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Deconstructing the hedonic treadmill: Is happiness autoregressive?

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ABSTRACT

Affective habituation is well-documented in social sciences: people seem to adapt to many life events, ranging from lottery windfalls to terminal illnesses. A group of studies have tried to measure habituation by seeing how lagged values of life events affect present happiness. We propose an additional adaptation channel: current happiness may depend directly on past happiness, which amounts to assessing whether happiness is autoregressive. We run dynamic happiness regressions using individual-level panel data from the German Socio-Economic Panel Study, the Japanese Panel Survey of Consumers, the British Household Panel Survey and the Swiss Household Panel. As in previous studies, the coefficients on lagged events (e.g., becoming unemployed, getting married) suggest strong habituation. However, all the econometric models suggest that the coefficient on lagged happiness is positive and significant. We discuss whether this may be evidence of happiness having an inertial force (besides the usual habituation channel).

1. Introduction

Brickman and Campbell (1971) coined the term "hedonic treadmill" to describe how people tend to adapt to good and bad events and then return to the same baseline level of happiness. Since then a number of papers in the fields of psychology and economics have shown some evidence that people adapt to particular life events, ranging from lottery windfalls (Brickman et al., 1978) to losing a limb to cancer (Tyc, 1992). A group of papers have used survey data to measure habituation through the lagged effects of life events: e.g., Lucas et al., 2003; Diener et al., 2006; Di Tella et al., 2007; Clark et al., 2008. We propose an additional channel for adaptation: current happiness may depend directly on past happiness, which amounts to assessing whether happiness is autoregressive.

We call this the "general habituation" channel: i.e. having experienced moments of happiness (unhappiness) in the present will directly make people prone to feelings of unhappiness (happiness) in the future, regardless of whether the original increase (decrease) in happiness was due to changes in income, health or love partners. As a matter of fact, in the psychology literature there are similar distinctions between the different adaptation channels: e.g., Kahneman (2000) distinguishes between the "hedonic treadmill" and the "satisfaction treadmill."[1]

To the best of our knowledge, we are the first to run dynamic happiness regressions with individual-level data. We exploit data from the German Socio-Economic Panel Study, the Japanese Panel Survey of Consumers, the British Household Panel Survey and the Swiss Household Panel. We propose a variety of econometric models to overcome many identification challenges. In accordance with the existing results in the literature, we find that happiness increases one year after negative events like becoming unemployed or widowed, and it decreases one year after positive events like getting married or having children. However, the coefficient on lagged happiness is positive and statistically relevant. We discuss whether, instead of habituation, this may imply that past feelings of happiness have an inertial effect on contemporary happiness (besides the usual habituation channel).

Section 2 briefly summarizes the literature on hedonic adaptation and discusses the difference between the general- and specific-habituation channels. Section 3 presents the econometric results. The final section concludes.

2. Hedonic adaptation

2.1. Literature review

There are a numerous studies in the social sciences presenting evidence that people experience hedonic adaptation to specific life events, which we denote the *specific* habituation channel. For instance, Brickman et al. (1978) show that state lottery winners reported only slightly higher levels of life satisfaction than a con-

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[1] In a similar spirit, Frederick and Loewenstein (1999) introduce the concept "specific-domain hedonic adaptation."

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trol group. Oswald and Powdthavee (2008) provide longitudinal evidence that people who become disabled exhibit a 30–50% recovery in mental well-being. Tyc (1992) found no difference in quality of life between young patients who had lost limbs to cancer compared with those who had not. In a study of prisoners, Wormith (1984) observed significant improvement in deviance, attitude, and personality measures. Among the health studies, hedonic adaptation has been studied with burn victims (Patterson et al., 1993) and hemodialysis patients (Riis et al., 2005).

Many economists seem to be familiar with the hedonic adaptation hypothesis: in the 2007 policy-views survey of a random sample of members of the American Economic Association, less than half of the respondents agreed that economic growth in developed countries like the U.S. leads to greater levels of happiness (Whaples, 2009). Indeed, some economists have been working on the measurement of hedonic adaptation. For example, Di Tella et al. (2007) used panel data on life satisfaction and concluded that 65% of the initial effect of an increase in income is lost over the ensuing four years. Clark et al. (2008) use panel data to find evidence of adaptation to life events such as unemployment, layoffs, marriage, and divorce. For more details about empirical and experimental evidence see Frederick and Loewenstein (1999).

Most of these studies rely on subjective well-being scores to measure hedonic adaptation. Subjective well-being measures have been shown to correlate with objective measures of well-being, like smiling frequency (Ekman et al., 1990) and clinical ratings (Pavot et al., 1991). In particular, Perez Truglia (2010) shows that life satisfaction and happiness scores are quantitatively consistent with revealed-preference measures of consumption utility.[2] But even if happiness scores were consistent at a single point in time, it is still possible that they are inconsistent over time (see for example Hagerty, 2003). If that were the case, then the evidence on hedonic adaptation could be invalidated to a large extent (Stevens, 1958).

There have been occasional attempts to avoid the problems created by "scale-norming" in affective habituation studies. For instance, in a study of chronic dialysis patients Baron et al. (2003) found that making the scales more precise only reinforces the estimates of adaptation. Moreover, Kahneman and Krueger (2006) argue that other measures of current happiness (e.g., from the day reconstruction method) show even stronger hedonic adaptation than happiness scores (for more details see Frederick and Loewenstein, 1999). However, Smith et al. (2006) argues that the jury is still out. They elicited current levels of happiness from people with colostomies and those whose colostomies had been reversed, where the latter are expected to become less happy. Both groups reported identical happiness. However, they also asked each group how happy they had been in the past. Those with colostomies recalled being significantly happier than they currently were. On the other hand, those with reversed colostomies recalled being significantly less happy. Also, neither group believed that people with colostomies were about as happy as people whose colostomies had been reversed. For more details see Loewenstein et al. (2008), which discusses similar results for dialysis patients and happiness across age groups.

2.2. General habituation

Rayo and Becker (2007) and Perez Truglia (2009) looked at what we might recognize as the evolutionary origins of hedonic adaptation. The basic intuition is that positive and negative hedonic states are costly from a fitness perspective: e.g., generating feelings is a waste of energy for the brain. In order to minimize those fitness costs, humans have adapted with hedonic states that quickly return to "normal levels." The reward centers of the brain can thus be viewed as homeostatic systems that trigger adaptation whenever upper and lower thresholds are achieved.

There are many different ways in which those homeostatic systems in the brain can work. Indeed, even though there is some agreement about the empirical relevance of hedonic adaptation, there is no consensus on the actual mechanisms that make such adaptation happen (Kahneman, 2000). For instance, rewarding feelings may be a function of deviations from expectations. If individuals are rational, then the average individual will get exactly what he expects and therefore will have "normal" levels of rewarding feelings. Also, individuals may form habits, such as individuals in a "steady state" have "normal" levels of rewarding feelings. Finally, the reward centers in the brain may work as a spring: i.e., as soon as an individual excites some area in the brain, the corresponding reward system will automatically start pushing in the opposite direction with a force that is proportional to the deviation from the "normal" rewards.

In order to illustrate the above theories more clearly, let R_t denote rewarding feelings at time t (e.g. happiness), let S_t denote positive stimulus and let $S^e_{t-1,t}$ denote expected stimulus at t from the perspective of $t-1$. Current rewarding feelings can be represented by the following function:

$$R_t = f\left(R_{t-1}, S_{t-1}, S^e_{t-1,t}\right)$$

The habit-formation hypothesis says that R_t is decreasing in S_{t-1}: i.e., people habituate to past consumption so, ceteris paribus, greater past consumption will decrease current rewarding feelings. The aspiration hypothesis says that $S^e_{t-1,t}$ is decreasing in R_t: i.e., ceteris paribus, having had higher expectations about present stimulus decreases the level of rewarding feelings. Those hypotheses are very difficult to distinguish from one another because people are not completely irrational and S_{t-1} and $S^e_{t-1,t}$ therefore closely follow each other. Finally, R_t may depend directly on R_{t-1}. If the relationship is negative, we call this the "general habituation" channel: i.e., just like in the example of the spring, having experienced moments of happiness yesterday induces a force in the opposite direction on current happiness.

The effect of R_{t-1} on R_t is very difficult to disentangle from the effects of S_{t-1} and $S^e_{t-1,t}$, since they are all closely related to each other by construction. That is not the goal of this paper. Even though the differences between specific habituation and general habituation may be subtle from a theoretical point of view, they are relatively clear from an econometrician's perspective: i.e., while the effect of specific habituation to income will be captured by the coefficients on lagged income, the effect of general habituation will be captured by the coefficient on lagged happiness. As a consequence, the effect on happiness from an increase in income will be twofold. On the one hand, higher income increases future income aspirations and, ceteris paribus, decreases future happiness (specific habituation). On the other hand, higher income increases present happiness and then makes the individual more prone to feelings of unhappiness tomorrow (general habituation).

Finally, there is at least one important advantage of measuring adaptation through the direct effect of past happiness. Consider a more realistic setup where the function matching rewards and stimuli is stochastic and heterogeneous across individuals. The hedonic adaptation hypothesis would predict that hedonic states bounce back only for those individuals who were effectively rewarded by the stimuli to begin with. As a consequence, the effect of past happiness on current happiness is supposed to pick up a more direct prediction of the hedonic adaptation hypothesis.

[2] For a discussion of the general problems behind self-report data see Bertrand and Mullainathan (2001) and Schwarz (1999).

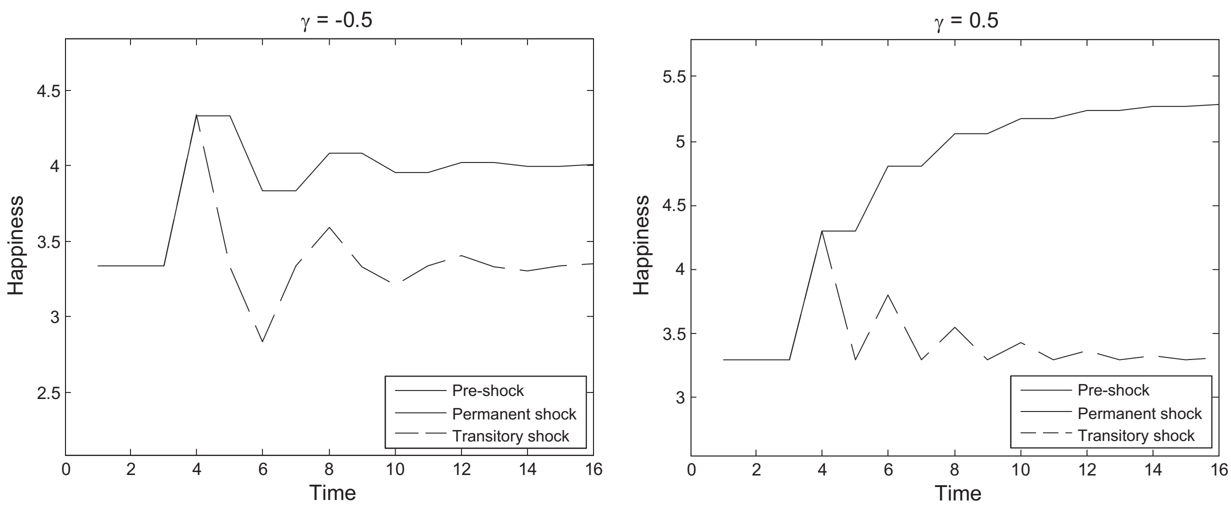

Fig. 1. Examples of adaptive and intertial hedonic states for positive shocks on happiness.

2.3. Econometric model

The baseline linear model is:[3]

$$H_{i,t} = \sum_{q=1}^{Q} \gamma_q H_{i,t-q} + \sum_{r=0}^{R} \beta_r X_{i,t-r} + \alpha_i + \psi_t + \varepsilon_{i,t} \quad (1)$$

The dependent variable $H_{i,t}$ is self-reported happiness, $X_{i,t}$ is a vector of time-varying individual controls, Q and R are, respectively, the number of lags to be considered for each of the variables, η_i are individual fixed effects, ψ_t corresponds to year fixed effects and $\varepsilon_{i,t}$ is the error term. If coefficient γ was negative (positive), then happiness would display habituation (inertia): feelings of happiness this year would make an individual prone to feelings of unhappiness (happiness) during the next year.

Consider the simplified model:

$$H_{i,t} = \gamma H_{i,t-1} + \lambda X_{i,t} + \alpha_i + \varepsilon_{i,t}$$

where $X_{i,t}$ is a vector of "fundamentals" for happiness. Suppose such fundamentals are held constant at X_i^{ss}. The steady state of happiness will be: $H_i^{ss} = \lambda X_i^{ss}/(1-\gamma)$. Therefore, the contemporaneous effect of changing the fundamentals is given by $\hat{\lambda}$, while the effect in the long run is $\hat{\lambda}/(1-\hat{\gamma})$. If we find a negative (positive) $\hat{\gamma}$, this would imply that the impact on the steady state is smaller (greater) than the contemporaneous effect. If γ is positive the dynamics are very simple: i.e., an increase from X_i^{ss} to $X_i^{ss}+\phi$ will initially increase happiness in $\lambda\phi$, next period happiness will increase by a further $\gamma\lambda\phi$, the next period by $\gamma^2\lambda\phi$, and so on.

If γ is negative, then happiness oscillates when approaching the new steady state, just like a spring oscillates when returning to rest: an increase from X_i^{ss} to $X_i^{ss}+\phi$ will initially increase happiness in $\lambda\phi$, next period happiness will drop by $\left|\gamma\lambda\phi\right|$, then it will increase by $\left|\gamma^2\lambda\phi\right|$, then drop by $\left|\gamma^3\lambda\phi\right|$, and so on. Intuitively, in this dynamic model the happiness state would follow a variant of Hooke's law, which states that the force with which a spring pushes back is linearly proportional to the distance from its equilibrium length (see for example Sprott, 2005).[4] Fig. 1 illustrates both habituation and inertia for positive shocks on happiness that are transitory and permanent.

Apart from the general habituation channel, we will also allow for specific-habituation:

$$H_{i,t} = \gamma H_{i,t-1} + \lambda_1 X_{i,t} + \lambda_2 X_{i,t-1} + \alpha_i + \varepsilon_{i,t}$$

where $\hat{\lambda}_2 < 0$ would represent specific-habituation. The net effect of a permanent increase of X on long-run happiness becomes: $(\hat{\lambda}_1 + \hat{\lambda}_2)/(1-\hat{\gamma})$.

As we will discuss later on, the identification of γ depends crucially on the error term not being persistent. Our identification strategy will consist in controlling for as many covariates and semi-parametric controls as possible, such as the usual individual controls, time and individual fixed effects, region-specific time effects and individual-specific time trends. In the following section we will construct the analysis "from the bottom up", introducing the econometric models on a one-by-one basis.

3. Results

3.1. Data

To test our hypothesis empirically, we will make use of the German Socio-Economic Panel Study[5] (GSOEP), the Japanese Panel Survey of Consumers[6] (JPSC), the British Household Panel Survey[7] (BHPS) and the Swiss Household Panel[8] (SHP). In what follows we present the regressions results for the GSOEP, JPSC, SHP and BHPS as A, B, C and D-Tables, respectively (Tables 1A–1D). The panel lengths are 22, 14, 8 and 10 for the GSOEP, JPSC, SHP and BHPS, respectively.[9] The challenge in estimating a dynamic model with fixed effects is that, for well-known reasons, it yields inconsistent estimates with large N but short T. Since the GSOEP is the

[3] Assuming that reported utility is cardinal or ordinal seems to make little difference as long as fixed effects are taken into account (Ferrer-i-Carbonell and Frijters, 2004).

[4] Also, notice that $\gamma \to -1$ does not imply full-adaptation.

[5] Data were made available to us by the German Institute for Economic Research (DIW), Berlin.

[6] We thank the Institute of Household Economy for access to microdata on the *Japanese Panel Survey of Consumers*.

[7] University of Essex. Institute for Social and Economic Research, *British Household Panel Survey: Waves 1–15, 1991–2006* [computer file]. *3rd Edition.* Colchester, Essex: UK Data Archive [distributor], June 2007. SN: 5151.

[8] Data have been collected in the "Living in Switzerland" project, which is based at the Swiss Foundation for Research in Social Sciences FORS, University of Lausanne (a project financed by the Swiss National Science Foundation).

[9] However, there is a gap in the middle of the BHPS for data on happiness. This causes the loss of 2 periods (instead of one) for each lag introduced in the model.

Table 1A
Autoreqressive happiness estimates – GSOEP.

	(1) Within	(2) Within	(3) HS	(4) AB	(5) HS	(6) AB	(7) HS	(8) AB
Happiness $t-1$		0.13	0.098	0.108	0.14	0.141	0.046	0.037
		[0.005]***	[0.007]***	[0.006]***	[0.008]***	[0.008]***	[0.012]***	[0.011]***
Happiness $t-2$					0.041	0.044		
					[0.006]***	[0.006]***		
Log household income t	0.13	0.121	0.066	0.067	0.062	0.063	0.033	0.034
	[0.017]***	[0.016]***	[0.019]***	[0.019]***	[0.019]***	[0.019]***	[0.028]	[0.028]
Log household income $t-1$	0.04	0.02	0.003	0.001	−0.006	−0.006	−0.018	−0.016
	[0.014]***	[0.014]	[0.017]	[0.017]	[0.018]	[0.017]	[0.028]	[0.027]
Log household income $t-2$	0.025	0.026	0.02	0.021	0.011	0.012	0.013	0.014
	[0.013]*	[0.013]**	[0.016]	[0.016]	[0.017]	[0.017]	[0.026]	[0.025]
Observations	118137	117473	98550	98550	97992	97992	82668	82668
Number of individuals	13258	13221	11922	11922	11876	11876	10693	10693
Order 1 autocorrelation test (P-value)			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Order 2 autocorrelation test (P-value)	–	–	<0.001	<0.001	0.927	0.3747	<0.001	<0.001
Order 3 autocorrelation test (P-value)	–	–	0.6219	0.594	0.0104	0.0017	0.6789	0.7985
Sargan (P-value)	–			<0.001	.	<0.001	–	0.1507
Weak instruments (P-value)	–	–	<0.001	–	<0.001	–	<0.001	–

Notes: All columns include 2 lags of control variables, time and individual fixed effects. Time-varying controls: log(household income), log(personal income), age, age squared, number of children, household size, days spent at hospital, disabled, employment status indicators, years of education, marital status indicators, geographic indicators. Columns 1 and 2 are estimated using the within transformation. All odd numbered columns after are estimated using Anderson-Hsiao (HS); all even numbered columns are estimated using Arellano-Bond (AB). Columns 7 and 8 present estimates for individual specific time trend model transformation. All standard errors are clustered at the individual level.1% ***; 5% **; 10% *.

Table 1B
Autoregressive happiness estimates – JPCS.

	(1) Within	(2) Within	(3) HS	(4) AB	(5) HS	(6) AB	(7) HS	(8) AB
Happiness $t-1$		0.114	0.106	0.117	0.142	0.151	0.061	0.027
		[0.010]***	[0.015]***	[0.014]***	[0.020]***	[0.017]***	[0.030]**	[0.022]
Happiness $t-2$					0.038	0.052		
					[0.015]***	[0.013]***		
Log household income t	0.009	0.009	0.013	0.013	0.015	0.015	0.011	0.012
	[0.005]*	[0.004]**	[0.005]**	[0.005]**	[0.006]***	[0.006]***	[0.007]	[0.006]*
Log household income $t-1$	−0.002	−0.003	0.001	0.001	−0.001	−0.001	0	0.001
	[0.004]	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]	[0.007]	[0.006]
Observations	19494	19446	16783	16783	14309	14309	14308	14308
Number of individuals	2585	2584	2415	2415	2279	2279	2278	2278
Order 1 autocorrelation test (P-value)			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Order 2 autocorrelation test (P-value)	–	–	0.023	0.006	0.568	0.481	<0.001	<0.001
Order 3 autocorrelation test (P-value)	–	–	0.611	0.522	0.076	0.021	0.800	0.504
Sargan (P-value)		–		<0.001	–	<0.001	–	0.012
Weak instruments (P-value)	–	–	<0.001	–	<0.001	–	0.035	–

Notes: All columns include 1 lag of control variables, time and individual fixed effects. Time-varying controls: log(household income), age, age squared, number of children, household size, dummy for married, employment indicators. Columns 1 and 2 are estimated using the within transformation. All odd numbered columns after are estimated using Anderson-Hsiao (HS); all even numbered columns are estimated using Arellano-Bond (AB). Columns 7 and 8 present estimates for individual specific time trend model transformation. All standard errors are clustered at the individual level. 1% ***; 5% **; 10% *.

longest panel, we will organize the discussion around its results. Nevertheless, the results are quite robust across datasets, and we will make a remark whenever there is any significant difference.

For detailed information on all datasets along with descriptive statistics please refer to Appendix A. Data definitions are available in Appendix B. In the GSOEP, an individual's self-reported happiness is obtained from the question: "How satisfied are you with your life, all things considered?" Responses range from 0 (completely dissatisfied) to 10 (completely satisfied).[10] In the following we refer to life satisfaction as happiness. Only the JPSC contains both variables and the results are very similar when using either definition. Apart from the individual and time fixed effects, some of the control variables are: logarithm of net total annual household income (in real prices), education, household composition, unemployment, marital status, etc. We always report robust standard errors clustered at the individual level.

3.2. Specific habituation

Suppose that current happiness depends on present and past values of income ($y_{i,t}$ and $y_{i,t-1}$, respectively):

$$H_{it} = \theta_1 y_{i,t} + \theta_2 y_{i,t-1} + \alpha_i + \varepsilon_{i,t} \tag{2}$$

[10] The other panels have similar questions, though the scales are different: JPSC (1–5), SHP (0–10), BHPS (1–7). More details available in Appendix B.

Table 1C
Autoregressive happiness estimates – SHP.

	(1) Within	(2) Within	(3) HS	(4) AB	(5) HS	(6) AB	(7) HS	(8) AB
Happiness $t-1$		−0.123	0.111	0.106	0.146	0.107	0.071	0.056
		[0.012]***	[0.024]***	[0.024]***	[0.040]***	[0.040]***	[0.049]	[0.047]
Happiness $t-2$					0.045	0.029		
					[0.023]*	[0.023]		
Log household income t	0.089	0.09	0.06	0.061	0.102	0.102	0.153	0.153
	[0.049]*	[0.050]*	[0.050]	[0.049]	[0.056]*	[0.056]*	[0.073]**	[0.072]**
Log household income $t-1$	0.024	0.034	0.025	0.026	−0.013	−0.011	0.096	0.096
	[0.032]	[0.036]	[0.052]	[0.051]	[0.056]	[0.055]	[0.064]	[0.063]
Observations	21454	17620	12214	12214	9136	9136	8098	8098
Number of individuals	5232	4841	4014	4014	3443	3443	3090	3090
Order 1 autocorrelation test (P-value)			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Order 2 autocorrelation test (P-value)	–	–	0.4378	0.3456	0.7949	0.3456	<0.001	<0.001
Order 3 autocorrelation test (P-value)	–	–	0.3727	0.3114	0.6642	0.3114	0.8527	0.7847
Sargan (P-value)	–		–	0.143	.	0.143	–	0.2861
Weak instruments (P-value)	–	–	<0.001	–	<0.001	–	0.132	–

Notes: All columns include 1 lag of control variables, time and individual fixed effects. Time-varying controls: log(household income), log(personal income), age, age squared, number of children, household size, number of visits to the doctor, health indicators, education indicators, marital status indicators, employment indicators, geographic indicators. Columns 1 and 2 are estimated using the within transformation. All odd numbered columns after are estimated using Anderson-Hsiao (HS); all even numbered columns are estimated using Arellano-Bond (AB). Columns 7 and 8 present estimates for individual specific time trend model transformation. All standard errors are clustered at the individual level. 1% ***; 5% **; 10% *.

Table 1D
Autoregressive happiness estimates – BHPS.

	(1) Within	(2) Within	(3) HS	(4) AB	(5) HS	(6) AB	(7) HS	(8) AB
Happiness $t-1$		−0.044	0.067	0.065	0.141	0.13	−0.016	−0.018
		[0.006]***	[0.011]***	[0.011]***	[0.025]***	[0.024]***	[0.025]	[0.025]
Happiness $t-2$					0.051	0.045		
					[0.015]***	[0.014]***		
Log household income t	0.033	0.035	0	0.001	0.014	0.015	−0.017	−0.017
	[0.010]***	[0.010]***	[0.012]	[0.012]	[0.017]	[0.017]	[0.019]	[0.019]
Log household income $t-1$	−0.005	−0.004	−0.018	−0.018	0.005	0.006	−0.014	−0.014
	[0.009]	[0.009]	[0.012]	[0.012]	[0.017]	[0.016]	[0.020]	[0.020]
Observations	70956	70956	45077	45077	24739	24739	24562	24562
Number of individuals	16265	16265	14884	14884	13681	13681	13581	13581
Sargan (P-value)	–	–		<0.001		0.186		0.0114
Weak instruments (P-value)	–	–	<0.001		<0.001		0.5258	

Notes: All columns include 1 lag of control variables, time and individual fixed effects. Time-varying controls: log(household income), log(personal income), age, age squared, number of children, household size, days spent in hospital, disabled, health indicators, employment status, education indicators, marital status indicators, geographic indicators. Autocorrelation tests are omitted since they could not be calculated thanks to the fact that there is a gap in the middle of the panel, reducing observations significantly when introducing lags. Columns 1 and 2 are estimated using the within transformation. All odd numbered columns after are estimated using Anderson-Hsiao (HS); all even numbered columns are estimated using Arellano-Bond (AB). Columns 7 and 8 present estimates for individual specific time trend model transformation. All standard errors are clustered at the individual level. 1% ***; 5% **; 10% *.

Besides specific-habituation, lags may also measure delayed rewards. For example, when income rises in t, some individuals save part of this increase for consumption in the future (i.e., consumption smoothing), therefore we could expect a lagged effect on future happiness. A similar argument can be made for the other lagged variables. For the sake of simplicity we always interpret the coefficients on lagged variables as suggesting specific-habituation, but at least in some cases that may not be the case.

We already mentioned that the habituation effects can be the result of different phenomenon. Suppose for example that happiness is a function of income (y_t) above the income aspiration (A_t): $H_t = \alpha(y_t - A_t) + \xi_t$. But we cannot observe A_t, so we estimate (2). Since A_t is formed at $t-1$, it is probably strongly correlated with y_{t-1}. Therefore, $\hat{\theta}_2$ will be capturing indirectly the effect of past aspirations about present income.Even though the utility from income is a parameter that is of special interest to economists, we want to measure adaptation to many other specific life domains in X (e.g. getting married, becoming unemployed):

$$H_{i,t} = \sum_{r=0}^{R} \beta_r X_{i,t-r} + \alpha_i + \psi_t + \varepsilon_{i,t} \quad (3)$$

Results for this specification are presented in column (1) of Table 1A. The coefficients on current and past income are statistically significant, and some of the lags for control variables are significant as well.[11] The lags for most of our controls are of opposite sign to the current level's coefficient. For instance, losing a spouse today is associated with a coefficient of −0.6 that is statistically significant at the 1% level, but the lags (also statistically significant)

[11] The sign of the coefficients on lagged income are not negative, as obtained in other studies. This is not puzzling, since a simple model of consumption smoothing predicts that a positive income shock will be smoothed over the following years.

Table 2
Specific-habituation estimates for a selection of control variables.

	GSOEP		JPCS		SHP		BHPS	
	(1)Within	(2) HS	(1)Within	(2) HS	(1)Within	(2)HS	(1)Within	(2) HS
Happiness $t-1$		0.046		0.061		0.071		−0.016
		[0.012]***		[0.030]**		[0.049]		[0.025]
Log household income t	0.13	0.033	0.009	0.011	0.089	0.153	0.033	−0.017
	[0.017]***	[0.028]	[0.005]*	[0.007]	[0.049]*	[0.073]**	[0.010]***	[0.019]
Log household income $t-1$	0.04	−0.018	−0.002	0	0.024	0.096	−0.005	−0.014
	[0.014]***	[0.028]	[0.004]	[0.007]	[0.032]	[0.064]	[0.009]	[0.020]
Log household income $t-2$	0.025	0.013						
	[0.013]*	[0.026]						
No. of children in t	0.055	0.08	0.055	−0.013	0.045	−0.05	0.07	0.026
	[0.050]	[0.081]	[0.031]*	[0.049]	[0.033]	[0.084]	[0.016]***	[0.040]
No. of children in $t-1$	−0.018	−0.188	−0.081	−0.075	−0.022	−0.155	−0.063	−0.053
	[0.048]	[0.073]**	[0.027]***	[0.048]	[0.033]	[0.095]	[0.017]***	[0.042]
No. of children in $t-2$	−0.003	−0.089						
	[0.048]	[0.074]						
Married in t	0.221	−0.075	0.193	−0.152	0.323	−0.084	0.153	0.088
	[0.040]***	[0.078]	[0.045]***	[0.085]*	[0.080]***	[0.190]	[0.039]***	[0.092]
Married in $t-1$	−0.163	−0.294	−0.158	−0.216	−0.143	−0.115	−0.136	0.029
	[0.042]***	[0.067]***	[0.041]***	[0.065]***	[0.072]**	[0.163]	[0.038]***	[0.091]
Married in $t-2$	−0.147	−0.139						
	[0.038]***	[0.074]*						
Widowed in t	−0.597	−0.407			−0.74	−0.758	−0.333	−0.15
	[0.094]***	[0.185]**			[0.391]*	[0.652]	[0.094]***	[0.181]
Widowed in $t-1$	0.314	0.425			0.196	−1.154	0.133	0.11
	[0.101]***	[0.160]***			[0.399]	[0.984]	[0.088]	[0.202]
Widowed in $t-2$	0.292	0.183						
	[0.088]***	[0.185]						
Unemployed in t	−0.348	−0.411	−0.279	−0.212	−0.458	−0.399	−0.265	0.288
	[0.027]***	[0.047]***	[0.065]***	[0.099]**	[0.104]***	[0.239]*	[0.037]***	[0.068]***
Unemployed in $t-1$	0.103	0.08	−0.021	−0.009	−0.139	0.019	0.063	−0.006
	[0.027]***	[0.049]	[0.059]	[0.089]	[0.094]	[0.231]	[0.033]*	[0.062]
Unemployed in $t-2$	0.057	−0.013						
	[0.027]**	[0.046]						
Observations	118137	82668	19494	14308	21454	6939	70956	24562
Number of individuals	13258	10693	2585	2278	5232	2662	16265	13581

Notes: Columns for GSOEP include 2 lags of control variables (1 lag for other panels), time and individual fixed effects. Time-varying controls include household composition, marital status, employment status, health proxies. Column 1 presents select control variables used in the first column of Table 1. Columns 2 presents estimates for the individual-specific time trends specification in columns 7 of Table 1. Columns 1 are estimated using within transformation, columns 2 are estimated using Anderson-Hsiao (HS). All standard errors are clustered at the individual level. 1% ***; 5% **; 10% *.

are 0.31 and 0.29. In other words, reported happiness bounces back completely after two years. Adaptation to unemployment is 72% after 2 years. We found a similar pattern for marriage, divorce, and childbirth, among others. Some of the covariates and their respective lags are presented in Table 2. These findings are comparable to those found in other studies (Clark et al., 2008; Lucas et al., 2003; Diener et al., 2006).

3.3. General habituation

Apart from the 2 lags of the control variables, we now include one lag of happiness:[12]

$$H_{i,t} = \gamma H_{i,t-1} + \lambda_1 X_{i,t} + \lambda_2 X_{i,t-1} + \alpha_i + \varepsilon_{i,t} \quad (4)$$

It is well known that using the within transformation when estimating (5) would involve a considerable small-T bias (Nickell, 1981). We will use some the standard solutions. Using all of the available lags of the dependent variable in the set of instruments does not sound very reasonable in the particular context of happiness regressions. Intuitively, the relation between $(H_{i,t-1} - H_{i,t-2})$ and $H_{i,t-19}$ is undoubtedly weak and noisy. Angrist and Pischke (2008) illustrate the consequences of using weak instruments. Denote $F = R/\sigma_\xi^2 \cdot Q$ the F-statistic for the joint significance of all regressors in the first stage regression, where Q is the number of instruments, σ_ξ^2 is the residual variance and R is the R-squared of the first stage. Then the bias can be approximately written as (Angrist and Pischke, 2008, Chapter 4):

$$E[\hat{\beta}_{2SLS} - \beta] \approx \frac{\sigma_{\eta\xi}}{\sigma_\xi^2} \frac{1}{F+1}$$

Only as F gets large 2SLS does better than OLS. When the instruments are weak, the F-statistic itself varies inversely with the number of instruments. To see why, consider adding useless instruments to an 2SLS model, that is, instruments with no effect on the first-stage R-squared. The model's sum of squares and the residual variance will remain the same, but Q will go up. The F-statistic becomes smaller as a result. This is why the addition of many weak instruments increases bias.

Indeed, there is Monte Carlo evidence suggesting that Anderson-Hsiao (hereafter, HS) yields less bias than other methods such as Arellano-Bond and Arellano-Bover, and its efficiency compares favorably (e.g. Judson and Owen, 1999). We will use HS as the

[12] Since the panels are significantly shorter in the other datasets, we prefer to err on the conservative side and present the results with only one lag of the control variables.

baseline model, which will also be helpful for the sake of notational simplicity. Nevertheless, when we present the results for AB estimates we do not find substantial differences.

In column (2) we show the autoregressive happiness model estimated by the within transformation. The estimate for the autoregressive term is positive and statistically different from zero.[13] If $\left|\gamma\right| < 1$ the sign of the small-T bias is negative, which would suggest that we find $\hat{\gamma} > 0$ *in spite of* the small-T bias. This is puzzling, because we expected happiness to display habituation instead of inertia.

Consider the first differences of Eq. (4):

$$(H_{i,t} - H_{i,t-1}) = \gamma(H_{i,t-1} - H_{i,t-2}) + \lambda(X_{i,t} - X_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (5)$$

The source of the bias is clear above: the term $(H_{i,t-1} - H_{i,t-2})$ is correlated with the error term $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ through $\varepsilon_{i,t-1}$. The HS estimator exploits the fact that $H_{i,t-2}$ can be used as an instrumental variable for $(H_{i,t-1} - H_{i,t-2})$. The results for HS are presented in column (3). The $\hat{\gamma}$ is positive and statistically significant at the 1% level.

For the following estimates we test the presence of weak instruments based on the Anderson–Rubin Wald test. The results are similar when using alternative tests. Under the null hypothesis the instrumental variables are weak and the over-identifying restrictions are valid. We reject the null at the 1% level. For the upcoming regressions we will not mention the weak instrument test unless we cannot reject the null. Notice that the model in differences has first-order autocorrelation by construction. However, if second-order autocorrelation were found, then the instrumental variables would not be valid. Indeed, we reject the null hypothesis of no second-order autocorrelation at the 1% level. The models that follow do not fail this validity test.

3.4. Second-order general habituation

The most basic explanation for the second-order autocorrelation in the difference model is that the model in levels should include two lags of happiness instead of one:

$$H_{i,t} = \gamma_1 H_{i,t-1} + \gamma_2 H_{i,t-2} + \alpha_i + \varepsilon_{i,t} \quad (6)$$

Take first differences:

$$(H_{i,t} - H_{i,t-1}) = \gamma_1(H_{i,t-1} - H_{i,t-2}) + \gamma_2(H_{i,t-2} - H_{i,t-3}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (7)$$

where $H_{i,t-2}$ is as an instrumental variable for $(H_{i,t-1} - H_{i,t-2})$ and $H_{i,t-3}$ for $(H_{i,t-2} - H_{i,t-3})$. The results are presented in column (4) of Table 1A. Both lags are positive and statistically significant, where the second lag is 1/3 the coefficient of the first lag. Now we cannot reject the null hypothesis of no second-order autocorrelation. The results for Arellano-Bond are reported in columns (4) and (6), respectively. The results are not substantially different from HS. We cannot reject the null of the Sargan test at the 1% level in either case. In what follows we will explore whether the positive autoregressive coefficient is the product of the usual omitted variable bias.

3.5. Persistence in the error term

We know that happiness depends on unobservables (S_t):

$$H_{i,t} = \gamma H_{i,t-1} + \lambda_1 X_{i,t} + \lambda_2 X_{i,t-1} + \beta S_{i,t} + \alpha_i + \varepsilon_{i,t} \quad (8)$$

Take first differences:

$$H_{i,t} - H_{i,t-1} = \gamma(H_{i,t-1} - H_{i,t-2}) + \lambda_1(X_{i,t} - X_{i,t-1}) + \lambda_2(X_{i,t-1} - X_{i,t-2}) + \beta(S_{i,t} - S_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \quad (9)$$

If (9) were true and (5) was estimated instead, the error term in the difference equation would be the whole second line in (10). Suppose that the unobservable is persistent (i.e. $S_{i,t-1}$ and $S_{i,t-2}$ are correlated). Since $H_{i,t-2}$ and $S_{i,t-2}$ are correlated by definition, using $H_{i,t-2}$ as an instrument for $(H_{i,t-1} - H_{i,t-2})$ would not be valid. Persistence of omitted variables is probably the main source of bias in the dynamic framework.[14]

There is a more direct way to solve the problem of having a persistent error term. In the simplest scenario the error term follows a MA(1) (moving average), so the difference of the error term is MA(2). The convenient property of the MA(1) process is that the second- and higher-order autocorrelations are zero. As a consequence, if $\varepsilon_{i,t}$ is MA(1) in Eq. (6) then, even though H_{t-2} is no longer valid as an instrumental variable, H_{t-3} and longer lags remain valid. This obviously comes at a price, since further lags are weaker instrumental variables and therefore exacerbate the small-sample bias of the IV estimates. In unreported results we use H_{t-3} as instrument instead of H_{t-2}. The coefficient on lagged happiness is positive, much larger in value and statistically significant. However, we do not report the results because they are not very robust to slight changes in specification and they do not always pass the test of weak instruments.

On the contrary, if the error term in the model was AR(1), $\varepsilon_{i,t} = \rho\varepsilon_{i,t-1} + \nu_{i,t}$, we would not be able to apply the same strategy, since $\varepsilon_{i,t}$ would be correlated to all of its past values. Nevertheless, we can still learn something. Consider the first difference in the simpler model:

$$(H_{it} - H_{i,t-1}) = \gamma(H_{i,t-1} - H_{i,t-2}) + (\rho\varepsilon_{i,t-1} - \rho\varepsilon_{i,t-2} + \nu_{it} - \nu_{i,t-1}) \quad (10)$$

If we use H_{t-2} as an instrument, the asymptotic bias would be:

$$\text{plim} \quad \hat{\gamma} - \gamma = \frac{Cov(\varepsilon_{it} - \varepsilon_{i,t-1}, H_{i,t-2})}{Cov(H_{i,t-2}, H_{i,t-1} - H_{i,t-2})} \quad (11)$$

Under the hedonic adaptation hypothesis the denominator is negative. The sign of the numerator depends on the sign of the autocorrelation of the error term. If the error term is positively autocorrelated ($\rho > 0$), we could get $\hat{\gamma} > 0$ even if γ was actually negative.

3.6. Individual-specific time trends

We imperfectly measure many aspects of life (e.g., marital status is a coarse proxy for love and relationships) and we completely omit some (e.g., intellectual achievements). Since we cannot use more time-varying controls than those available in the data, we explore a semi-parametric strategy. The most reasonable step would be to include individual-specific time trends, since omitting them could generate substantial persistence in the error term. In order to see this clearly, consider a time-series model without the autoregressive component, but with a linear trend:

$$H_t = \rho \cdot t + \xi_t \quad (12)$$

[13] Note that for the SHP and BHPS the coefficient is negative, product of the small T bias.

[14] Apart from important life spheres that we do not observe (e.g., sex life), another source of $S_{i,t}$ is omitted variability in included variables (e.g., material standard of living), since we can only control for proxies.

Table 3
Estimates for other subjective outcomes.

Satisfaction with	GSOEP		JPCS		SHP		BHPS	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Health	0.082	0.025			0.07	0.022	0.098	0.056
	[0.006]***	[0.012]**			[0.018]***	[0.034]	[0.010]***	[0.026]**
Observations	98823	82997			14734	10227	44726	24309
Household income	0.104	0.032	0.145	0.068	0.11	0.014	0.132	0.082
	[0.006]***	[0.012]***	[0.017]***	[0.034]**	[0.017]***	[0.032]	[0.010]***	[0.028]***
Observations	96944	81105	14211	11858	16299	11458	44682	24279
Leisure time	0.106	0.052	–	–	–	–	0.078	0.043
	[0.006]***	[0.012]***					[0.010]***	[0.030]
Observations	98138	82269					45077	24562
Work	0.101	0.047	–	–	–	–	0.088	0.081
	[0.009]***	[0.017]***					[0.013]***	[0.039]**
Observations	50793	40064					45077	24562

Notes: Each coefficient belongs to a separate regression. Estimates for GSOEP include 2 lags of control variables (1 lag otherwise), time and individual fixed effects. Time-varying controls include household composition, marital status, employment status, health proxies. Column 1 presents select estimates for Anderson-Hsiao (HS) identical to those presented in column 3 in Table 1 (changing the dependent variables of course). Columns 2 present HS estimates for the individual specific time trend models presented in columns 7 in Table 1. All standard errors are clustered at the individual level. 1% ***; 5% **; 10% *.

where ξ_t is i.i.d. with mean zero and variance σ_ξ. Imagine that instead, we are estimating a dynamic model without a linear trend:

$$H_t = \gamma \cdot H_{t-1} + \varepsilon_t \tag{13}$$

OLS would yield:

$$\text{plim}\ \ \hat{\gamma} = 0 + \frac{Cov(H_{t-1}, \rho \cdot t + \xi_t)}{Var(H_{t-1})} = \frac{Cov(\rho \cdot t - \rho + \xi_{t-1}, \rho \cdot t + \xi_t)}{Var(H_{t-1})} \neq 0 \tag{14}$$

That is to say, if we did not account for time trends we would be obtaining a "fake" autoregressive coefficient. Consider a model with both individual-specific linear time trend and individual-specific intercept:

$$H_{i,t} = \gamma H_{i,t-1} + \alpha_{1i} + \alpha_{2i} t + \varepsilon_{i,t} \tag{15}$$

Taking first differences does not solve the problem:

$$H_{i,t} - H_{i,t-1} = \gamma(H_{i,t-1} - H_{i,t-2}) + \alpha_{2i} + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \tag{16}$$

If we denote $R_{i,t} = H_{i,t} - H_{i,t-1}$, it is clear that the equation above is a dynamic model with fixed effects, subject to the usual small-T bias. If we omitted α_{2i} as included regressor it would be part of the error term, and since α_{2i} is correlated to $H_{i,t-2}$ by construction, the latter would no longer be a valid instrument. Notice that, just as feared, the bias in $\hat{\gamma}$ would be positive.

Fixed effects control for certain things depending on the time horizon. For example, when the panel is just two years long many things remain relatively stable: career choice, family composition, the criteria used to answer the happiness question, etc. But when we increase the time horizon further, practically everything becomes time-varying. Using individual-specific time trends addresses this problem by controlling not only for the within-individual variation that is constant, but also for that variation that evolves approximately as a linear trend. To estimate the model with individual-specific trends, take differences once again:

$$(H_{i,t} - 2H_{i,t-1} + H_{i,t-2}) = \gamma(H_{i,t-1} - 2H_{i,t-2} + H_{i,t-3}) + (\varepsilon_{i,t} - 2\varepsilon_{i,t-1} + \varepsilon_{i,t-2}) \tag{17}$$

Now we can use $H_{i,t-3}$ as instrumental variable. Results are reported in column (7) of Table 1. Past happiness is still positive and statistically different from zero at the 1% level, but the coefficient is now much lower than the coefficients obtained in the previous specifications. If we repeat the exercise using two lags of happiness, the second lag of happiness is not statistically significant anymore. Notice that by construction we now have autocorrelation of first and second order in the (second) difference equation. As needed for the instrumental variables to be valid, we cannot reject the null of no third-order autocorrelation.

3.7. Robustness checks

The non-response rate for the life satisfaction question is quite low for the GSOEP (8.9%), BHPS and JPSC (near 0% in both), and quite high for the SHP (24.4%). We estimated the probability of non-response for this question using first-wave characteristics and did not find important predictors of non-response (they explained only 2% of the variation). Attrition is also an important issue in household panels. By the last wave we only count with around half the households from the first wave. But there are many covariates (e.g., income, civil status) each with few missing values but that combined (take into consideration that the model includes lags for all the variables involved) make the mean number of observations per household fall significantly short of its full potential. For instance, in the GSOEP each individual contributes on average 9 observations out of 22 waves. The small-T bias is more exacerbated the lower T is. We can run the regression for a subset of individuals that contributes (say) more than 15 observations each. This would be valid as long as the censoring process is completely random, so there is a trade-off between selection-bias and small-T bias. We run the regressions above with this modification, and the results are practically the same.

Finally, in Table 3 we present the autoregressive coefficient for other hedonic states: satisfaction with health, household income, work and spare time (i.e., variables that are about the same in the three databases). We use our favorite specification, given by column (7) from Table 1A. Even though all hedonic states are expected to be adaptive, we always find positive autoregressive coefficients. One possibility is that the autoregressive coefficients are artificially generated by the functioning of self-reports. Because of obvious space constraints, we provide a discussion of that possibility in the Web Appendix.[15] Also, we might fail to find a negative autoregressive

[15] See author's website.

coefficient because most adaptation may take place well within a year. For those readers interested in this possibility, in the Web Appendix we take a closer look by exploiting daily instead of yearly happiness data.

3.8. Is happiness inertial?

As discussed before, some sources of model misspecification can generate a positive autocorrelation coefficient when there is actually no *direct* effect of past happiness on present happiness. For instance, Wunder and Schwarze (2010) use a very restrictive formulation of habit formation given by Frederick and Loewenstein (1999) to show that our positive autoregressive coefficient (actually, in a slightly different specification) can represent specific hedonic habituation. It is very difficult to distinguish between the two stories, because past stimuli and past happiness are closely related by construction. For a more direct test, we would need variation in either habits or aspirations that does not affect past happiness. However, such a goal is beyond the scope of this paper.

4. Conclusions

Motivated by a conceptual distinction in the interpretation of the hedonic adaptation hypothesis, we tried to assess whether happiness is autoregressive. Firstly, we should ask whether using dynamic instead of static regressions modifies the estimates on the (static and dynamic) coefficients of the most common variables in the happiness literature. As shown in Table 2, the coefficients remain roughly the same, especially if we take into consideration the great loss in efficiency and sample size implied by the dynamic econometric models.

Secondly, we found that the coefficient on lagged happiness is positive and statistically significant. Taken at face value, that would suggest that happiness is inertial: i.e., ceteris paribus, having greater feelings of happiness in the past directly increases the probability of feeling happy in the present. This channel would work independently from the specific habituation channel: i.e., as shown in Table 2, it is still true that there is specific-habituation to many stimuli, like getting married or becoming unemployed. Notwithstanding, the positive autoregressive coefficient may have alternative interpretations in other model specifications (e.g., Wunder and Schwarze, 2010). We leave this as an open question for future research.

Appendix A. Data description

See appendix Tables A.1–A.4.

German Socio-Economic Panel Study (GSOEP)

The GSOEP is a longitudinal data set which is representative of the German population. It began randomly sampling households for the west states of the Federal Republic of Germany in 1984. The original sample size was around 6000 households, yielding a sample of above 12,000 individuals. With the fall of the Berlin Wall in 1989, Germany was reunited and the sample was expanded to represent Germany as a whole. In order to maximize panel length we use the original sample (West Germany only) covering the years 1984–2005.[16] Our dependent variable (happiness) is defined as the individual's overall life satisfaction. In the survey, this question is only responded by individuals age 16 and over. Our variable for household income is taken from the Cross-National Equivalent File (1984–2005) where it is defined as "Real Household Post-Government Income." This variable corresponds to total household income (i.e., labor income, pensions, etc.) after taxes and

[16] For instance, Di Tella et al. (2007) undertake the same strategy. Results are robust to including whole sample.

Table A.1
Summary statistics – GSOEP.

Variable		Mean	Std. Dev.	Min	Max	No. of Obs.
Happiness (0–10 scale)		7.052	1.822	0	10	N = 118137
	Between		1.428	0	10	n = 13258
	Within		1,292	−1.632	14.353	T (avg) = 8.9
Household income (in euros)		31621.2	17961.5	0	405045.4	N = 125665
	Between		15854.4	54.06642	278905.9	n = 14015
	Within		10361.6	−170819.9	240819.4	T = 8.9
Household size		2.966	1.422	1	17	N = 125665
	Between		1.316	1	11	n = 14015
	Within		0.712	−4.034	11.216	T = 8.9
Days in hospital		1.892	9.292	0	365	N = 125665
	Between		6.614	0	280	n = 14015
	Within		8.151	−88.108	321.267	T = 8.9
Full-time employment		0.463	0.499	0	1	N = 125665
	Between		0.427	0	1	n = 14015
	Within		0.285	−0.487	1.413	T = 8.9
Not employed		0.381	0.486	0	1	N = 125665
	Between		0.401	0	1	n = 14015
	Within		0.308	−0.569	1.331	T = 8.9
Marital status: married		0.672	0.469	0	1	N = 125665
	Between		0.448	0	1	n = 14015
	Within		0.219	−0.278	1.622	T = 8.9
Marital status: single		0.185	0.389	0	1	N = 125665
	Between		0.408	0	1	n = 14015
	Within		0.159	−0.765	1.135	T = 8.9
Registered disabled		0.116	0.320	0	1	N = 125665
	Between		0.264	0	1	n = 14015
	Within		0.168	−0.834	1.066	T = 8.9

Table A.2
Summary statistics – JPCS.

Variable		Mean	Std. Dev.	Min	Max	No. of Obs.
Happiness (0–5 scale)		3.459	0.966	1	5	N = 22440
	Between		0.759	1	5	n = 2836
	Within		0.672	0.126	6.459	T (avg) = 7.9
Household income (in thousands of yen)		143.0	189.7	0	9998	N = 22497
	Between		145.3	0	1905.571	n = 2836
	Within		116.2	−1762.552	8235.448	T (avg) = 7.9
Household size		4.033	1.579	1	11	N = 22497
	Between		1.447	1	10.14286	n = 2836
	Within		0.706	−0.7	9.8	T (avg) = 7.9
Full-time employment		0.319	0.466	0	1	N = 22497
	Between		0.416	0	1	n = 2836
	Within		0.257	−0.6	1,2	T (avg) = 7.9
Unemployed		0.017	0.128	0	1	N = 22497
	Between		0.078	0	1	n = 2836
	Within		0.115	−0.733	0.945	T (avg) = 7.9
Marital status: married		0.709	0.454	0	1	N = 22497
	Between		0.444	0	1	n = 2836
	Within		0.212	−0.219	1.638	T (avg) = 7.9

Table A.3
Summary statistics – 5HP.

Variable		Mean	Std. Dev.	Min	Max	No. of Obs.
Happiness {0–10 scale)		8.018	1.390	0	10	N = 21454
	Between		1.211	0	10	n = 5232
	Within		0.828	0.418	13.418	T (avg) = 4.3
Household income (in euros)		103327.3	68221.8	0	2142253	N = 22538
	Between		59889.9	4742.857	1280684	n = 5314
	Within		35040.8	−1017967	1320615	T = 4.2
Household size		2.904	1.408	1	10	N = 22538
	Between		1.356	1	9	n = 5314
	Within		0.401	−2.896	7.104	T (avg) = 4.2
No. of doctor consultations		3.447	7.819	0	365	N = 22538
	Between		6.729	0	216	n = 5314
	Within		5.504	−164.6	287.6	T (avg) = 4.2
Full-time employment		0.735	0.441	0	1	N = 22538
	Between		0.414	0	1	n = 5314
	Within		0.192	−0.122	1.592	T (avg) = 4.2
Unemployed		0.012	0.110	0	1	N = 22538
	Between		0.079	0	1	n = 5314
	Within		0.087	−0.738	0.869	T (avg) = 4.2
Marital status: married		0.651	0.477	0	1	N = 22538
	Between		0.471	0	1	n = 5314
	Within		0.125	−0.206	1.508	T (avg) = 4.2
Marital status: divorced		0.076	0.266	0	1	N = 22538
	Between		0.254	0	1	n = 5314
	Within		0.073	−0.781	0.934	T (avg) = 4.2

other transfers (combines payments of all household members). Data on CPI was taken from the OECD. For more detailed information on the history of the GSOEP please refer to Wagner et al. (2007).

Japanese Panel Survey of Consumers (JPSC)

The JPSC is a panel of young aged women between 24 and 34 selected from across Japan in 1993. Additional cohorts were added in 1997, 2003 and 2008. The JPSC is recognized known for its relatively high response rate, overcoming the inherent shortcomings of a panel survey. This study examines a wide spectrum of factors including income, expenditures, savings, work patterns and family relationships. It was designed with a focus on changing lifestyles. For more information refer to their website: http://www.kakeiken.or.jp/.

British Household Panel Survey (BHPS)

The BHPS is a random representative sample of the population of the United Kingdom. It began in 1991 surveying some 5500 households and additional household were incorporated in 1999 and 2001 yielding a sample of over 10,000 household containing over 24,000 individuals aged 15 onwards. Individuals who left their original household to form a new one were followed and all adults were consequentially interviewed. We make use of data from wave 6 to 15 due to the fact that questions on life satisfaction were introduced as of wave 6. In wave 11 the question on life satisfaction was dropped from the survey because space constraints in Self Completion Schedule, and replaced by the Quality of Life module (introduced every 5 years). Data for wave 11 then has missing values for happiness. This yields a panel with a maximum length of

Table A.4
Summary statistics – BHPS.

Variable		Mean	Std. Dev.	Min	Max	No. of Obs.
Happiness (0–7 scale)		5.229	1.287	1	7	N = 70956
	Between		1.084	1	7	n = 16265
	Within		0.772	0.086	9.514	T (avg) = 4.4
Household income (in GB pounds)		28398.1	22833.5	0	1205210	N = 70956
	Between		19010.5	0	347694.2	n = 16265
	Within		13458.7	−305247.9	1012130	T (avg) = 4.4
Household size		2.758	1.324	1	13	N = 70956
	Between		1.278	1	12.66667	n = 16265
	Within		0.489	−2.9	8.2	T (avg) = 4.4
Days in hospital		0.905	5.785	0	280	N = 70956
	Between		4.148	0	104.5	n = 16265
	Within		4.524	−74.8	190.9	T (avg) = 4.4
[5pt] Full-time employment		0.527	0.499	0	1	N = 70956
	Between		0.450	0	1	n = 16265
	Within		0.234	−0.330	1.384	T (avg) = 4.4
Unemployed		0.027	0.163	0	1	N = 70956
	Between		0.125	0	1	n = 16265
	Within		0.121	−0.830	0.884	T (avg) = 4.4
Marital status: married		0.590	0.492	0	1	N = 70956
	Between		0.473	0	1	n = 16265
	Within		0.163	−0.267	1.447	T (avg) = 4.4
Marital status: divorced		0.086	0.280	0	1	N = 70956
	Between		0.263	0	1	n = 16265
	Within		0.104	−0.771	0.943	T (avg) = 4.4

10 waves and a mean of 7 waves per respondent. Data on CPI were taken from the UK Office of National Statistics.

Swiss Household Panel (SHP)

Not widely used in Economics of Happiness literature, the SHP is a relatively new longitudinal data set which was started in 1999. It is surveyed annually covering more than 5000 representative households, with a sample size of over 13,000 respondents. All individuals over the age of 14 in the household are surveyed. In comparison to the BHPS or GSOEP, the SHP collects data on a wider variety of topics which are of interest in social science. For more information on the SHP refer to Budowski et al. (2001). We use data covering waves 1–8 (1999–2006) with a mean of 5 waves per respondent. Questions on life satisfaction were included as of the year 2000. Data on CPI were taken from OECD.

Appendix B. Data definitions

German Socio-Economic Panel Study

Happiness/Satisfaction with Life: Individual response to question: "*How satisfied are you with your life, all things considered?*" [0 Completely Dissatisfied]–[10 Completely Satisfied].

Satisfaction with Household Income: Individual response to question: "*How satisfied are you with your household income?*" [0 Completely Dissatisfied]–[10 Completely Satisfied].

Household Income: "Real Household Post-Government Income" from the CNEF. It includes all income perceived by ALL household members (i.e. labor income, pensions, windfalls, etc.). Since all income data is reported as monthly average, the data has been annualized. Government tax burdens were estimated by the DIW using calculation routines developed by Schwarze. Values reported are in EURO deflated to prices of the year 2000 using data from the OECD.

Equivalence Corrected Income: Elasticity to household size correction for income, using equivalence scale elasticity obtained by regressing variables against satisfaction with household income.

Health Satisfaction: Respondent's answer to the question: "*How satisfied are you with your health?*" [0 Completely Dissatisfied]–[10 Completely Satisfied]

Satisfaction with Spare Time: Respondent's answer to the question: "*How satisfied are you with your spare time?*" [0 Completely Dissatisfied]–[10 Completely Satisfied]

Control Variables:

Household Composition variables: Number of children, household size (number of individuals in household).

Age: In years and age squared.

Employment state: Set of dummies for different employment states derived from a generated variable by the DIW using data on labor force participation and non-employment characteristics.

Hours worked: Annual. Constructed by DIW using information on employment status, average number of hours worked per week and the number of months worked in the previous year. No corrections for vacations were made.

Marital State: Set of dummies (Married, Separated, Divorced, Widowed, Single, Not living with a partner) derived from variable constructed in CNEF where categories indicate legal marital status.

Education: Number of years. Variable constructed by assigning years according to type of education. For example: Individuals with a school leaving degree are assigned a minimum of between 9 and 12.

Days Spent in Hospital: Individuals were asked: "*How many nights in total did you spend in the hospital last year?*". Since this question was not included in the questionnaire for years 1990 and 1993, this control is not included in results presented in order to maximize panel length. Regardless, results are robust to including this variable.**Japanese Panel Survey of Consumers**

Satisfaction with Life: Individual response to question: "Are you generally satisfied with your life?" [1 Not at all]–[5 Very Much]

Happiness: Do you think you are happy or unhappy? [1 I am very unhappy]–[5 I am very happy]

Satisfaction with Income: Are you satisfied with the current income of your family? [1 Not at all]–[5 Very Much]

Control Variables:

Household Income: "Annual income earned by household" in thousands of Yen.

Age: In years and age squared.

Household size: "How many members are there in your household?"

Number of children: Respondents are asked to name their children and basic information (e.g. age, sex, etc.).

Single: Respondents indicate their marital status: [1 Single]; [2 Married]

Employment Status: Set of dummies for different employment states derived from completing their student/working status: [1 Preschooler]; [2 Student in the 1st–3rd grade of primary school]; [3 Student in the 4th–6th grade of primary school]; [4 Junior-high school student]; [5 Senior-high school student]; [6 University or college student]; [7 Vocational school student]; [8 Worker]; [9 Without occupation]

British Household Panel Survey

Happiness/Satisfaction with Life: Individual response to question: "How satisfied or dissatisfied are you with your life overall?" [1 Not satisfied at all]–[7 Fully satisfied]

Satisfaction with Household Income: Individual response to question: "How satisfied or dissatisfied are you with the income of your household?" [1 Not satisfied at all]–[7 Fully satisfied]

Household Income: Household Gross Income deflated to prices of 2005 using information on CPI from UK Statistics. Including all income perceived by household: labor, transfers, welfare, etc. Income value is reported in GB Pounds.

Control Variables:

Equivalence Corrected Income: Elasticity to household size correction for income, using equivalence scale elasticity obtained by regressing variables against satisfaction with household income.

No. of Serious Accidents: Number of accidents which require medical treatment by a doctor or a hospital visit.

Health Satisfaction: Respondent's answer to the question: "*How dissatisfied or satisfied are you with your health?*" [1 Not satisfied at all]–[7 Fully satisfied]

Satisfaction with Social Life: Respondent's answer to the question: "*How dissatisfied or satisfied are you with your social life?*" [1 Not satisfied at all]–[7 Fully satisfied]

Household Composition Variables: Includes number of children, employed, retired individuals in household.

Household Size: Number of people in household.

Employment State: Set of dummies for different employment states derived from the following question: "Which best describes your current situation?" [1 Self Employed], [2 Paid Employment], [3 Unemployed], [4 Retired], [5 Maternity Leave], [6 Looking After Family], [7 Attending Classes], [8 Sick or Disabled] and [9 Government Training]. Plus dummy for having a second job.

Age: Age in years derived from date of interview and individual responses to the question about the birth dates.

Marital State: Set of dummies (Married, Separated, Divorced, Widowed and Never Married) obtained from question: "What is your legal marital status? [1 Married], [2 Separated, [3 Divorced], [4 Widowed] and [5 Never married].

Education: Set of dummy variables derived from individual responses to the question: "Which is the highest qualification he/she has got? [1 Training Certificate], [2 Trade Apprenticeship], ..., [11 University Diploma], ..., [13 University Higher Degree]".

Health State: A set of dummies on diverse health problems obtained from question: "Have any of the health problems listed on this card? (i.e. difficulty seeing, diabetes, breathing problems, etc.)"

Smokes: A dummy variable derived from the individual responses to the question: "Do you smoke cigarettes? [1 Yes] [2 No]".

No of Cigarettes: Derived from question: "How many cigarettes did you smoke in the last 7 days?"

Days in Hospital: Number of days respondent spent in hospital derived from question: "Since (date), in all, how many days have you spent in a hospital or clinic as an in-patient?"

Swiss Household Panel

Happiness/Satisfaction with Life: Individual response to question: "In general, how satisfied are you with your life if 0 means "not at all satisfied" and 10 means "completely satisfied"?"

Satisfaction with Household Income: Individual response to question: "Overall how satisfied are you with the financial situation of your household. If 0 means "not at all satisfied" and 10 "completely satisfied"?"

Health Satisfaction: Respondent's answer to "How satisfied are you with your state of health, if 0 means 'not satisfied at all' and 10 'completely satisfied'?"

Free Time Satisfaction: Respondent's answer to "How satisfied are you with the amount of free time you have, if 0 means 'not satisfied at all' and 10 'completely satisfied'?"

Control Variables:

Equivalence Corrected Income: Elasticity to household size correction for income, using equivalence scale elasticity obtained by regressing variables against satisfaction with household income.

Household Income: "Yearly Household Income, Net" variable constructed in the SHP. It includes all income perceived by ALL household members (i.e. labor income, pensions, windfalls, etc.) after deduction of social security contributions. Taxes not deducted. Values reported are in EURO deflated to prices of the year 2000 using data from the OECD.

Household Composition variables: Number of children, household size (number of individuals in household).

Age: In years and age squared.

Employment State: Set of dummies for different employment states derived from variable generated by SHP from diverse question on employment.

Marital State: Set of dummies (Married, Separated, Divorced, Widowed, Never Married) indicating actual civil status in year of interview.

Education: Set of dummy variables indicating respondent's highest level of education achieved: ranging from incomplete compulsory school to university, higher specialized school.

Health State: Set of dummies indicating different health problems such as: back problems, weakness/weariness, sleeping problems, headaches, chronic illness or long-term health problem.

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