	Furniture	0.5427 (0.4229)	0.5960 (0.5137)	0.7013 (0.6074)
	Jewelry	0.1679 (0.2475)	0.1938 (0.3005)	0.3045 (0.4283)
Value of purchase	Vehicles	7,536 (6,882)	7,447 (7,649)	9,131 (8,646)
	Furniture	1,709 (2,547)	2,168 (3,717)	2,888 (4,155)
	Jewelry	847 (835)	1,055 (1,279)	1,259 (2,139)
Family income		30,818 (22,123)	28,544 (19,450)	33,499 (43,884)
Age		42.49 (9.15)	42.06 (9.24)	40.32 (9.60)
Earnings uncertainty		0.0374 (0.0425)	0.0374 (0.0400)	0.0394 (0.0419)
Accidents per 1,000 cars		10.57 (2.12)	11.08 (2.52)	10.40 (2.08)
Years of schooling		10.40 (3.77)	10.84 (4.20)	11.83 (4.17)
Family size		3.54 (1.24)	3.35 (1.29)	3.19 (1.14)
South		0.2539 (0.4359)	0.2922 (0.4552)	0.2499 (0.4341)
Public transports		5.52 (0.91)	5.72 (1.04)	5.39 (0.98)
Local council offices		5.26 (0.88)	5.45 (0.97)	5.13 (0.83)
Traffic congestion		6.77 (0.84)	6.87 (0.96)	6.67 (0.90)
Number of observations (sample fraction)		322 (0.1641)	564 (0.3005)	193 (0.1018)

Table 3
Probit for the upgrading of durables stocks

Our measures of earnings uncertainty (standard deviation of future earnings), drift (predicted consumption growth in the frictionless case) and adjustment costs (inefficiency of the local public administration) are described in the text. The variable 'Car accidents' is the frequency of car accidents per 1,000 cars at province level. 'Public transports', 'Local council offices', and 'Traffic congestion' are 1-10 indexes of dissatisfaction with the efficiency of public transports, efficiency of local council offices, and the extent of traffic congestion at the province level, respectively (10 corresponds to the highest level of dissatisfaction). Standard errors are adjusted for provincial clustering. The standard deviation and the mean of future earnings (μ^e) are expressed in 1,000 euro.

	Vehicles	Furniture	Jewelry
X/C, vehicles	−0.2994	0.0150	0.0082
	(0.0497)	(0.0340)	(0.0182)
X/C, furniture	0.0194	−0.0986	−0.0036
	(0.0141)	(0.0310)	(0.0139)
X/C, jewelry	0.0081	0.0705	0.0367
	(0.0206)	(0.0348)	(0.0186)
Earnings uncertainty	−0.0218	−0.0198	−0.0106
	(0.0092)	(0.0136)	(0.0064)
Drift	0.7544	0.0381	0.2726
	(0.1490)	(0.2262)	(0.1537)
Adjustment costs	−0.0461	−0.0375	−0.0101
	(0.0197)	(0.0407)	(0.0202)
μ^e	0.0039	0.0040	0.0022
	(0.0014)	(0.0017)	(0.0008)
Education	0.0041	0.0111	0.0083
	(0.0021)	(0.0034)	(0.0018)
Age	−0.0043	−0.0067	−0.0016
	(0.0011)	(0.0016)	(0.0009)
Family size	0.0193	0.0028	−0.0229
	(0.0110)	(0.0166)	(0.0087)
Kids 0-5	−0.0262	−0.0346	0.0291
	(0.0232)	(0.0318)	(0.0142)
Kids 6-13	−0.0156	−0.0103	0.0217
	(0.0157)	(0.0231)	(0.0133)
Kids 14-17	0.0218	0.0028	−0.0070
	(0.0219)	(0.0327)	(0.0156)
Number of earners	0.0509	0.0326	0.0435
	(0.0139)	(0.0179)	(0.0098)
Small town	0.0290	−0.0478	0.0341
	(0.0296)	(0.0590)	(0.0391)
Medium town	0.0123	−0.0021	0.0260
	(0.0286)	(0.0515)	(0.0351)
Large town	0.0197	−0.0042	0.0353
	(0.0199)	(0.0461)	(0.0317)
Car accidents	−0.0097	−0.0025	−0.0001
	(0.0062)	(0.0075)	(0.0043)
Public transports	0.0456	0.0695	0.0088
	(0.0147)	(0.0318)	(0.0172)
Traffic congestion	−0.0003	0.0028	−0.0024
	(0.0118)	(0.0212)	(0.0132)
South	−0.0551	−0.1366	−0.0181
	(0.0299)	(0.0536)	(0.0276)
Center	−0.0299	−0.0366	−0.0076
	(0.0497)	(0.0357)	(0.0226)

Table 4
Heckman selectivity model

Our measures of earnings uncertainty (standard deviation of future earnings), drift (predicted consumption growth in the frictionless case) and adjustment costs (inefficiency of the local public administration) are described in the text. The variable 'Car accidents' is the frequency of car accidents per 1,000 cars at province level. 'Public transports', 'Local council offices', and 'Traffic congestion' are 1-10 indexes of dissatisfaction with the efficiency of public transports, efficiency of local council offices, and the extent of traffic congestion at the province level, respectively (10 corresponds to the highest level of dissatisfaction). Standard errors are adjusted for provincial clustering. The standard deviation and the mean of future earnings (μ^e) are expressed in 1,000 euro.

	Vehicles	Furniture	Jewelry
Earnings uncertainty	1.2898	0.4496	−0.0333
	(0.5067)	(0.2972)	(0.0965)
Drift	−2.1648	−2.7510	−3.8753
	(9.9772)	(2.2195)	(1.3718)
Adjustment costs	0.6879	0.0294	−0.7094
	(0.9227)	(0.3700)	(0.2477)
μ^e	0.0614	0.1152	0.0426
	(0.0618)	(0.0379)	(0.0087)
Education	−0.1108	−0.0935	−0.0179
	(0.0973)	(0.0561)	(0.0191)
Age	0.0417	−0.0954	0.0255
	(0.0553)	(0.0175)	(0.0111)
Family size	−0.1568	−0.0185	−0.0584
	(0.4104)	(0.2321)	(0.1251)
Kids 0-5	−0.2652	−0.8492	0.3644
	(0.7492)	(0.3492)	(0.2447)
Kids 6-13	0.0577	−0.6170	0.0829
	(0.6676)	(0.2634)	(0.1691)
Kids 14-17	−1.9568	−0.4855	0.0639
	(0.8541)	(0.3105)	(0.1976)
Number of earners	−0.3702	−0.1350	−0.0585
	(0.6833)	(0.2205)	(0.1725)
Small town	2.0041	0.2759	−0.7244
	(1.0256)	(0.5360)	(0.4255)
Medium town	2.5132	0.1920	−0.3143
	(1.0941)	(0.4965)	(0.5260)
Large town	1.3418	−0.0435	−0.3589
	(0.7339)	(0.4525)	(0.3038)
Car accidents	0.3072	−0.0685	0.0454
	(0.2821)	(0.0756)	(0.1007)
Public transports	−1.3203	−0.6832	0.2888
	(0.6464)	(0.2257)	(0.1601)
Traffic congestion	0.0002	0.1434	0.0480
	(0.4203)	(0.2407)	(0.1394)
South	−0.6063	1.7695	1.2019
	(1.4795)	(0.6464)	(0.3436)
Center	1.2055	0.4416	0.5677
	(1.0062)	(0.4181)	(0.2375)
ρ	−0.5555	−0.3221	−0.4321
	(0.0843)	(0.0817)	(0.1681)
Wald-test (p-value)	0.0000	0.0002	0.0252

Table 5
Unconditional marginal effects and elasticities

Our measures of earnings uncertainty (standard deviation of future earnings), drift (predicted consumption growth in the frictionless case) and adjustment costs (inefficiency of the local public administration) are described in the text. The variable 'Car accidents' is the frequency of car accidents per 1,000 cars at province level. 'Public transports', 'Local council offices', and 'Traffic congestion' are 1-10 indexes of dissatisfaction with the efficiency of public transports, efficiency of local council offices, and the extent of traffic congestion at the province level, respectively (10 corresponds to the highest level of dissatisfaction). Marginal effects ($\frac{\partial E(A_i)}{\partial x_{ik}}$) are in 1,000 euro.

	Marginal Effect	Intensive margin	Extensive margin	Elasticity
Earnings uncertainty	0.0306	0.2053	-0.1747	0.016
Drift	5.7069	-0.3446	6.0516	-0.034
Adjustment costs	-0.2602	0.1095	-0.3696	-1.316
μ^e	0.0410	0.0098	0.0312	0.527
Education	0.0149	-0.0176	0.0325	0.138
Age	-0.0280	0.0066	-0.0346	-1.019
Family size	0.1299	-0.0250	0.1549	0.417
Kids 0-5	-0.2523	-0.0422	-0.2101	-0.068
Kids 6-13	-0.1162	0.0092	-0.1254	-0.046
Kids 14-17	-0.1368	-0.3115	0.1747	-0.031
Number of earners	0.3495	-0.0589	0.4085	0.583
Small town	0.5434	0.3190	0.2244	0.128
Medium town	0.4967	0.4000	0.0967	0.104
Large town	0.3700	0.2136	0.1564	0.140
Car accidents	-0.0288	0.0489	-0.0777	-0.292
Public transports	0.1557	-0.2102	0.3659	0.804
Traffic congestion	-0.0020	0.0000	-0.0020	-0.013
South	-0.5545	-0.0965	-0.4580	-0.195
Center	-0.0285	0.1919	-0.2204	-0.005

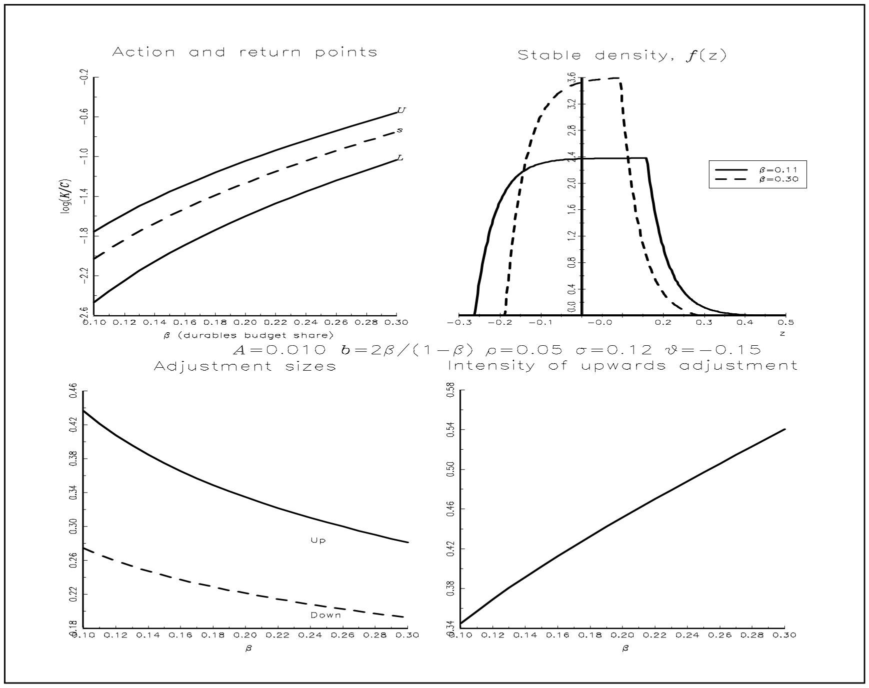

Figure 1: The implications of different durable budget shares for the durable/nondurable ratio trigger and return points and for the long-run stable distribution of its deviations from the static optimum.

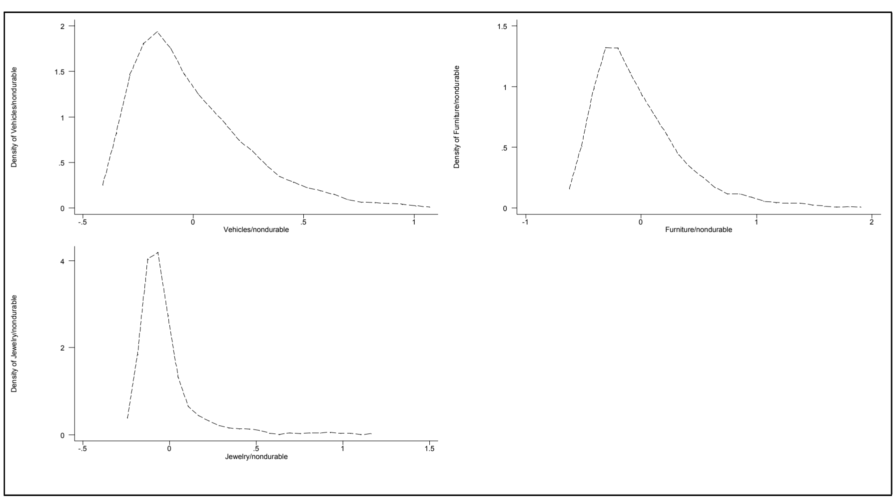

Figure 2: The empirical density of X/C for vehicles, furniture, and jewelry.

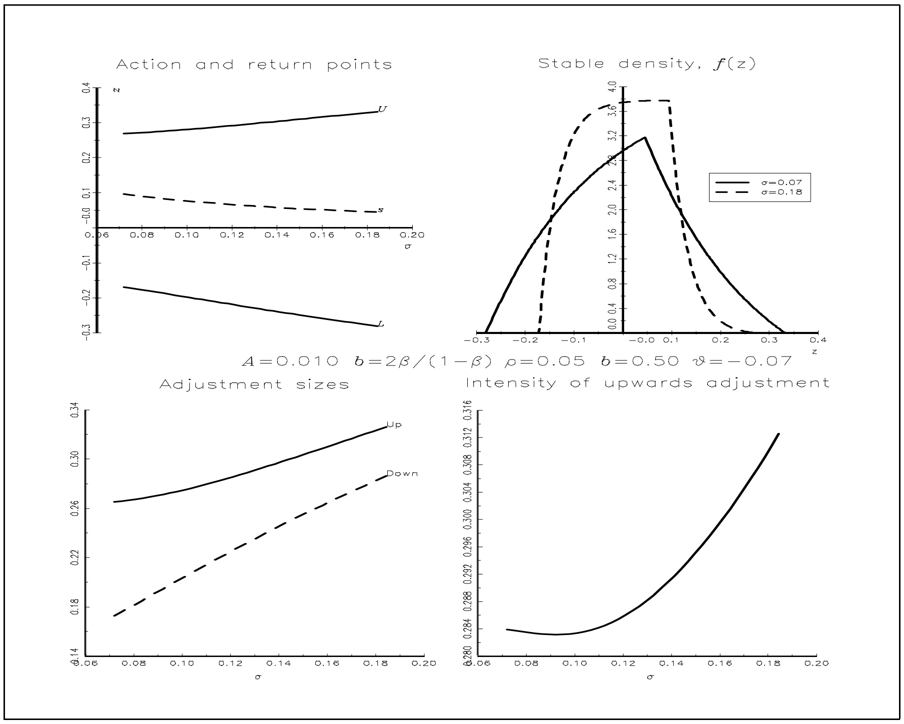

Figure 3: The implications of different degrees of uncertainty for the optimal adjustment policy and stable distribution.

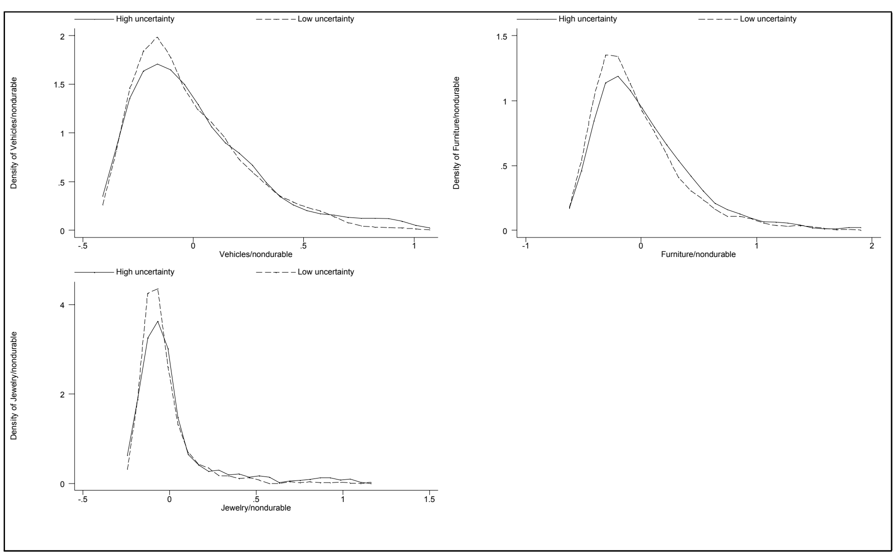

Figure 4: The empirical density of X/C for high- and low-risk households.

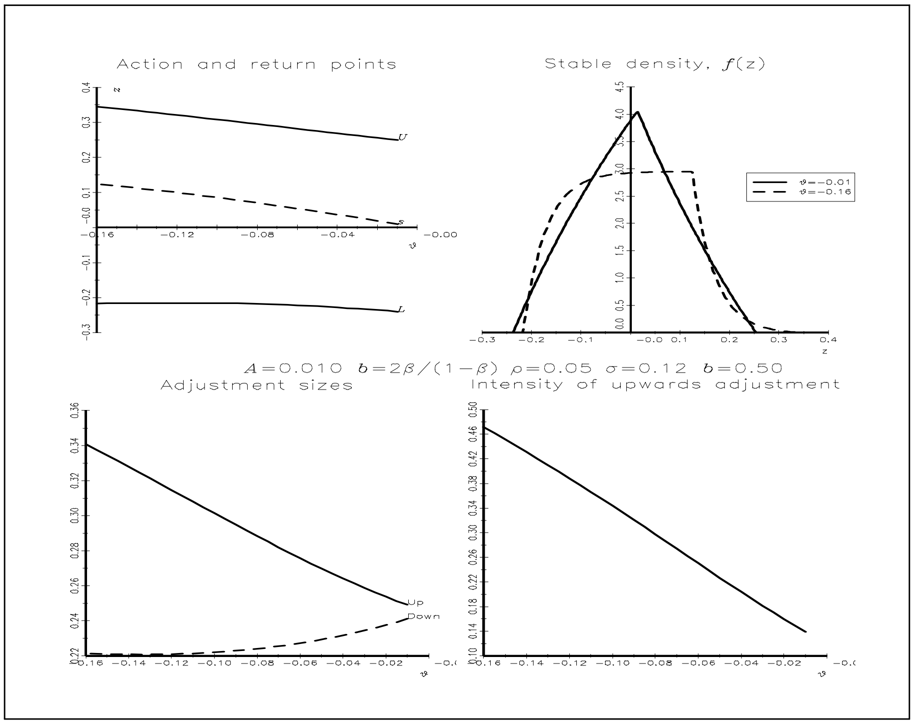

Figure 5: The implications of different drifts for the optimal adjustment policy and stable distribution.

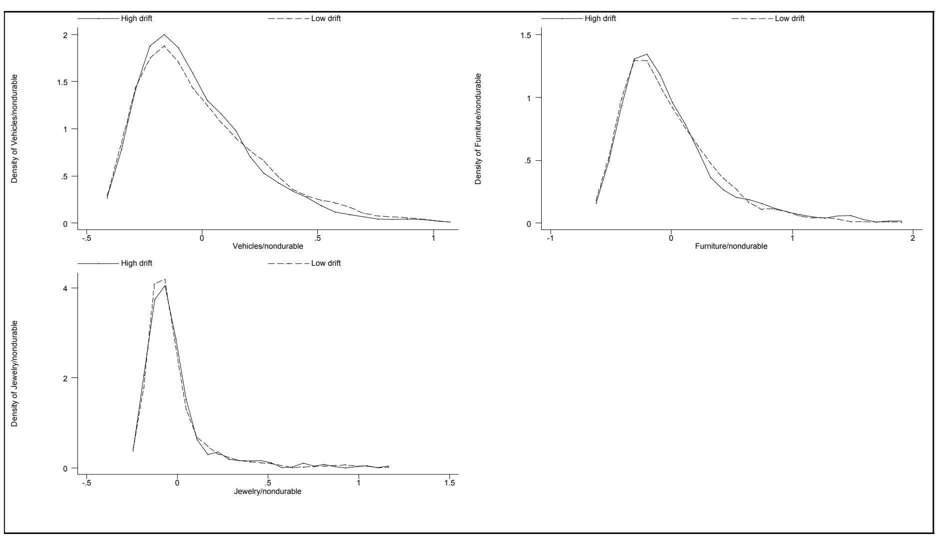

Figure 6: The empirical density of X/C for high- and low-drift households.

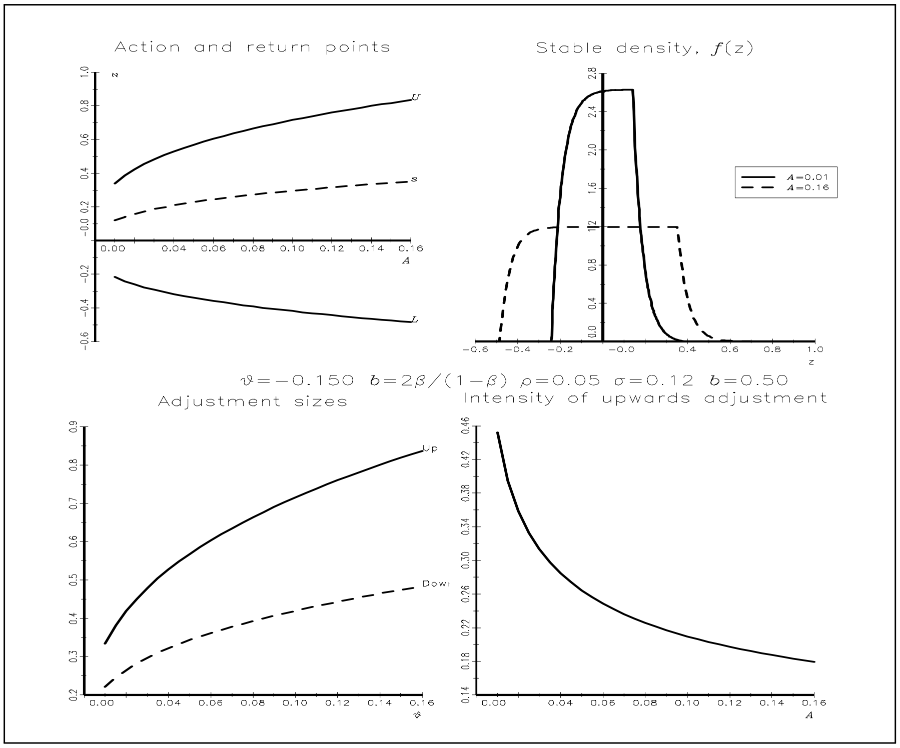

Figure 7: The implications of different adjustment costs for the optimal adjustment policy and stable distribution.

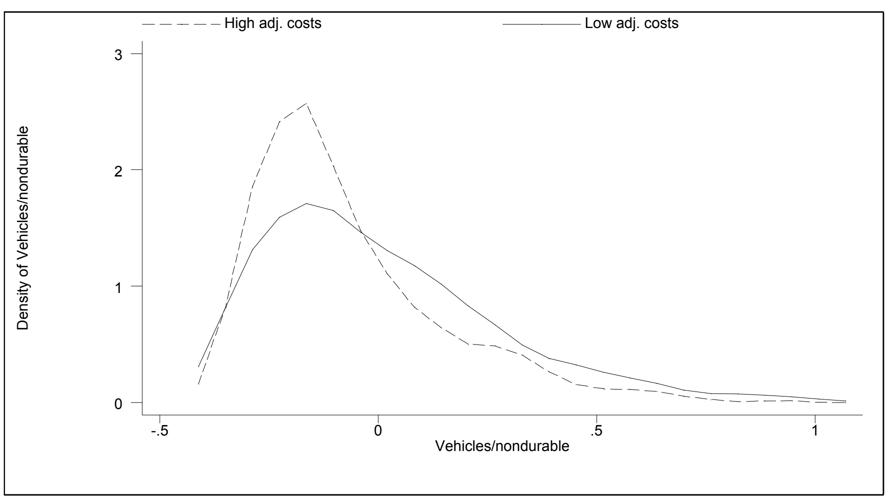

Figure 8: The empirical density of X/C (vehicles) for high- and low-adjustment costs households.