Durable Consumption Goods and Happiness – a dynamic perspective*

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We analyze the effect of purchase decisions of durable goods, namely cars, on individual utility measured by subjective overall well-being over time. Using panel data from the UK, we are able to observe individuals' well-being trajectories several years before and after a purchase is made, while controlling for idiosyncratic individual-specific effects. We find significant drops in individuals' happiness after a car purchase. Moreover, this negative effect becomes stronger over time. Our theoretical analysis shows that this result can be explained by a model of consumption of durable goods involving habit formation. Due to unanticipated habit formation, utility derived from consumption of the good depends on past consumption. In more general terms, the empirical results can be interpreted as a further and economically important aspect of projection bias (Loewenstein, O'Donoghue, and Rabin, 2003).

Keywords: Durable goods, happiness, consumption, misprediction, reference dependence

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1. Introduction

The literature on happiness or reported subjective well-being has seen a rapid increase over recent years. Thereby, reported subjective well-being is used as a proxy measure for individual utility which is increasingly used and successfully applied in various contexts (e.g. Easterlin 2001; Frey and Stutzer 2002; Stutzer and Frey 2008; Clark, Frijters, and Shields 2008). Panel data including such a measure are now becoming more and more available to study dynamic effects spanning large time horizons.

Regarding consumption decisions in particular of durable goods, the role of cognitive biases has been studied highlighting that consumers might make wrong decisions due to several biases in their perception of utility. This paper builds on those two main literatures focusing on the role of habit formation or adaptation using happiness data.

Habit formation has been proposed as a model to integrate a reference point which agents compare their current consumption or income level to. The concept of habit formation relies on the idea that one's own past consumption might have an effect on the utility derived from current consumption. Preferences that include habit formation date back to works by Marshall and Duesenberry (1949) and since then have been formalized e.g., in Pollak (1970) for dynamic demand systems or more recently in Clark and Oswald (1998) and Carroll, Overland, and Weil (2000). Habit formation has also been used as a possible explanation of the equity premium puzzle in Constantinides (1990) and Campbell and Cochrane (1999). Typically, it is assumed that consumers are naive or myopic in that they neglect the effect of current consumption decisions on their future preferences, see Alessie and Teppa (2009).[1]

All these papers take into account that utility does not only depend on the absolute consumption level of a specific good but also on the relative consumption level to some reference level. This reference level can be external, i.e., comparing one's own consumption with the one of a peer group, or internal. Positional concerns through an external reference level have been widely used, including using experiments on consumption decisions (Alpizar, Carlsson, and Johansson-Stenman, 2005). In this paper we are interested in habit formation or an internal reference level where the reference point is some measure of past consumption levels that affects utility of today's consumption.

Using aggregate consumption data of three broad categories and food expenditures respectively, this has been studied in Meghir and Weber (1996) and Dynan (2000) using the intertemporal Euler equation. Both studies do not find significant effects of habit persistence. However, due to data limitations, they do not control for personal traits using fixed effects, while Carrasco, Labeaga, and López-Salido (2005) showed that the use of fixed effects can crucially alter the results.

Most similar to this paper is the study by D'Ambrosio and Frick (2007) who use reported well-being as well and showed that it depends on past income realizations. Similarly, Stutzer (2004) finds that past income affects a required minimum level of income as expressed by households whereas in his study he does not control for individual fixed effects.

More generally, different cognitive biases that can lead to seemingly irrational behaviour have been proposed in a large literature in between psychology and economics. For instance, the notion of getting used to a durable consumption good can be explained by ef-

[1] Alternatively, Spinnewyn (1981) proposed that habit formation could also be rationally anticipated by consumers.

fects of repeated sensory and cognitive stimuli, see e.g., Frederick and Loewenstein (1999). After a period of enjoyment, the hedonic effects of higher consumption adapt to a base level. This explanation is somewhat linked to other potential biases in consumption decisions. In particular, the anticipation of future preferences can suffer from several cognitive biases as discussed e.g., in Loewenstein, O'Donoghue, and Rabin (2003) or Kahneman and Thaler (2006). For instance, a "projection bias" of future valuations for a durable consumption good as in Loewenstein, O'Donoghue, and Rabin (2003) can lead to over-buying due to fluctuations in one's valuation for the good.

Finally, durable consumption goods including cars, can exhibit important extrinsic attributes (material possessions, fame, status or prestige). It has been argued that people might overestimate such extrinsic attributes as compared to intrinsic attributes, see Frey and Stutzer (2008) for a recent overview. They include four potential reasons for this to happen: underestimation of adaptation, distorted memories, rationalization of decisions ex-post, and the idea that people in general only have an "intuitive" way of anticipating what makes them happy. These psychological explanations can give a rationalization of the habit or reference point models presented above in the context of durable consumption goods.

In this paper, we do not stress a particular cognitive explanation but rather take a straightforward habit formation model as starting point for analyzing consumption data. In general, empirical evidence on habit persistence when controlling for individual specific effects is scarce. Moreover, habits for individual consumption goods have to our knowledge not been analyzed empirically as longitudinal data for individual consumption goods is rather scarce. Experimental studies on the other hand necessarily focus on a rather short maximum time frame. The main novelty of this paper is therefore the application of habit formation to individual consumption goods, in particular buying a car. The availability of data in the British Household Panel Survey (BHPS) over a total time span of almost two decades makes this analysis feasible in a very robust panel framework. We provide empirical evidence for habit persistence for car purchases which are both statistically significant and economically relevant.

In the following chapter, we lay out a simple model of adaptation in order to develop testable hypotheses over the effect of durable consumption good purchases and its effect over time on individual well-being, which is used as a proxy for utility. The procedure to derive the needed variables from the data are is described in chapter three. Section four presents the main results and alternative specifications. Chapter five concludes.

2. The theoretical setup

In the following we will develop a small model based on the literature on external reference levels/habits for consumption such as Constantinides (1990), Clark and Oswald (1998) or Johansson-Stenman, Carlsson, and Daruvala (2002). We look at the effect on utility over time of a purchase of a durable good, say, a car and denote the binary variable of whether a car is bought in period t by c_t. That is, c_t takes on the value of c when a car has been purchased and zero otherwise. The agent experiences habit persistence in that his instantaneous utility depends on both his current consumption level and an average of past consumption of the good, $\overline{c}_t$. We use an additive specification as in Campbell and

Cochrane (1999) or Clark and Oswald (1998)[2]. Moreover, we use the simplest model with a linear utility function. Note that since we are only interested in the qualitative predictions of the model, this does not restrict our analysis. Perceived utility by the agent at time t is then given by

$$U_t(c_t, \bar{c}_t) = (1-\gamma)c_t + \gamma\,(c_t - \bar{c}_t) \tag{1}$$

where $\bar{c}_t$ denotes the habit level as some average of past consumption and γ the degree to which relative consumption is important to the agent.[3]

Regarding the reference or habit level, $\bar{c}_t$, we follow Fuhrer (2000) and assume it evolves over time according to the process

$$\bar{c}_t = \alpha\bar{c}_{t-1} + (1-\alpha)c_{t-1} \tag{2}$$

where $\alpha \in [0,1]$ measures the degree of persistence of the level of habits. That is, if $\alpha = 0$, the reference level is only last period's consumption while for larger values of α, the reference level is determined "further back" or that the mean lag of the habit reference level is larger. This law of motion implies that this reference level can be computed as an exponentially weighted average of past consumption.

Given the simple binary variable c_t, the level of habits will be a weighted average between the value c and zero. More precisely, the reference level $\bar{c}_t$ for any date t after the date of purchase T can be written as $\bar{c}_t = (1-\alpha)\sum_{\tau=0}^{t-T-1}\alpha^\tau c$ and zero for $t \leqq T$. We denote by $\Delta t = t - T\ \forall t > T$ the time in years since a car purchase while it is zero otherwise. This implies that we can write the habit level for the case where a purchase has been made Δt periods before as $\bar{c}_t = c(1-\alpha^{\Delta t})$.[4] Then, we can write perceived utility at time t the following way:

$$U_t(c_t) = \begin{cases} c - \gamma c(1-\alpha^{\Delta t}) & \text{if } t > T \\ c & \text{if } t = T \\ 0 & \text{if } t < T \end{cases} \tag{3}$$

If the agent rationally anticipates the habit persistence and thus knows his true value of γ, his current consumption decisions would maximize this utility function. However, fundamental to the habit-formation model is the fact that the habit persistence is not taken into account when the decision is made. That is, the effect of current consumption on future tastes or utility is not considered, see Pollak (1970). That is, the agents' assumed utility from the car purchase in the future is instead $V_t(c_t) = c$ for $t > T$ or that $\gamma = 0$.

Note that another reason for a non-constant utility profile after the purchase of a durable consumption good could be due to depreciation. However, this effect is comparably easy to anticipate and seems more easily to be taken into account in the buying decision. In any case, the consumption profile (3) can be interpreted as combining habit formation and (unexpected) depreciation over time. More generally speaking, the formulation of (3) can also be interpreted as a "projection bias" of future utility as proposed in Loewenstein, O'Donoghue, and Rabin (2003) which in turn can lead to sub-optimal decisions. While we do not model the explicit buying decision here, it is straightforward in our context in

[2] Alternatively, ratio comparison models have been used, as in Abel (1990) or Clark and Oswald (1998), which give qualitatively similar results.

[3] Empirical estimates for γ are in the range between 0.35 (Johansson-Stenman, Carlsson, and Daruvala, 2002) and 0.5 (Carlsson, Johansson-Stenman, and Martinsson, 2007).

[4] Formally, there is a initial level of the reference level $\bar{c}_0$ at date zero which we assume to be zero.

analogy with Loewenstein, O'Donoghue, and Rabin (2003) that a purchase will be made too often given the agent wrongfully anticipates no habit formation.

From the utility function (3) we can get an approximation for the habit formation effect or how utility will likely change over time after a durable good is purchased. First, it is clear that from the formulation $U_t = c - \gamma c(1 - \alpha^{\Delta t})$ for the case of after a purchase, that $\frac{\partial U_t}{\partial \Delta t} = \gamma c \alpha^{\Delta t} ln\alpha < 0$ for $\alpha < 1$ or that after a purchase, utility thereof decreases due to the building up of the habit or reference level.

In order to derive a more tractable version for the estimation, we use an approximation to derive a linear version of this formulation. For small values of Δt, we can use an approximation of the exponential decay by applying a second-order Taylor expansion of $\alpha^{\Delta t}$ around $\Delta t = 3$ which is the median in our sample (considering only positive values for Δt, see below).[5] This gives us $\alpha^{\Delta t} \backsimeq \alpha^3(1 + 3ln\alpha^{-1} + 3^2(ln\alpha^{-1})^2) - \alpha^3 ln a^{-1}(1 + 6ln\alpha^{-1}) \cdot \Delta t + \alpha^3(ln\alpha^{-1})^2 \Delta t^2$. This finally yields a quadratic approximation of utility as a function of the time since the purchase was made:

$$U_t \simeq c\left\{K_0 - \gamma\alpha^3 ln a^{-1}(1 + 6ln\alpha^{-1})\Delta t + \gamma\alpha^3(ln\alpha^{-1})^2\Delta t^2\right\} \text{ if } t > T \tag{4}$$

where $K_0 = (1 - \gamma) + \alpha^3(1 + 3ln\alpha^{-1} + 3^2(ln\alpha^{-1})^2)$ represents the time-independent term. That is, utility is decreasing after a purchase while the speed of this decline depends on the relevance of adaptation and the decay of habits over time.

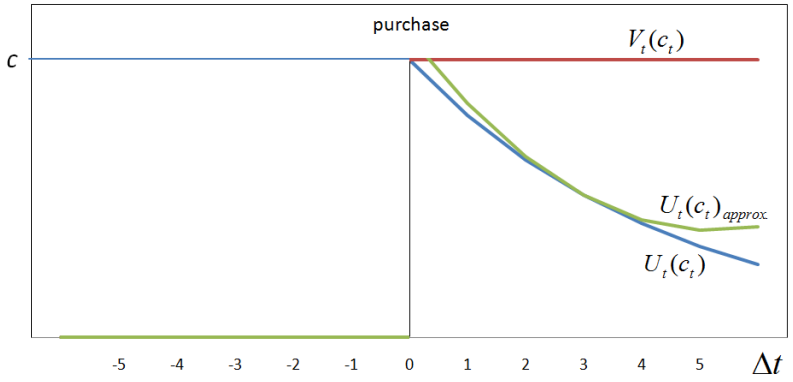

Figure 1: Utility profile over time (perceived and predicted)

In the following chapter, we therefore consider subjective well-being of individuals as a function of the time since the last car purchase including a large set of different control variables. That is, we estimate individual utility or happiness including the distance since the last car purchase and its squared value[6], Δt and Δt^2. Moreover, we denote by $C_{\{t=T\}}$ a dummy variable that takes on the value of one for the year of a purchase, that is, if $t = T$. The basic equation can thus be written as

$$U_{it} = \beta_0 + \beta_c C_{\{t=T\}} + \beta_{\Delta t}\Delta t + \beta_{\Delta t^2}\Delta t^2 + X'_{it}\Xi + \varepsilon_{it} \tag{5}$$

[5] Alternatively, a simple first-order Taylor approximation linear trend yields for the utility function $U_t \simeq (1 - \gamma)c + \gamma\alpha^3(1 + 3ln\alpha^{-1}) - \gamma\alpha^3 ln\alpha^{-1}\Delta t$ if $t > T$ and for the linear estimated parameter $\beta_{\Delta t} = -\gamma\alpha^3 ln\alpha^{-1}$. The differences to the 2nd order approximation in the estimation are only minor. The reason for evaluating the decay function at the median of Δt is to obtain a more appropriate approximation of the exponential decay for the values of interest.

[6] We omit individual and time subscripts for these variables only in order to improve readability.

where X_{it} is the set of controls and ε_{it} an error term. When we compare this equation with the theoretical utility function, we get for the parameters of interest the relationships

$$\beta_{\Delta t} = -c\gamma\alpha^3 lna^{-1}(1 + 6ln\alpha^{-1}) < 0$$

$$\beta_{\Delta t^2} = +c\gamma\alpha^3(ln\alpha^{-1})^2 > 0$$

Note that if $\gamma = 0$ and/or $\alpha = 1$ (implying a constant reference level), both parameters would be zero. That is, we can test whether the data exhibits habit formation by analyzing the signs of the two parameters. We now turn to the data used in order to estimate this equation.

3. Data and empirical strategy

The British Household Panel Survey is a representative survey for the UK and began in 1991 with an initial sample of 10,300 individuals. We use the latest release that covers data for 1991-2009.[7] The question eliciting overall life satisfaction is available for waves 6-18 (years 1997-2009) with the exception of wave 11. The question reads "All things considered, how satisfied or dissatisfied are you with your life overall using a 1-7 scale? 1=very dissatisfied, ..., 7=very satisfied".

[7]The data set is available from the UK Data archive: Study Number 5151.

	mean	sd	min	max
life_satisfaction	5.25	1.23	1.0	7
year_of_purchase	0.11	0.31	0.0	1
delta_t	0.87	1.60	0.0	11
delta_t if positive	2.72	1.73	1.0	11
log_income	6.52	4.35	0.0	14
hours_worked	19.73	18.55	0.0	99
car_to_work	0.40	0.49	0.0	1
fulltime	0.52	0.50	0.0	1
unemployed	0.03	0.17	0.0	1
married	0.58	0.49	0.0	1
single	0.20	0.40	0.0	1
divorced	0.05	0.21	0.0	1
hhsize	3.03	1.35	1.0	16
nkids	0.67	1.00	0.0	8
commuting_time	13.19	19.34	0.0	500
degree	0.14	0.35	0.0	1
a_level	0.41	0.49	0.0	1
o_level	0.23	0.42	0.0	1
no_qualification	0.19	0.40	0.0	1
female	0.53	0.50	0.0	1
born_abroad	0.00	0.05	0.0	1
good_financial_situation	0.71	0.45	0.0	1
bad_financial_situation	0.07	0.25	0.0	1
financial_situation_improved	0.29	0.45	0.0	1
financial_situation_worsened	0.22	0.41	0.0	1
loan_repayments	0.33	0.47	0.0	1
moved	0.09	0.29	0.0	1
N	119712			

Table 1: Descriptive Statistics

As explained in the previous section, the main explanatory variables are a dummy variable indicating the year of purchasing a car for each individual and the distance and squared distance (in years) for subsequent years after the purchase. For example, if in one particular household a car is purchased in the year 2003, the indicator variable $C_{\{t=T\}}$ equals one for the year 2003 and the variable Δt is defined as survey-year minus 2003 for that household. In the years before the purchase, it is zero. We derive these variables by linking the individual files to the respective household files that provide information on the number of owned cars in each household in the BHPS. Exploiting the panel feature of our data, this variable allows to generate a profile of the current stock of cars for each household and the respective out and inflows. In total there are 38140 of the 119712 observations or 32% with positive values of Δt.

With respect to the external validity of our sample, we note that, according to the Department of Transport (2010), since the year 2000 an average of 40 new cars are bought per 1000 inhabitants and about 45% of the population has exactly one car. Our BHPS sample matches these statistics very well with an estimated 55 new cars per 1000 inhabi-

tants including used cars and 49% of the households possessing exactly one car on average over the last 9 years.

To check the robustness of our findings with respect to the empirical specification, we consider a number of regression equations derived from equation (5). As in the previous section, we omit the individual subscripts of the distance variables for ease of presentation. The main specification is therefore as follows,

$$U_{it} = \beta_0 + \beta_c C_{\{t=T\}} + \beta_{\Delta t}\Delta t + \beta_{\Delta t^2}\Delta t^2 + X'_{it}\Xi + \alpha_i + \eta_{it} \tag{6}$$

where X'_{it} contains standard control variables like time dummies, age, age squared, education, employment status, marital status, household size, number of children in the household. We use the log of annual labour income as a control variable on the individual level.[8] The vector X'_{it} holds as well a number of controls that are more specific with respect to our analysis. These are commuting time and a dummy variable indicating whether the household moved since the last interview. In particular, we include questions regarding changes in the financial situation of the household and a variable probing if anyone in the household is required to repay a loan or took up a loan. These variables allow us to control for non-marginal changes in the financial situation of the household potentially related to the car purchase.

We mostly discuss our results obtained from a linear specification where unobserved individual characteristics α_i are assumed to be fixed over time. Consequently time invariant variables like gender are omitted in this formulation. While the fixed effects model allows the individual heterogeneity to be correlated with other regressors, it raises also problems regarding the identification of age and time effects. We therefore additionally consider a random effects assumption for α_i and estimate equation (6) by generalized least squares.

As a further robustness check we relax the assumptions with respect to the adaptation process. In particular, we replace the two distance variables by a series of dummy variables capturing the years after the purchase for each individual. Omitting once more the individual subscripts for the distance variables, the respective regression equation reads

$$U_{it} = \beta_c + \beta_0 p_{t-0} + \beta_1 p_{t-1} + \beta_2 p_{t-2} + \ldots \beta_6 p_{t-6} + X'_{it}\Xi + \alpha_i + \varepsilon_{it} \tag{7}$$

where $p_{t-\Delta t}$ is a dummy variable indicating a car purchase Δt periods before t. The dummy variable p_{t-0} indicates the year of purchasing the car and all prior years. This dummy acts as the reference category and is therefore omitted. As we hypothesize that the negative effect of the car purchase increases over time, we expect an increasing (in absolute values) profile of the respective (negative) coefficients $\{\beta_1, \beta_2, \ldots, \beta_6\}$.

4. Empirical results

Table 2 compiles the results for the main specification. As explained in the previous section, we enter individual and time fixed effects into this specification, but omit the respective coefficients for ease of presentation. The first column presents the OLS results, while the remaining two columns enter individual random and respectively fixed effects into the model.

The vector of distance coefficients obtained from the FE model (column 3) is $(\beta_{\Delta t}, \beta_{\Delta t^2}) = (-0.02, +0.033)$. This implies a decrease in life satisfaction of -0.017 in the first year and

[8] We also used total annual household income, but the differences were only minor.

Table 2: Life satisfaction trajectories after a car purchase

	(1) OLS pooled		(2) RE		(3) FE	
purchase year	-0.044***	(0.012)	-0.016*	(0.0096)	-0.0027	(0.0098)
Δt	-0.045***	(0.0069)	-0.030***	(0.0061)	-0.020**	(0.0082)
Δt^2	0.0036***	(0.0011)	0.0036***	(0.00083)	0.0033***	(0.0011)
log income	0.023***	(0.0014)	0.0073***	(0.0013)	0.00073	(0.0016)
hours worked	-0.0015***	(0.00034)	-0.00035	(0.00038)	0.00017	(0.00045)
car to work	0.043***	(0.0086)	0.014	(0.0094)	-0.0053	(0.011)
age	-0.057***	(0.0015)	-0.036***	(0.0019)	-0.022*	(0.013)
agesq	0.00064***	(0.000017)	0.00041***	(0.000020)	0.000092**	(0.000038)
fulltime	-0.057***	(0.011)	-0.047***	(0.012)	-0.043***	(0.015)
unemployed	-0.21***	(0.026)	-0.16***	(0.019)	-0.13***	(0.027)
married	0.30***	(0.012)	0.24***	(0.015)	0.20***	(0.022)
living as couple	0.24***	(0.013)	0.21***	(0.014)	0.21***	(0.020)
widowed	-0.057**	(0.026)	-0.13***	(0.029)	-0.17***	(0.056)
divorced	-0.099***	(0.021)	-0.028	(0.023)	0.054	(0.035)
hhsize	-0.0078*	(0.0041)	-0.014***	(0.0043)	-0.019***	(0.0058)
nkids	-0.014**	(0.0053)	-0.0019	(0.0057)	0.013	(0.0081)
commuting_time	-0.0010***	(0.00019)	-0.00031	(0.00020)	-0.000093	(0.00022)
degree	-0.055***	(0.013)	-0.0095	(0.021)	-0.063	(0.045)
a-level	-0.033***	(0.011)	0.025	(0.016)	0.029	(0.035)
o-level	-0.0078	(0.011)	0.018	(0.017)	0.019	(0.038)
female	0.018**	(0.0073)	-0.0012	(0.014)		
born_abroad	0.17**	(0.082)	0.13**	(0.060)		
good_financial_situation	0.48***	(0.0091)	0.26***	(0.0078)	0.19***	(0.0092)
bad_financial_situation	-0.59***	(0.019)	-0.40***	(0.013)	-0.33***	(0.018)
financial_situation_improved	0.0087	(0.0080)	0.059***	(0.0071)	0.076***	(0.0072)
financial_situation_worsened	-0.19***	(0.0096)	-0.13***	(0.0077)	-0.12***	(0.0085)
loan_repayments	-0.060***	(0.0074)	-0.025***	(0.0069)	-0.0085	(0.0076)
moved	0.010	(0.012)	0.028***	(0.0099)	0.037***	(0.011)
Constant	5.88***	(0.036)	5.69***	(0.043)	5.78***	(0.47)
Time fixed effects	No		No		No	
Observations	116773		116773		116773	

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01

a decrease of -0.031 (both effects measured in overall life satisfaction as defined before) three years after the purchase. We can easily assess the magnitude of these movements by comparing it to movements in individual life satisfaction associated with other important life events. For example, the negative impact of unemployment on life satisfaction equals -0.13 in the FE model. Hence, the decrease in life satisfaction three years after purchasing a car equals roughly one fourth of the effect associated with becoming unemployed.

We can partly link these results to the structural parameters in the theoretical part. Given the theoretical model, it is clear that the utility from buying a car and the relevance of the habit motive γ in individual utility cannot be identified as they enter linearly in the relevant Δt variables. However, we can use the estimated time profile in order to derive the theoretical habit formation process. While a non-linear estimation would allow a direct estimate of the parameter α, such an estimation is numerically complex and given the large number of observations and covariates not tractable. But wen can still use the estimated time profile to get an estimate of the parameter α. From the theoretical counterparts of the coefficients, we can compute the ratio of the two coefficients $\beta_{\Delta t}$ and $\beta_{\Delta t^2}$ in order to eliminate the parameters γ and c. Then, we can solve this equation for the estimated value $\hat{\alpha}$ and find the unique solution as

$$\hat{\alpha} = exp\left(\frac{\beta_{\Delta t^2}}{6\beta_{\Delta t^2} + \beta_{\Delta t}}\right).$$

Using the main specification, this gives a value of $\alpha = 0.86$ for the pooled estimation and $\alpha = 0.73$ for the random effects specification. For the Fixed Effects specification, the quadratic approximation seems the least appropriate and therefore the estimate is not meaningful. However, we can look at the second specification with a series of dummy variables and estimate $\hat{\alpha}$ by the change of Δt around the median, i.e., from $\Delta t = 2$ to $\Delta t = 4$. Computing $\frac{\beta_{\Delta t=4}}{\beta_{\Delta t=2}} = 1 - \alpha^2$, this yield estimated values for $\hat{\alpha}$ of 0.72, 0.73 and 0.84 for the pooled, RE, and FE specification respectively. In general, the estimated profile of habit formation indicates a value of α around 0.70 to 0.9 on a yearly basis. This indicates a rather persistent pattern of habits or that the weights decay at around 20% per year. After three years, the habit level arrives at around half of the full value while after five years it reaches roughly 67%.

Moving to the control variables, we first note that the coefficients for variables like education that exhibit almost no within-individual variation are small and imprecisely estimated. The marital status coefficients indicate economically important effects and are in line with prior research. For example, being married compared to being separated is associated with a positive shift in individual well-being that is slightly larger as the negative impact of unemployment. The positive effect of living as a couple is quite similar to the effect of marriage. While the widowed coefficient is negative and of similar magnitude as the marriage coefficient, the divorced coefficient is positive and imprecisely estimated.

As mentioned in the previous section, we enter controls for income and the financial situation of the household in all specifications. These controls are particularly important, as they are obvious confounding variables. For example, an individual might decide to purchase a car and might shortly afterwards experience an unexpected bad financial situation. If she is willing to sell the car to improve the financial situation but unable to do so, the negative car purchase coefficients might pick up this effect. Since we condition on income and the financial situation, the purchase coefficient is solely driven by the "non-monetary" factors – that is the misprediction with respect to habit formation or adaptation.

Table 3: Life satisfaction trajectories after a car purchase (categories)

	(1) OLS pooled		(2) RE		(3) FE	
p_{t-1}	-0.036***	(0.011)	-0.035***	(0.0086)	-0.032***	(0.0088)
p_{t-2}	-0.035***	(0.012)	-0.045***	(0.0092)	-0.045***	(0.0098)
p_{t-3}	-0.062***	(0.013)	-0.067***	(0.010)	-0.066***	(0.011)
p_{t-4}	-0.040***	(0.015)	-0.050***	(0.012)	-0.052***	(0.012)
p_{t-5}	-0.083***	(0.018)	-0.077***	(0.014)	-0.075***	(0.015)
p_{t-6}	-0.071***	(0.017)	-0.039***	(0.014)	-0.031*	(0.017)
log income	0.0071***	(0.0013)	0.0011	(0.0012)	0.000019	(0.0016)
hours worked	-0.00064*	(0.00034)	0.0000083	(0.00038)	0.00035	(0.00045)
car to work	0.014*	(0.0086)	-0.0012	(0.0093)	-0.0084	(0.011)
fulltime	-0.11***	(0.011)	-0.070***	(0.012)	-0.044***	(0.015)
unemployed	-0.28***	(0.026)	-0.18***	(0.019)	-0.13***	(0.027)
married	0.17***	(0.0093)	0.17***	(0.012)	0.18***	(0.022)
living as couple	0.14***	(0.012)	0.16***	(0.013)	0.20***	(0.020)
widowed	0.063***	(0.024)	-0.071***	(0.027)	-0.18***	(0.056)
divorced	-0.27***	(0.020)	-0.095***	(0.022)	0.034	(0.035)
hhsize	0.00089	(0.0040)	-0.010**	(0.0042)	-0.017***	(0.0058)
nkids	-0.049***	(0.0052)	-0.020***	(0.0056)	0.011	(0.0080)
commuting_time	-0.0010***	(0.00019)	-0.00033	(0.00020)	-0.00011	(0.00022)
degree	-0.082***	(0.013)	-0.071***	(0.021)	-0.12***	(0.044)
a-level	-0.041***	(0.011)	-0.0074	(0.016)	0.00084	(0.035)
o-level	-0.00078	(0.012)	0.018	(0.017)	0.012	(0.038)
female	-0.025***	(0.0072)	-0.021	(0.014)		
born_abroad	0.18**	(0.082)	0.14**	(0.060)		
good_financial_situation	0.50***	(0.0092)	0.27***	(0.0078)	0.19***	(0.0092)
bad_financial_situation	-0.62***	(0.019)	-0.40***	(0.013)	-0.33***	(0.018)
financial_situation_improved	0.024***	(0.0079)	0.067***	(0.0070)	0.080***	(0.0072)
financial_situation_worsened	-0.18***	(0.0096)	-0.12***	(0.0077)	-0.11***	(0.0084)
loan_repayments	-0.068***	(0.0074)	-0.025***	(0.0068)	-0.0066	(0.0076)
moved	0.027**	(0.012)	0.031***	(0.0098)	0.040***	(0.011)
Constant	5.02***	(0.019)	5.13***	(0.023)	5.12***	(0.037)
Time fixed effects	No		No		No	
Observations	116778		116778		116778	

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Table 3 compiles the results obtained from the second set of specifications. In these estimations we check the robustness of our findings with respect to the functional form by entering a series of dummy variables indicating the various years after purchasing a car (see equation 7). Since these dummy variable vary only on a yearly bases, they introduce obvious identification issues for individual and time effects. We therefore initially omit the time fixed effects. Table 3 shows that the distance coefficients in this set of specifications are quite similar across the different models. The results for the control variables are as well similar in the OLS, RE and FE model. For example, in both the RE and FE model the coefficient indicating the effect five years after the car purchase is roughly equal to -0.075. This coefficient indicates that the decrease in life satisfaction five years after the purchase is about half that of unemployment. Furthermore, most of the coefficients closely resemble the evidence obtained from our baseline specification (Table 2). One exception is the coefficient of the dummy variable indicating whether the individual holds a degree. The coefficient in the FE model (column 3) equals -0.12 and is therefore comparable to the unemployment coefficient. We also consider one set of regressions employing household income as a control variable (see Table 6 in the Appendix).[9] These regressions produce qualitatively the same evidence.

Next we extend this specification and enter time fixed effects into the regressions. Table 4 shows the results. While the purchase coefficients in the RE model are hardly affected, the aforementioned collinearity of time and purchase dummies is visible in the FE model. Most of the FE coefficients are smaller compared to the previous FE estimates without time dummies (Table 3). For instance, the estimate of β_3 is now equal to -0.031 while it was -0.066 in Table 3. Note that the estimated value of -0.031 matches exactly the estimated decrease of life satisfaction three years after the purchase decision obtained from the FE baseline specification (Table 2). Figure 4 further compares the two sets of results (Tables 2 and 4) for $t = T$, $t = T + 1, \ldots, t = T + 6$.

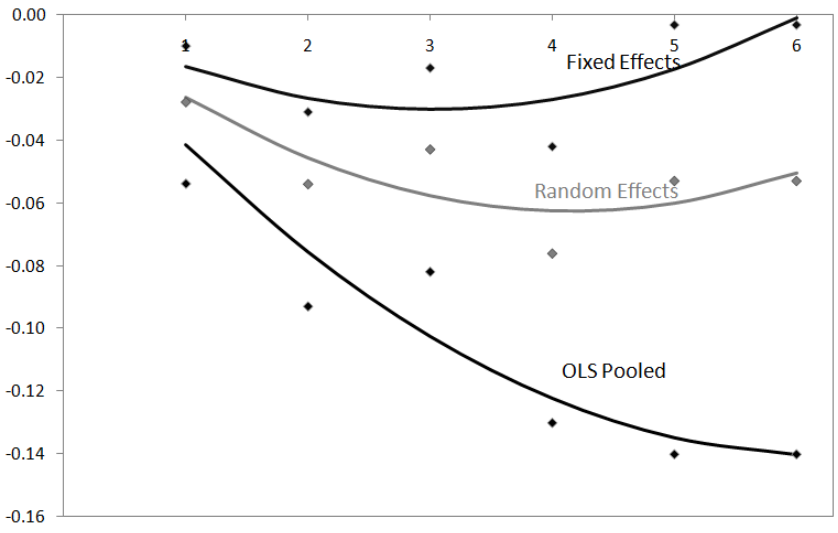

Figure 2: Estimated adaptation effects (solid lines: quadratic specification, squares: categories)

[9] While one could use these results to compute the monetary equivalent of the effect on happiness, the outcome would be only very imprecise and we therefore do not report them here.

Table 4: Life satisfaction trajectories after a car purchase (categories, extended set of controls)

	(1) OLS pooled		(2) RE		(3) FE	
p_{t-1}	-0.047***	(0.012)	-0.017*	(0.0100)	-0.0020	(0.010)
p_{t-2}	-0.054***	(0.013)	-0.028**	(0.011)	-0.010	(0.013)
p_{t-3}	-0.093***	(0.015)	-0.054***	(0.013)	-0.031*	(0.016)
p_{t-4}	-0.082***	(0.017)	-0.043***	(0.015)	-0.017	(0.019)
p_{t-5}	-0.13***	(0.021)	-0.076***	(0.018)	-0.042*	(0.023)
p_{t-6}	-0.14***	(0.020)	-0.053***	(0.020)	-0.0033	(0.028)
log income	0.023***	(0.0014)	0.0073***	(0.0013)	0.00069	(0.0016)
hours worked	-0.0015***	(0.00034)	-0.00035	(0.00038)	0.00018	(0.00045)
car to work	0.043***	(0.0086)	0.014	(0.0094)	-0.0053	(0.011)
age	-0.057***	(0.0015)	-0.036***	(0.0019)	-0.022*	(0.013)
agesq	0.00064***	(0.000017)	0.00041***	(0.000020)	0.000093**	(0.000038)
fulltime	-0.057***	(0.011)	-0.047***	(0.012)	-0.043***	(0.015)
unemployed	-0.21***	(0.026)	-0.16***	(0.019)	-0.13***	(0.027)
married	0.30***	(0.012)	0.24***	(0.015)	0.20***	(0.022)
living as couple	0.24***	(0.013)	0.21***	(0.014)	0.21***	(0.020)
widowed	-0.056**	(0.026)	-0.13***	(0.029)	-0.17***	(0.056)
divorced	-0.099***	(0.021)	-0.027	(0.023)	0.056	(0.035)
hhsize	-0.0077*	(0.0041)	-0.014***	(0.0043)	-0.020***	(0.0058)
nkids	-0.014***	(0.0053)	-0.0017	(0.0057)	0.013*	(0.0081)
commuting_time	-0.0010***	(0.00019)	-0.00031	(0.00020)	-0.000093	(0.00022)
degree	-0.055***	(0.013)	-0.0096	(0.021)	-0.062	(0.045)
a-level	-0.033***	(0.011)	0.025	(0.016)	0.029	(0.035)
o-level	-0.0078	(0.011)	0.018	(0.017)	0.020	(0.038)
female	0.018**	(0.0073)	-0.0012	(0.014)		
born_abroad	0.16**	(0.082)	0.13**	(0.060)		
good_financial_situation	0.48***	(0.0091)	0.26***	(0.0078)	0.19***	(0.0092)
bad_financial_situation	-0.59***	(0.019)	-0.40***	(0.013)	-0.33***	(0.018)
financial_situation_improved	0.0087	(0.0080)	0.059***	(0.0071)	0.076***	(0.0072)
financial_situation_worsened	-0.19***	(0.0096)	-0.13***	(0.0077)	-0.12***	(0.0085)
loan_repayments	-0.060***	(0.0074)	-0.025***	(0.0069)	-0.0086	(0.0076)
moved	0.010	(0.012)	0.028***	(0.0099)	0.037***	(0.011)
Constant	5.88***	(0.036)	5.69***	(0.043)	5.79***	(0.47)
Time fixed effects	Yes		Yes		Yes	
Observations	116773		116773		116773	

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Finally, we fit a series of ordered logit models to further inquire the robustness of our findings. Table 5 compiles the results. The first column presents maximum likelihood estimates from a usual ordered logit model without individual fixed effects. Column 2 provides estimates from a fixed effects ordered logit model (Baetschmann, Staub, and Winkelmann, 2011) and is therefore comparable to our baseline FE estimation (column 3, Table 2). The last column enters individual fixed effects, but omits time fixed effects. The results presented in the second column are in line with the FE baseline estimation. For example, both the unemployment coefficient and the coefficient indicating whether the individual is married are roughly 10 times as large as $\beta_{\Delta t}$. As the relative size of the coefficients translates into the relative size of the respective marginal effects, we discuss only these ratios of coefficients.

Once again variables like education that exhibit almost no within-individual variation obtain small coefficients which are imprecisely estimated. To summarize, all estimations strongly corroborate the results of the baseline estimation. A car purchase is associated with a strong decrease in life satisfaction for several years. In the two parameter model, the $(\beta_{\Delta t}, \beta_{\Delta t^2})$ estimates suggest that the angular point of the parabola is around 3-4 years after purchasing the car.

5. Conclusion

This paper uses UK panel data to analyze the impact of car purchases on individual life satisfaction. Following the same persons over several years before and after the purchase, we show that individuals' life satisfaction systematically drops for several years after the purchase decision. All results are obtained while controlling for potential confounding factors like changes in the financial situation of the respective individual. We consider a variety of models to avoid spurious results. The longitudinal data set permits us to control for selection effects by entering fixed effects. We start our analysis with a linear model, thereby treating the response variable as a cardinal variable. We compare these results to estimations obtained from an ordered logit model with fixed effects and show that both models yield very similar results.

Our empirical evidence is compatible with a simple structural model of habit formation and adaptation. Individuals wrongfully neglect this adaptation process and therefore follow non-optimal consumption plans. On average, individuals suffer three years after the purchase decision from a drop in life satisfaction equivalent to one fourth of the negative impact of unemployment. This strong effect adds another empirical piece of evidence to misprediction of utility of consumption. The habit is rather persistent with a decay rate of around 20% per year. More generally, the results might also be interpreted in the context of intrinsic vs. extrinsic consumption, where for the latter a car is one primer example.

Table 5: Life satisfaction trajectories after a car purchase (ordered logit models)

	(1) ordered logit		(2) FE ordered logit		(3) FE ordered logit	
main						
purchase year	-0.068***	(0.018)	0.029	(0.034)	-0.10***	(0.032)
Δt	-0.070***	(0.015)	-0.054**	(0.024)	-0.26***	(0.015)
Δt^2	0.0052**	(0.0020)	0.0080***	(0.0028)	0.024***	(0.0024)
log income	0.037***	(0.0036)	0.00074	(0.0051)	0.0025	(0.0049)
hours worked	-0.0022**	(0.00089)	0.0017	(0.0015)	0.0016	(0.0014)
car to work	0.073***	(0.022)	-0.037	(0.037)	-0.040	(0.036)
age	-0.11***	(0.0050)	-0.097**	(0.047)		
agesq	0.0012***	(0.000057)	0.00037***	(0.00011)		
fulltime	-0.045	(0.030)	-0.023	(0.049)	-0.065	(0.047)
unemployed	-0.72***	(0.050)	-0.50***	(0.070)	-0.55***	(0.074)
married	0.59***	(0.036)	0.48***	(0.065)	0.43***	(0.061)
living as couple	0.39***	(0.034)	0.53***	(0.058)	0.47***	(0.054)
widowed	-0.064	(0.087)	-0.44***	(0.15)	-0.33**	(0.14)
divorced	-0.23***	(0.061)	0.17*	(0.093)	0.17*	(0.089)
hhsize	-0.016	(0.011)	-0.034**	(0.017)	-0.041**	(0.017)
nkids	-0.058***	(0.014)	0.027	(0.025)	0.025	(0.024)
commuting_time	-0.0020***	(0.00046)	-0.00023	(0.00075)	-0.00023	(0.00073)
degree	0.0023	(0.043)	-0.12	(0.14)	0.056	(0.13)
a-level	-0.041	(0.037)	0.14	(0.11)	0.22**	(0.10)
o-level	-0.0018	(0.041)	0.073	(0.12)	0.085	(0.11)
female	0.072***	(0.024)				
born_abroad	0.29**	(0.13)				
Time fixed effects	Yes		Yes		No	
cut1						
Constant	-6.13***	(0.11)				
cut2						
Constant	-5.07***	(0.10)				
cut3						
Constant	-3.95***	(0.10)				
cut4						
Constant	-2.83***	(0.099)				
cut5						
Constant	-1.42***	(0.098)				
cut6						
Constant	0.46***	(0.098)				
Observations	116773		212080		1272480	

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01

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A. Table: Household income as regressor

Table 6: Life satisfaction trajectories after a car purchase (HH income)

	(1) life_satisfaction	(2) life_satisfaction	(3) life_satisfaction
0b.DistanceCat	0 (.)	0 (.)	0 (.)
1.DistanceCat	-0.035*** (0.011)	-0.037*** (0.0085)	-0.037*** (0.0087)
2.DistanceCat	-0.037*** (0.012)	-0.048*** (0.0091)	-0.048*** (0.0097)
3.DistanceCat	-0.064*** (0.013)	-0.072*** (0.010)	-0.072*** (0.011)
4.DistanceCat	-0.045*** (0.015)	-0.055*** (0.012)	-0.056*** (0.012)
5.DistanceCat	-0.091*** (0.018)	-0.085*** (0.014)	-0.082*** (0.015)
6.DistanceCat	-0.081*** (0.016)	-0.046*** (0.014)	-0.039** (0.017)
hh_income_per_capita	0.0012*** (0.00035)	0.00059 (0.00037)	-0.00022 (0.00041)
hours worked	-0.00020 (0.00033)	0.00011 (0.00036)	0.00040 (0.00044)
car to work	0.024*** (0.0083)	0.0014 (0.0091)	-0.0075 (0.011)
fulltime	-0.089*** (0.011)	-0.062*** (0.012)	-0.044*** (0.015)
unemployed	-0.27*** (0.026)	-0.17*** (0.018)	-0.13*** (0.026)
married	0.091*** (0.0096)	0.096*** (0.011)	0.082*** (0.018)
single	-0.047*** (0.012)	-0.050*** (0.013)	-0.11*** (0.020)
divorced	-0.34*** (0.020)	-0.17*** (0.021)	-0.053 (0.034)
hhsize	0.000084 (0.0040)	-0.0076* (0.0042)	-0.011* (0.0058)
nkids	-0.043*** (0.0052)	-0.020*** (0.0056)	0.0055 (0.0080)
commuting_time	-0.00087*** (0.00019)	-0.00024 (0.00020)	-0.000028 (0.00021)
degree	-0.10*** (0.026)	-0.082** (0.033)	-0.014 (0.057)
a_level	-0.057** (0.025)	-0.019 (0.030)	0.099* (0.051)
o_level	-0.020 (0.025)	0.0039 (0.030)	0.11** (0.051)
no_qualification	-0.019 (0.026)	-0.013 (0.032)	0.11* (0.059)
female	-0.023*** (0.0071)		
born_abroad	0.20*** (0.072)		
good_financial_situation	0.49*** (0.0092)	0.27*** (0.0077)	0.19*** (0.0091)
bad_financial_situation	-0.62*** (0.019)	-0.40*** (0.013)	-0.33*** (0.017)
financial_situation_improved	0.024*** (0.0078)	0.067*** (0.0070)	0.079*** (0.0072)
financial_situation_worsened	-0.17*** (0.0095)	-0.12*** (0.0076)	-0.11*** (0.0083)
loan_repayments	-0.061*** (0.0073)	-0.020*** (0.0068)	-0.0033 (0.0075)
moved	0.031*** (0.012)	0.038*** (0.0097)	0.046*** (0.010)
_cons	5.12*** (0.030)	5.19*** (0.033)	5.10*** (0.053)
N	120196	120196	120196

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01