Unmet Aspirations as an Explanation for the Age U-shape in Wellbeing

by

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Abstract

An emerging economic literature has found evidence that wellbeing follows a U-shape over age. Some theories have assumed that the U-shape is caused by unmet expectations that are felt painfully in midlife but beneficially abandoned and experienced with less regret during old age. In a unique panel of 132,609 life satisfaction expectations matched to subsequent realizations, I find that future life satisfaction is strongly overestimated when young and underestimated during old age. This pattern is stable over time and observed within cohorts as well as across socio-economic groups. These findings support theories that unmet expectations drive the age U-shape in wellbeing.

Keywords: life satisfaction, aging, expectations, forecast errors

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1. Introduction

An emerging economic literature has found evidence that wellbeing follows a U-shape over age except in the years right before death (Blanchflower and Oswald 2008, Deaton 2008, Stone et al. 2010, Van Landeghem 2012, Wunder et al. 2013). This U-shape has been observed in more than 50 countries (Blanchflower and Oswald 2008), across socio-economic groups and recently also for great apes (Weiss, Oswald, et al. 2012). Yet little is known about its origins. One theory is that the U-shape is driven by unmet aspirations which are painfully felt in midlife but beneficially abandoned later in life (Frey and Stutzer 2002). A complementary theory builds on the neuroscientific finding that the emotional reaction to missed chances decreases with age so that the elderly might feel less regret about unmet aspirations (Brassen et al. 2012).

Assuming that regret about unmet aspirations drives the U-shape implies that people err systematically in predicting their wellbeing over the life-cycle. When young, people expect a bright future though actual wellbeing decreases. In old age expectations are adjusted downwards though actual wellbeing is rising. Human belief formation is known to exhibit systematic biases such as optimism (Weinstein 1980, Puri and Robinson 2007, Sharot et al. 2007, Mayraz 2011) and the underestimation of hedonic adaptation to changes in life circumstances (Loewenstein and Schkade 1999, Kahneman and Thaler 2006). However, existing literatures typically analyze specific forecast settings with less emphasis on overall wellbeing measures or the role of age. The extent to which people err in predicting changes in their wellbeing over the life-cycle is unknown.

This paper examines whether people make systematic errors when thinking about their wellbeing in five years time and how these errors change with age. Results are based on a unique data set from the German Socio-Economic Panel (SOEP) that includes both respondents' current life satisfaction as well as their expectations about life satisfaction in five years. The panel structure of the SOEP allows an individual's expectation in a given year to be matched to the same individual's realization five years ahead to form individual specific forecast errors. Matching 132,609 life satisfaction expectations to subsequent realizations, I find people to err systematically in predicting their life satisfaction over the life cycle. They expect -- incorrectly -- increases in young adulthood and decreases during old age. These errors are large, ranging from 9.8% at age 21 to -4.5% at age 68. This pattern is stable over time and observed within cohorts as well as within individuals. Further, forecast errors are very similar in East and West Germany and across gender but slightly more pronounced among the highly educated.

The age associated errors in expected life satisfaction documented in this paper support the notion that the age U-shape in wellbeing is driven by unmet expectations that negatively affect people's wellbeing in midlife but are abandoned and experienced with less regret during old age. Young adults in the SOEP data report high aspirations that are subsequently unmet. And their life satisfaction decreases with age as long as expectations remain high and unmet. Aspirations are abandoned and expectations align with current wellbeing in the late 50s. This is the age when wellbeing starts to rise again. Further, given the disappointed expectations accumulated until that age, it is possible that wellbeing increases if the elderly learn to feel less regret (Brassen et al. 2012). Following this interpretation of the U-shape in wellbeing, the observed negative forecast errors during old age might indicate that people do not anticipate the wellbeing enhancing effects of abandoning high aspirations and experiencing less regret.

To formalize this hypothesized relationship of current life satisfaction, expectations and forecast errors I propose a simple mathematical framework in which current life satisfaction depends on contemporaneous life circumstances, optimism and regret about past forecast errors. Calibrating this model to the data shows that a linearly decreasing age profile of optimism and a hump-shaped age profile of regret explain more than 95% of the observed age pattern in life satisfaction, expectations and forecast errors. This result suggests that the observed forecast errors can explain the observed age U-shape in wellbeing through a fairly simple model.

Age-related life satisfaction forecast errors are at odds with rational expectations (Muth 1961). Rational expectations do not imply that people's expectations are always right, but forecast errors should not be consistently predictable by information that is available at the time of the forecast, such as people's age. However, research from behavioral economics, psychology, neuroscience and biology has accumulated evidence of such systematic forecast errors.

One source of systematic forecast errors is that people underestimate how quickly they adapt to socio-economic changes in their lives such as changes in income (Loewenstein and Schkade 1999, Kahneman and Thaler 2006). Thus the observed age bias in life satisfaction forecasts could be generated by the young expecting too much from anticipated income increases and the elderly, who face decreasing incomes, committing the opposite error. In the data, forecast errors indeed roughly match with the average income profile which is increasing during young adulthood and decreasing after age 50. Further, the age bias is slightly more pronounced for the highly educated who have steeper income profiles than those with less education (Fig. A8).

However, the remarkable similarity across economically and culturally distinct regions and across gender suggests that some of the causes of the age bias go beyond age-related socio-economic characteristics. It is a well established finding in psychological and neuroscientific research that people tend to overestimate the likelihood of positive events and underestimate the likelihood of negative events.[1] For example, people expect to enjoy healthier lives than average

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[1] Weinstein (1980), Puri et al. (2007), Sharot et al. (2007), Sharot et al. (2011), Sharot et al. (2012), Mayraz (2011).

or underestimate the probability of being divorced (Puri and Robinson 2007). Optimism bias has also been demonstrated in non-human animals (Matheson et al. 2008). Neuroscientific research (Sharot et al. 2007, Sharot et al. 2011, Sharot et al. 2012) has accumulated broad evidence that this bias is generated by selective processing of negative and positive information in the frontal brain which allows people to maintain biased expectations when confronted with discomforting evidence. Sharot et al. (2007) hypothesize that optimism bias might be evolutionary efficient, motivating behavior in the present directed towards future goals and reducing anxiety and depression. These findings might provide a biological explanation for why life satisfaction expectations are overoptimistic during much of adulthood and adjust only slowly over time. Brunnermeier and Parker (2005) formalize this notion in the context of the standard life-cycle model. They show that optimism bias is utility maximizing if high aspirations feed into anticipatory utility as long as choices are not distorted too much by these biased beliefs.

Whether the forecast errors documented in this study distort intertemporal choices depends on the extent to which (predicted) life satisfaction is related to (predicted) utility. An emerging literature is carefully studying what it is that self-reported subjective well-being measures (SWB) such as life satisfaction capture and how these measures should be interpreted (Benjamin, Heffetz, Kimball and Rees-Jones 2012, 2013). Benjamin and his coauthors find that people's SWB predictions -- and life satisfaction predictions in particular -- are powerful predictors of their choices. Predicted life satisfaction coincide with choices 89% in their experimental data (Benjamin, Heffetz, Kimball and Rees-Jones 2012). On the other hand, the cases of choice reversals are found to be systematic, suggesting that there are aspects of utility that are not captured by these measures. While these findings caution against simply equalizing SWB with utility they indicate that people tend to choose those life circumstances which they believe will maximize their life satisfaction. In turn, systematic errors in life satisfaction forecasts imply that life choices that people make in their pursuit of life satisfaction might often be suboptimal.

Another insight from Benjamin et al. (2012, 2013) is that it is important to distinguish life satisfaction from other subjective wellbeing measures (see also Kahneman and Deaton, 2010). For example, the findings of this paper might not carry over to forecasts of momentary emotional affect. However, given their strong correlation with people's choices life satisfaction forecasts might be a particularly interesting measure for economists when analyzing prediction errors in subjective wellbeing.

2. Data and Method

The data used in this study come from the German Socio-Economic Panel (SOEP), a longitudinal survey of households in Germany that started in West-Germany in 1984 and includes East-Germany since 1990. Current life satisfaction is reported in all years while expected life satisfaction is included from 1991 to 2004. The wording of the questions, translated from German, is:

Please answer according to the following scale: 0 means 'completely dissatisfied', 10 means 'completely satisfied':

- *How satisfied are you with your life, all things considered?* *[1]*

- *And how do you think you will feel in five years?* *[2]*

The survey interviews are conducted personally and extensive efforts are made to follow-up survey participants (Wagner et al., 2007). This reduces potential biases due to endogenous sample selection and selective non-response, a concern recently raised by Heffetz and Rabin (2013) in the context of telephone surveys on subjective wellbeing.

Individual-specific forecast errors are constructed as the difference of an individual's answer to question [2] in a given year minus the same individual's answer to question [1] five years later. Question [1] is identical or similar to life satisfaction questions in other widely-used surveys, such as British Household Panel Survey, the Eurobarometer, the World Values Survey. Kahneman et al. (2006) have pointed out that the way in which life satisfaction is elicited in surveys might induce people to give too much weight to material aspects of their life reported beforehand in the same questionnaire. Such 'focusing illusion' might also matter for expected life satisfaction. For example, individuals with increasing income profiles might report higher life satisfaction expectations if the survey induced them to focus on their income. However, the same `focusing illusion' effect -- if existent -- will be at work once higher income profiles are reached and people report their realized life satisfaction. In other words, since forecast errors are constructed as the difference of two life satisfaction measures any common effect on the level of these measures is cancelled out.

The sample used in this study is all those respondents between the ages of 17 and 85 with non-missing demographic information who responded to question [2] in the waves 1991 to 2002 and to question [1] five years later. The resulting sample consists of 23,161 individuals for whom a total of 132,609 life satisfaction forecast errors were constructed. Descriptive statistics are provided in Table 1. 48% of the sample is male, 28% lives in East Germany, 46% have low education, 31% high education and the average age is 44.4.

A nonparametric approach is employed in order to analyze age patterns in life satisfaction forecast errors in a flexible and transparent way. Life satisfaction measures and forecast errors are averaged and plotted over age. Numerical values by single years of age are tabulated in the online appendix. To summarize the age patterns in forecast errors numerically I fit third order age polynomials over the average forecast errors weighted by the size of the age cells. The interaction of the age effects with time, region, gender and education is assessed by collapsing the data separately for each subgroup. Relevant subgroup differences in mean forecast errors are tested for significance by equality of means t-tests.

Constructing forecast errors and averaging them across individuals implies that expected and realized life satisfaction are cardinal measures which are comparable across individuals. For example, this procedure assumes that an individual who expects a 10 but later reports a 6 commits a forecast error twice as large as someone who expects a 6 but later reports a 4. A straight-forward way to relax these arguably strong cardinality and comparability assumptions is to redefine forecast errors into binary variables that indicate positive or negative errors.

Previous research suggests that life satisfaction reports in the SOEP might be distorted by time-in-panel effects, leading to excessively high life satisfaction reports in the first period (Ehrhardt, Aris and Veenhoven, 2000). I evaluate the relevance of such panel effects by excluding individuals' first and second interviews (following Wunder et al., 2013).

Another important question is whether observed age-patterns represent actual age effects, i.e. changes within people as they become older, or cohort effects, i.e. age-independent differences between people that are observed in the different age groups. I assess the role of cohort effects by plotting forecast errors over age by birth cohorts. If effects are driven by actual age effects then the pattern should occur within rather than between cohorts.

A stronger test for the role of age-independent differences as a driver of observed age patterns is to look at changes within individuals instead of changes within cohorts. In the wellbeing U-shape literature Frijters and Beatton (2012) and Kassenboehmer and Haisken-DeNew (2012) propose to estimate age effects controlling for individual fixed effects and time-in-panel effects. They find that the inclusion of these controls eliminates the age U-shape in wellbeing. However, age effects estimated conditional on individual fixed effects and time-in-panel effects are difficult to interpret. As Kassenboehmer and Haisken-DeNew (2012) note, such effects are identified through people who drop out and rejoin the sample which does not happen randomly but is likely to be endogenous. For example, it may result from life events that also directly affect life satisfaction.[2]

An alternative approach is to analyze how life satisfaction changes when people become older, i.e. to look directly at individual first differences averaged by single years of age, as proposed by Cheng, Powdthavee and Oswald (2013). These authors find that individual first differences over age match with the slope of the age U-shape in the cross-section, implying that the wellbeing U-shape occurs within people and is not just driven by cohort effects. I follow Cheng, Powdthavee and Oswald (2013) and compare the slope of the observed age pattern in forecast errors to the average of individual changes in forecast errors at each age (with and without controlling for panel effects). If the age pattern in forecast errors occurs within people, average first differences should match the slope of the age pattern observed in the cross-section.

3. Empirical Results

3.1 Current life satisfaction, expected life satisfaction and forecast errors over age

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[2] Think of a 60 year-old respondent who cannot be interviewed the following year due to severe illness. Two years later, at age 62, she rejoins the panel and reports lower life satisfaction than at age 60. The observed decrease in life satisfaction is unlikely to reflect an age effect. Rather, it is caused by the severe illness which forced her to drop out of the sample for one year.

Figure 1 (A) plots people's expected life satisfaction in five years averaged over age at the forecast, ranging from age 17 to 85, and the same sample's current life satisfaction five years ahead at ages 22 to 90. In line with the existing literature (Blanchflower and Oswald 2008, Wunder et al. 2013) current life satisfaction is U-shaped between ages 20 and 70, with peaks around ages 23 and 69, a local minimum in the mid-50s and a further decline after age 75. As the plot of life satisfaction expectations shows, this U-shape is not anticipated. During young adulthood people expect their life satisfaction to increase strongly. With age, expectations decrease but remain above current life satisfaction until the late 50s when the two graphs coincide. Thereafter expectations remain stable while actual life satisfaction increases, indicating that people do not anticipate the increase in old age wellbeing. After age 75 expectations decrease, simultaneously with current life satisfaction.

These different patterns in current and expected life satisfaction imply systematic forecast errors that change with age. Figure 1 (B) plots average forecast errors over age at time of the forecast along with 95% confidence intervals. Young adults in their 20s overestimate on average their future life satisfaction by about 0.7, or by about 10% (e.g. 0.693 ± 0.044 or 9.8% at age 23, Table A1). After age 30 forecast errors decrease steadily, turning negative at age 55 and decreasing further until age 68 (-0.308 ± 0.057; or -4.52%, Table A1) where after they remain at around -0.25.

Confidence intervals are small, indicating that means are estimated precisely. They only widen after age 75 when mortality reduces the size of these cohorts. A third order polynomial of age provides a good fit for this age pattern, explaining 97.2% of the variation in average forecast errors (Table 2, column 1).

Notice that expected life satisfaction and forecast errors are only computed for those who survive the following five years. Consequently, sample selection due to increased mortality could be responsible for the negative forecast errors observed during old age. Those who survive are the lucky ones who enjoy better health than they could have expected on average. However, mortality rates increase exponentially during old age (Fig. A1). Therefore, if mortality rates were driving negative forecast errors via sample selection one should observe a strongly increasing underestimation of future life satisfaction in old age. But forecast errors remain constant around -0.25 after the late 60s, suggesting that negative forecast errors during old age are not driven by sample selection due to mortality.

The interpretation of the age averages plotted in Figures 1 (A) and (B) requires strong assumptions regarding the cardinality and comparability of expected and current life satisfaction. One way to relax these assumptions is to transform forecast errors into binary indicators and plot the fractions of positive and negative errors over age (Fig. A2). In line with previous research (Ferrer-i-Carbonell and Frijters 2004) this ordinal treatment of current and expected life satisfaction yields qualitatively identical results. Another caveat of life satisfaction data are time-in-panel effects which might imply higher reports in the first interview rounds. Figure A3 shows that the age pattern is robust to the exclusion of the first and the second interview. Excluding these data only leads to a marginal downward shift (in line with a small positive panel effect), without affecting the slope of the age pattern.

To sum up, Figure 1 shows a strongly significant age pattern in life satisfaction forecast errors that even remains if errors are reduced to binary indicators and that is not driven by panel effects. However, these findings are not sufficient to establish a systematic age bias. In any given period forecast errors might have common components due to economy-wide shocks, i.e. new information arriving between forecasts and realizations, even for $N \rightarrow \infty$ (Chamberlain 1984). Instead, forecast errors have to be persistent over time to establish a systematic bias.

3.2 Forecast errors over age across time periods, within cohorts and within individuals

Figure 2 (A) plots forecast errors for three subperiods. Compared to the intermediate years, forecast errors were significantly higher in the aftermath of the German reunification, 1991-1993, and around the New Economy stock market bubble, 1998-2002 (0.287, p<0.001 and 0.294, p<0.001, resp.; Table 3 a-b). These temporary increases are unlikely to be informative about systematic biases, since people had good reasons to believe in a rosy future during these time periods.[3] Importantly, however, these time shocks come along as uniform shifts across the entire age range. The change in forecast errors over age is highly stable across all periods. In Table 2 cols. (3) and (4) I regress average forecast errors in the intermediate and the third subperiod on forecast errors predicted from the first subperiod. As the R^2 indicates forecast errors in 1991-1993 predict 89.1% of the variation in average forecast errors in 1994-1997 and 96.7% in 1998-2002. This indicates that the age pattern in forecast errors is not driven by a particular period but that it is highly stable over time, reflecting an actual bias.

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[3] In fact, as shown in Appendix Figure A4, the positive shift in the aftermath of the German Reunification is driven by East Germans who were falsely promised "blooming landscapes" by Chancellor Helmut Kohl while increased forecast errors around 2000 are driven by West-Germans who had broadly invested in the stock market and faced soaring returns. For a more detailed analysis of forecast errors during the aftermath of the German Reunification see Frijters et al. (2009).

Plotting the data by birth cohorts (Appendix Fig. A5) shows that the age pattern is not driven by cohort effects either. This indicates that the changes in average forecast errors over the life cycle are not caused by mere level differences between the different cohorts surveyed in the SOEP. Instead they reflect changes within cohorts as they are followed over time.

A stronger test whether changes over age reflect changes within rather than differences across people is to analyze individual first differences (Cheng, Powdthavee and Oswald, 2013). As discussed above, individual first differences should match with the slope of the forecast error age pattern if the changes over age occur within individuals.

The blue dots in Appendix Figure A6 (A) plot the year-to-year change in average forecast errors over age, i.e. the first difference of the age pattern shown in Figure 1 (B). Green triangles, on the other hand, plot individual specific year-to-year changes in forecast errors averaged over age. The dotted and solid lines show quadratic fits of these plotted age patterns, respectively. The dotted line can be thought of as the first derivative of the age pattern displayed in Figure 1 (B). If this pattern was entirely driven by differences across people and was not occurring within people as they become older then the solid line in Figure A6 should be a flat zero line. However, this is not the case. The solid fitted line has a stronger U-shape than the dotted line (though the difference is not statistically significant). Taken at face value, this shape suggests that the age profile in forecast errors might be even more pronounced if estimated solely from individual first differences. As Figure A6, panel B, shows the pattern looks very similar when the first two interviews are excluded to account for potential panel effects. While first differences have the disadvantage that they do not allow to analyze levels this exercise suggests that the age pattern in forecast errors occurs within people as they become older.

3.3 Forecast errors over age across regions, gender and education

Figure 2 (B) plots forecast errors over the life-cycle separately for East- and West-Germany. The pattern looks remarkably similar across these two regions that were economically and culturally different in the aftermath of German Reunification (Alesina and Fuchs-Schündeln 2007). Below age 55, forecast errors are not significantly different between regions, and only slightly more negative in East Germany above age 55 (Table 3 c-d). As shown in Figure 2 (C) age effects are also similar by gender. Below age 55, the gender difference is small and insignificant, while forecast errors are slightly more negative for males above age 55 (Table 3 e-f).

The similarity of the observed patterns across regions and their stability over time indicate that the findings might be generalizable to other developed countries in other decades. Indeed, suggestive cross-sectional evidence on life ladder ranking expectations from the Cantril surveys (Cantril, 1965) is in line with similar age biases in West-Germany and other developed countries around 1960 (Appendix Fig. A9). Easterlin (2001) interprets this cross-sectional gap between expected and present life ladder ranking with misprediction of hedonic adaptation to income. However, the Cantril surveys provide only a limited number of cross-sectional observations that do not allow for a detailed age-specific analysis of actual forecast errors.

Surprisingly, the life-cycle pattern is more pronounced for the more educated. As shown in Figure 2 (D), people with fewer years of education make significantly less positive forecast errors before age 55 (difference -0.116, $p<0.001$, Table 3 g) and significantly less negative forecast errors after age 55 (difference 0.166, $p<0.001$, Table 3 h). Notice, however, that smaller *average* forecast errors do not necessarily imply greater precision. On average, negative and positive errors cancel out. Average *absolute* forecast errors are indeed larger for the less educated (difference 0.226, $p<0.001$, Appendix Figure A7), which could be due to a lower ability to form accurate expectations or a higher frequency of unexpected shocks in the lives of the less educated.

Summing up, these findings show a systematic age bias in life satisfaction forecast. When young people strongly overestimate their future life satisfaction while they underestimate it during old age. These results are not driven by the strong cardinality assumption that is required to form forecast errors. Using binary indicators of positive and negative errors results in the same pattern. The observed age bias is stable across time periods reflecting an actual bias rather than the arrival of new information. This indicates that the results are not driven by common macro shocks in individual years. Further, the pattern occurs within cohorts and within individuals, suggesting that it represents an actual age effect rather than age-independent differences between people contained in the different age groups in the SOEP. Splitting up the sample by socio-economic subgroups shows that the age bias is similar across economically and culturally distinct regions, across gender and slightly more pronounced for the highly educated. Taken together these findings provide evidence of a strong and robust age bias in life satisfaction forecasts.

4. A Simple Framework

The empirical analysis has shown that the young strongly overestimate their future life satisfaction while the elderly underestimate it. As argued in the introduction, this finding supports the hypothesis that the age U-shape in life satisfaction is driven by unmet aspirations that are painfully felt during midlife but beneficially abandoned and felt with less regret during old age. In the following I present a simple framework that formalizes this hypothesized mechanism. I then estimate key parameters using the SOEP data, simulate the age profiles of current and expected life satisfaction and compare them to the actual profiles in the data. This exercise is intended to show that overoptimism and regret can generate the U-shape in life satisfaction through a simple model and that this model provides a good fit to the data. It is not intended to explain why people make forecast errors or how forecast errors affect people's behavior. The dynamics of the model can be thought of as simplified optimism and regret effects that do not to affect marginal rates of substitution and therefore do not alter people's choices.

Assume that life satisfaction depends on past forecast errors the following way

$$LS_t = v_t(x_t) - \rho_t \sum_{\tau=0}^{t-t0} \left[E_{t-\tau-1} LS_{t-\tau} - LS_{t-\tau} \right] \tag{1}$$

where LS_t is life satisfaction at age t, t_0 is the initial period, v_t is a function which translates current life circumstances x_t into satisfaction, and ρ_t is a regret parameter with $0 \leq \rho_t < 1$. $E_{t-1}LS_t$ is the expectation at age $t-1$ about life satisfaction at age t and $[E_{t-1}LS_t - LS_t]$ is the corresponding forecast error. The model does not specify whether forecast errors result from mispredictions of future life circumstances or future preferences (or both). Notice that while the regret parameter is allowed to vary with age, at a given age forecast errors from any past period are regretted in the same way. Regret is felt over the entire sum of disappointed expectations in one's life.

Further notice that the sum in equation (1) also contains the forecast error about current life satisfaction. This implies a circularity in life satisfaction: A given disappointment that is felt with regret lowers current life satisfaction, which in turn makes the disappointment even larger, further lowering life satisfaction. People feel 'regret about feeling regret'. The strength of this circularity is determined by the regret parameter.

In order to focus on the dynamics in this model generated by forecast errors, I keep the satisfaction derived from current life circumstances constant over age, i.e. $v_t(x_t) = \bar{v}$. I further assume that no forecast errors are made before the initial period, so $LS_{t0} = v_{t0}(x_{t0}) = \bar{v}$. Life satisfaction expectations are assumed to be determined by current life satisfaction and age-specific optimism

$$E_t LS_{t+1} = (1+\omega_t) LS_t \tag{2}$$

where ω_t is an optimism parameter. Substituting (2) in (1) and $v_t(x_t) = LS_{t0}$ yields (for the derivation see Appendix Section III)

$$LS_t = LS_{t0} - \frac{\rho_t}{1-\rho_t} \sum_{\tau=1}^{t-t0} \left[\omega_{t-\tau} LS_{t-\tau} \right] \tag{3}$$

Given an initial life satisfaction value, the evolution of current and expected life satisfaction and forecast errors in this framework is entirely determined by the age profiles of optimism (ω_t) and regret (ρ_t). Notice that for $\rho \to 1$, i.e. for strong circularity, the second term becomes very large. The intuition is that small disappointments -- caused in this setting by overoptimism in previous periods -- have strong effects on life satisfaction if people feel a lot of 'regret about feeling regret'.[4]

Figure 3 (A) plots the age-specific optimism and the regret parameters that are implied by the model given the observed life satisfaction profiles in the SOEP. The parameter values are obtained by solving eq. (2) and (3) for ω_t and ρ_t, respectively. LS_{t0} is set to average life satisfaction at age 22. One-year expectations are derived from five-year expectations by linear interpolation.[5]

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[4] see Appendix Section IV for the dynamics of a model with $\rho \to 1$.

[5] Alternatively, the model can be transformed into a five-year period model, with very similar results.

Figure 3 (A) shows that optimism is positive for the young, decreasing with age and turns negative at age 59. A linear age trend fits the optimism profile remarkably well, explaining 96% of the variation in age-specific optimism parameters. The left panel of Figure 3 (B) shows that in the baseline model regret follows a hump-shape over age. It is around zero when people are young and their life satisfaction is high despite positive forecast errors.[6] Regret increases with age when people's life satisfaction starts to decrease and reaches a peak at about 0.18 around age 50 when life satisfaction is at its trough. During old age regret decreases again to about half the value of the midlife peak, corresponding to increases in life satisfaction which do not entirely reach the level of the twenties.

Overall, the estimated regret parameter follows the hypothesized age profiles in that it is high during midlife and decreasing in old age. Further, the regret parameter range implies only a weak circularity of life satisfaction. At its maximum a direct regret effect of 0.18 corresponds to an additional regret effect due to circularity of merely 0.04.[7]

Figure 4 (A) compares the actual expected and current life satisfaction profiles to those generated by the model taking the initial life satisfaction value at age 22 from the data and using the fitted linear age profile for optimism and the fitted quadratic profile for regret in the baseline

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[6] The high variability during the initial years of the age range should not be overinterpreted. It is a consequence of the simplifying assumption that there are no forecast errors before the initial age (here 22), so that in the initial years the sum of past forecast errors is small and any changes in current life satisfaction imply large changes in the estimated regret parameter.

[7] The effect due to circularity equals the overall effect minus the direct effect: $\frac{\rho_t}{1-\rho_t} - \rho_t$.

model shown in Figure 3. The model simulation based on these simple parameter specifications provides a good fit, explaining 99% of expected and 85% of current life satisfaction.

One explanation for overoptimistic expectations is the notion that higher expectations could directly increase contemporaneous wellbeing (Brunnermeier and Parker 2004, Sharot et al. 2007). The proposed framework can be extended to allow for such direct effect of expectations on current life satisfaction:

$$LS_t = v_t(x_t) + A\omega_t - \rho_t \sum_{\tau=0}^{t-t0} [E_{t-\tau-1} LS_{t-\tau} - LS_{t-\tau}] \tag{4}$$

where ω_t is the optimism parameter that links current to expected life satisfaction (eq. 2) and A measures the direct effect on life satisfaction. Analogous to equation (3) the evolution of life satisfaction is described by

$$LS_t = LS_{t0} + \frac{A\omega_t}{1-\rho_t} - \frac{\rho_t}{1-\rho_t} \sum_{\tau=1}^{t-t0} [\omega_{t-\tau} LS_{t-\tau}] \tag{5}$$

Notice that in equation (3) optimism has -- in the presence of regret -- an unambiguously negative effect on life satisfaction. But once we allow for a direct positive optimism effect on contemporaneous life satisfaction in equation (5), the overall effect is ambiguous.[8]

The right graph in Figure 3 (B) shows the regret parameters corresponding to this extended model, for *A=10* (the optimism parameter is not affected). The regret profile changes

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[8] The effect of a change in optimism (assuming age-constant optimism, $\omega_t = \omega$) is:

$\frac{\delta LS_t}{\delta \omega} = \frac{A - \rho_t \sum_{\tau=1}^{t-t0} [LS_{t-\tau}]}{1-\rho_t}$. It increases with the direct effect of optimism (A) and decreases with age as the sum of past periods (and past disappointments) grows.

considerably. It does not increase as much during midlife as in the baseline model because part of the decrease in life satisfaction is accounted for by the decrease in optimism. Further, the regret reduction during old age is stronger, reaching zero around age 65. This is plausible. During old age life satisfaction increases despite the fact that optimism turns negative. Therefore regret has to decrease more. The resulting hump-shaped age profile is remarkably symmetric. Figure 4 (B) shows that this symmetric regret profile improves the simulation considerably for current life satisfaction while the simulation becomes slightly less accurate for expected life satisfaction. The R^2 is 97% and 98%, respectively.

To sum up this exercise has shown that the "unmet aspirations hypothesis" can be formalized in a simple framework that provides a good fit to the data. The fit improves when one allows for a direct effect of optimism on life satisfaction. This is not surprising since this extension requires an additional parameter, increasing the arbitrariness of the model. However, a direct optimism effect might be an important determinant of people's wellbeing and therefore make the model more realistic. After all, as Brunnermeier and Parker (2004) and Sharot et al. (2007) suggest a direct optimism effect might be the reason why people have overoptimistic expectations in the first place. Whether the true regret profile looks more like the plot in Figure 3 (A) or 3 (B), however, is a question for future research.

5. Conclusion

This paper provides evidence that people make systematic mistakes in predicting how satisfied they will be with their life over the course of their lives. Young people strongly overestimate their future life satisfaction while the elderly tend to underestimate it. This pattern is stable over time, observed within cohorts, within individuals and across different socio-economic groups.

Previous research has found a U-shape in wellbeing over the life cycle with reported satisfaction declining from the twenties to the fifties before increasing again into the later years. Some theories have assumed that the U-shape is caused by unmet aspirations that are felt painfully in midlife but beneficially abandoned and experienced with less regret during old age. The empirical findings from this paper support this notion. Further, I show that this relationship can be formalized in a fairly simple model, implying a linearly decreasing age profile of optimism and a hump-shaped age profile of regret.

Further research is needed to investigate the components of people's expectations underlying the biased life satisfaction forecast documented in this paper. One important question is whether forecast errors are driven by biased expectations about future life circumstances or about future preferences (or both). Given that the SOEP only contains data on life satisfaction expectations it is not well suited to investigate this question. Identifying whether life satisfaction forecast errors are driven by the misprediction of future life circumstances or by the misprediction of future preferences is also important for the understanding of potential choice distortions. For example, given a concave utility function overestimating future income would imply an underestimation of the future marginal utility from income and therefore induce the young to save too little. If, on the other hand, the young overestimate the marginal utility derived from a certain income level, say due to unanticipated hedonic adaptation to higher income, this would induce suboptimally high savings (or career investments).

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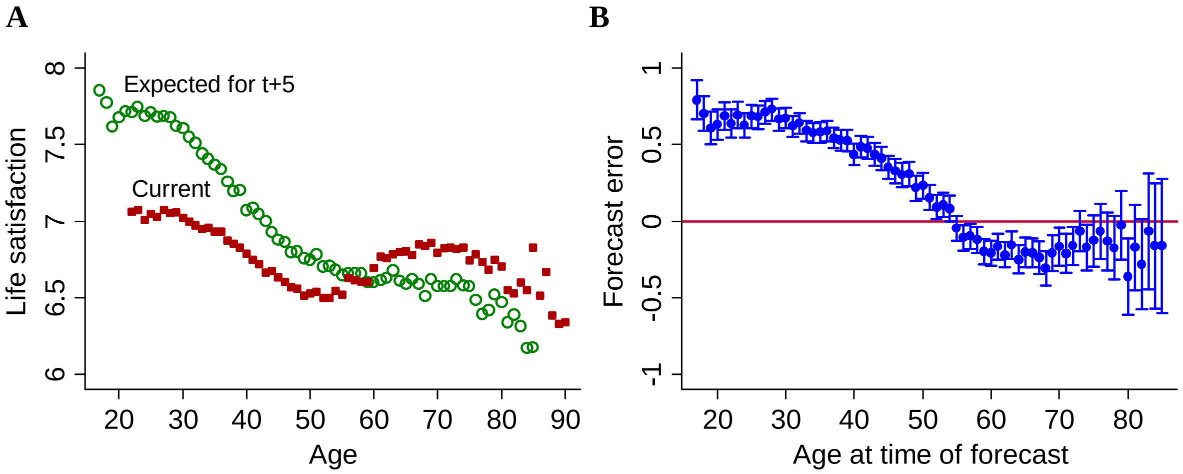
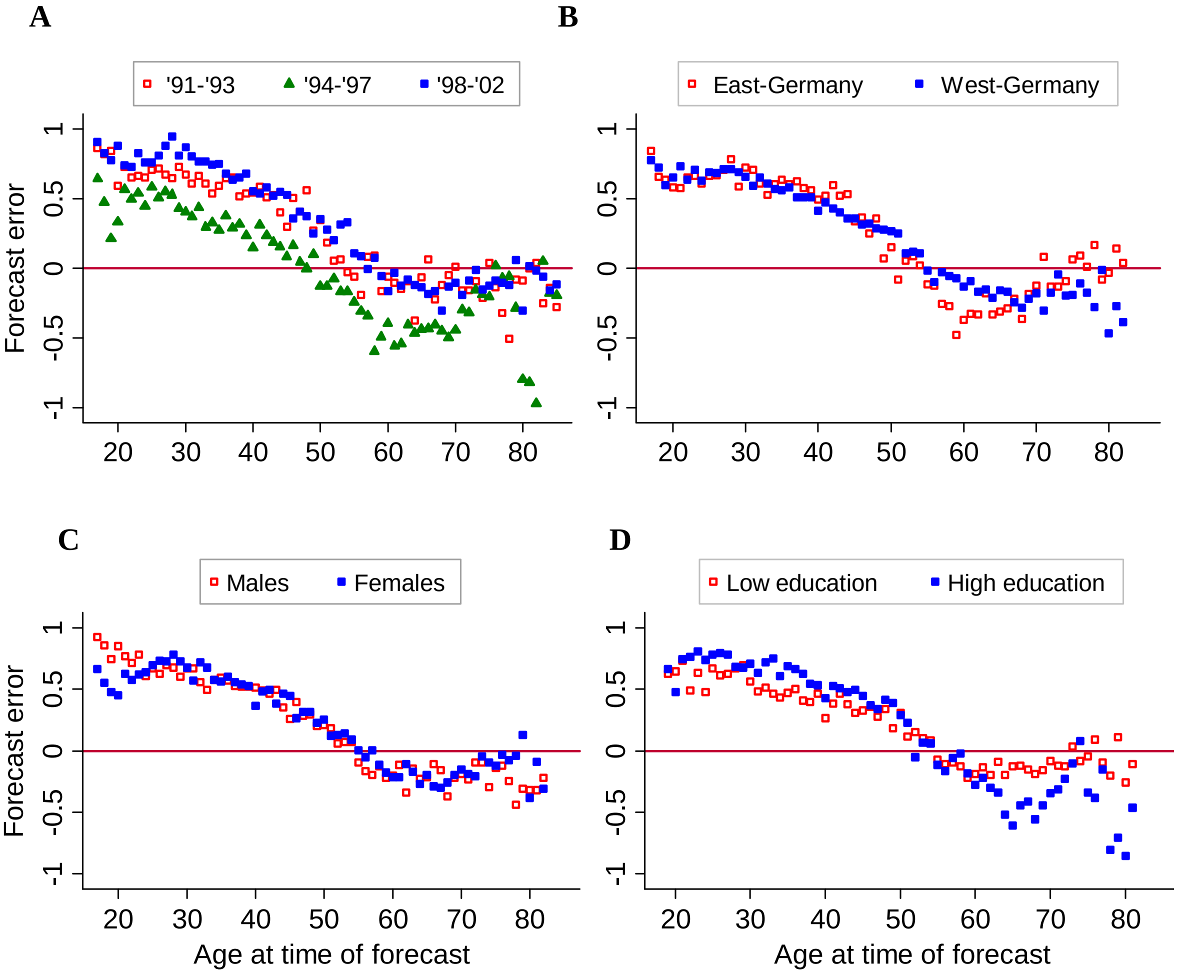
7. Figures and Tables

Figure 1. Expected life satisfaction, current life satisfaction and life satisfaction forecast errors over age.



Notes: Expected life satisfaction, current life satisfaction and life satisfaction forecast errors are plotted over age. **(A)** (o) Expectations about life satisfaction in five years averaged over age, ranging from age 17 to 85. Sample size is 132,609. (■) The same sample's average current life satisfaction at ages 22 to 90. Current and expected life satisfaction are coded for each individual from a scale of 0 (completely dissatisfied) to 10 (completely satisfied). **(B)** Individual forecast errors averaged over age at time of the forecast (●) with 95% confidence intervals (I), for the same sample as in (A). Individual forecast errors equal an individual's expected life satisfaction in five years minus the same person's current life satisfaction five years ahead. Numerical values corresponding to both figures are reported in the online appendix.

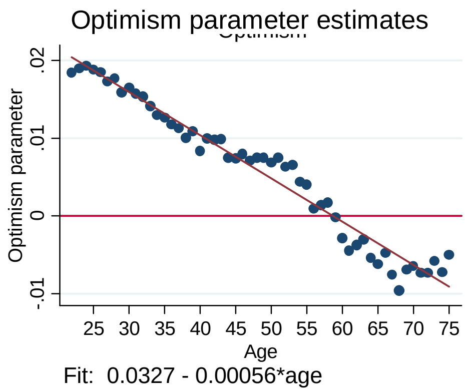
Figure 2. Life satisfaction forecast errors over age, by time periods, regions, gender and education.



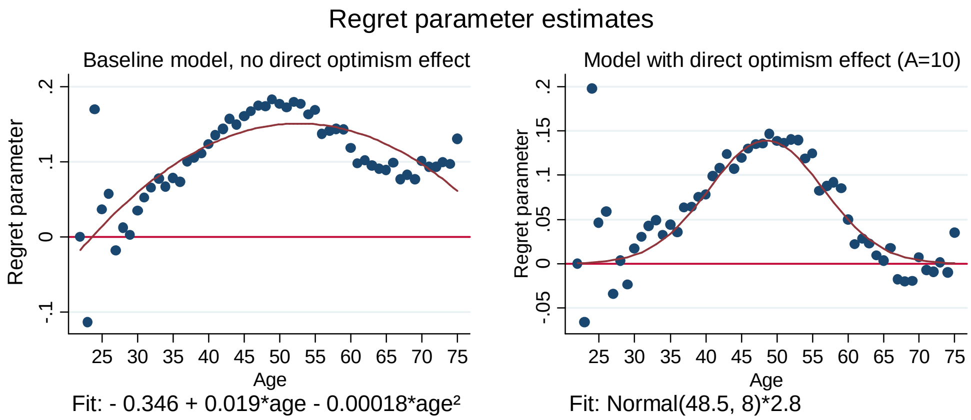
Notes: Life satisfaction forecast errors are plotted over age at the time of the forecast and **(A)** time periods, **(B)** regions, **(C)** gender, **(D)** education. Low education refers to less than 11 years of schooling and high education to more than 12.5 years. To keep figures reasonably scaled, ages above 82 are omitted in (A)-(C) and ages below 19 and above 81 in (D). Numerical values corresponding to these figures are reported in the online appendix.

Figure 3: Optimism and regret parameter estimates.

A



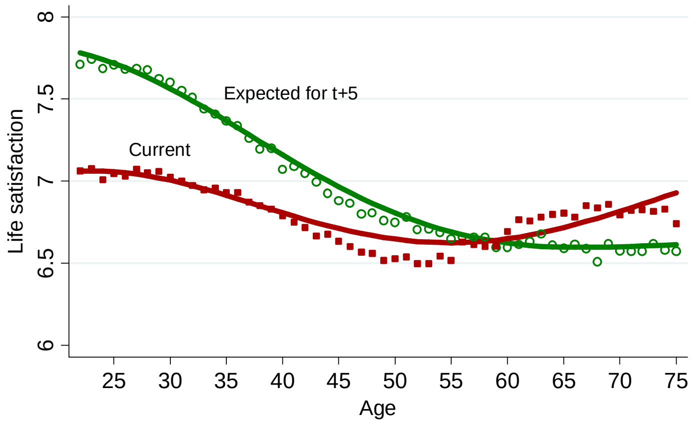
B



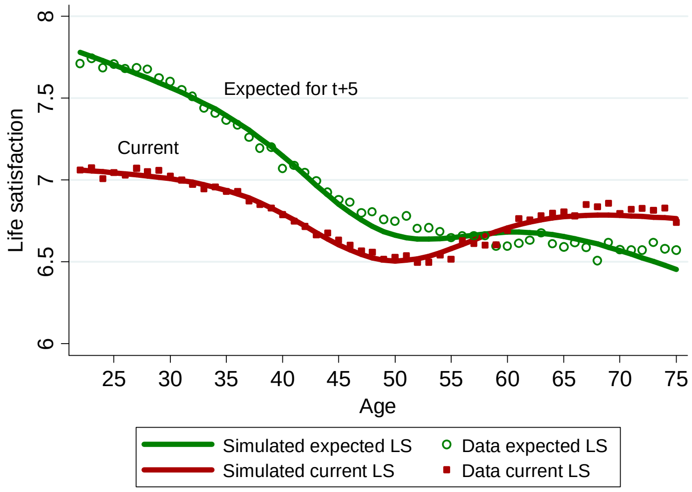
Notes: Optimism and regret parameters estimated through the "unmet aspirations" model are plotted by single years of age, for the ages 22 to 75. Optimism parameter values in panel **(A)** are obtained by solving eq. (2) for ω_t. Regret parameter values in panel **(B)** are obtained by solving eq. (5) for ρ_t with A=0 and A=10, respectively. LS_{t0} is set to average life satisfaction at age 22. One-year expectations are derived from five-year expectations in the SOEP data by linear interpolation. Alternatively, the model can be transformed into a five-year period model, with very similar results. Solid lines provide parametric fits.

Figure 4. Simulated and actual life satisfaction age profiles

A Baseline model, no direct optimism effect (*A=0*)



B Model with direct optimism effect (*A=10*)



Notes: Average current and expected life satisfaction is plotted by single years of age (dotted) along with simulated age profiles (solid lines). The simulation in panel **(A)** uses the linear and hump shaped fitted age profiles for optimism and regret shown in Figure 3, for the baseline model without a direct optimism effect. The simulation in panel **(B)** uses the linear and hump shaped fitted age profiles for optimism and regret shown in Figure 3, for the model with a direct optimism effect of *A=10*.

Table 1—Descriptive statistics

Variable	Mean	Std dev	Minimum	Maximum
Age	44.44	15.66	17	85
Male	0.48	0.50	0	1
East Germany	0.28	0.45	0	1
Low education	0.46	0.50	0	1
High education	0.31	0.46	0	1
Expected life satisfaction for t+5	7.07	1.87	0	10
Current life satisfaction in t+5	6.77	1.79	0	10
Forecast error	0.31	2.02	-10	10
Number of individuals	23,161			
Number of observations	132,609			

Notes: Low education refers to less than 11 years of schooling and high education to more than 12.5 years. The forecast error equals an individual's expected life satisfaction for t+5 minus the same individual's actual current life satisfaction in t+5.

Table 2—Regressions of forecast errors on age polynomials

Dependent variable: Average forecast errors over age	Sample period Overall 1991-2002 (1)	1991-1993 (2)	1994-1997 (3)	1998-2002 (4)
Age	0.110	0.087		
	(0.010)	(0.019)		
Age²/10	-0.029	-0.024		
	(0.002)	(0.004)		
Age³/1000	0.020	0.016		
	(0.002)	(0.002)		
Forecast errors predicted			1.057	1.120
by '91-'93 estimates (col. 2)			(0.045)	(0.025)
Constant	-0.528	-0.219	-0.296	0.035
	(0.139)	(0.261)	(0.021)	(0.012)
Adj. R²	0.972	0.900	0.891	0.967
N	69	69	69	69

Notes: OLS regressions of average forecast errors over age on third order age polynomials (col. 1 and 2) and on predicted '91-'97 forecast errors (col. 3 and 4). Regressions are weighted by the number of observations per year of age. Standard errors in parenthesis.

Table 3—T-tests for equality of mean forecast errors across subsamples.

Sample	Mean forecast error (1)	Std Err of the mean (2)	Difference in means (i)-(ii) (3)	t-stat of difference (4)	p-value (5)
a. Period 1 vs. 2					
(i) 1991-1993	0.388	0.012	0.287	17.96	<0.001
(ii) 1994-1997	0.101	0.010			
b. Period 3 vs. 2					
(i) 1998-2002	0.395	0.008	0.294	22.79	<0.001
(ii) 1994-1997	0.101	0.010			
c. Region, age < 55					
(i) East	0.493	0.013	-0.010	-0.656	0.512
(ii) West	0.502	0.007			
d. Region, age > 55					
(i) East	-0.239	0.021	-0.088	-3.638	<0.001
(ii) West	-0.151	0.013			
e. Gender, age < 55					
(i) Male	0.498	0.009	-0.004	-0.323	0.746
(ii) Female	0.502	0.009			
f. Gender, age > 55					
(i) Male	-0.201	0.016	-0.044	-2.018	0.044
(ii) Female	-0.156	0.015			
g. Education, age < 55					
(i) Low education	0.442	0.011	-0.116	-7.394	<0.001
(ii) High education	0.558	0.011			
h. Education, age > 55					
(i) Low education	-0.127	0.014	0.166	5.631	<0.001
(ii) High education	-0.293	0.026			

Notes: ' t-stat of difference' derived from two-sample t test with unequal variances. East and West refer to East-Germany and West-Germany. Low education refers to less than 11 years of schooling and high education to more than 12.5 years.

ONLINE APPENDIX
FOR

"Unmet Aspirations as an Explanation for the Age U-shape in Wellbeing"

Hannes Schwandt

November 2013

I. Appendix Figures

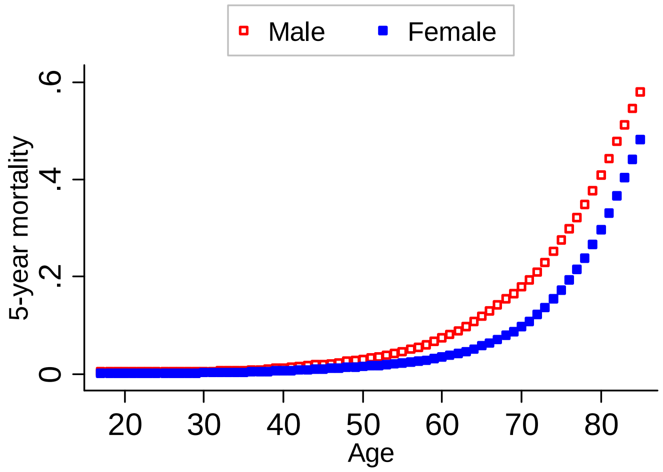
II. Appendix Tables

III. Model: Derivation of equation (3)

IV. Model: Regret parameter $\rho \to 1$ with time-varying current life circumstances

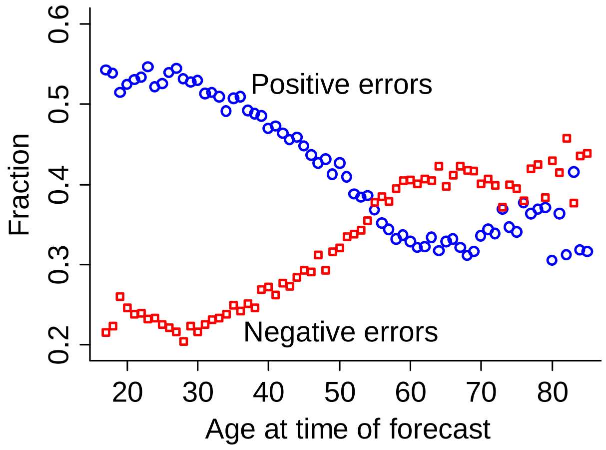
I. Appendix Figures

Figure A1: 5-year mortality rates over age by gender, Germany 1998/2000



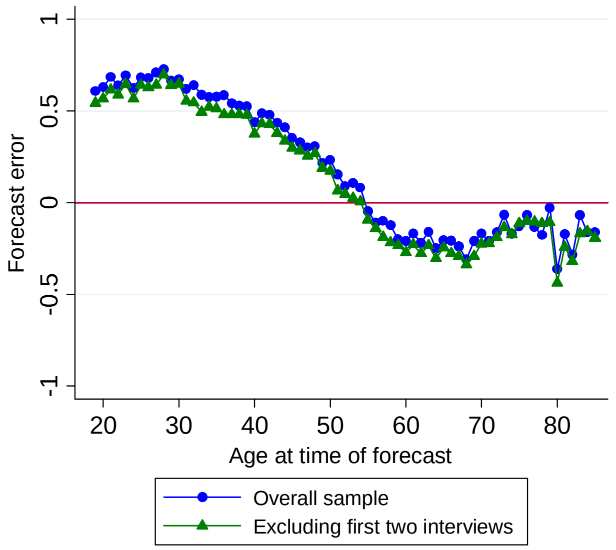
Notes: 5-year mortality rates are derived from life tables for Germany 1998/2000. Source: *Periodensterbetafeln für Deutschland - 1871/81 - 2008/10*, p. 271-274, downloadable at https://www.destatis.de/DE/Publikationen/Thematisch/Bevoelkerung/Bevoelkerungsbewegung/Periodensterbetafeln.html.

Figure A2. Binary indicators of positive and negative forecast errors over age.



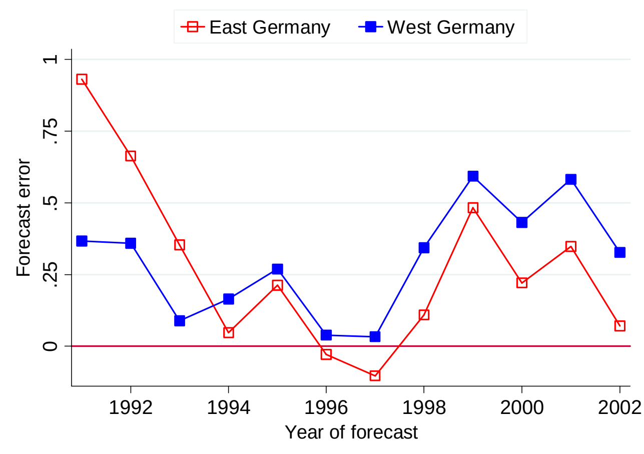
Notes: Fractions of people committing positive and negative errors plotted over age. For further comments see Figure 1. Corresponding numerical values are reported in the online appendix.

Figure A3: Forecast errors over Age, excluding first two interviews



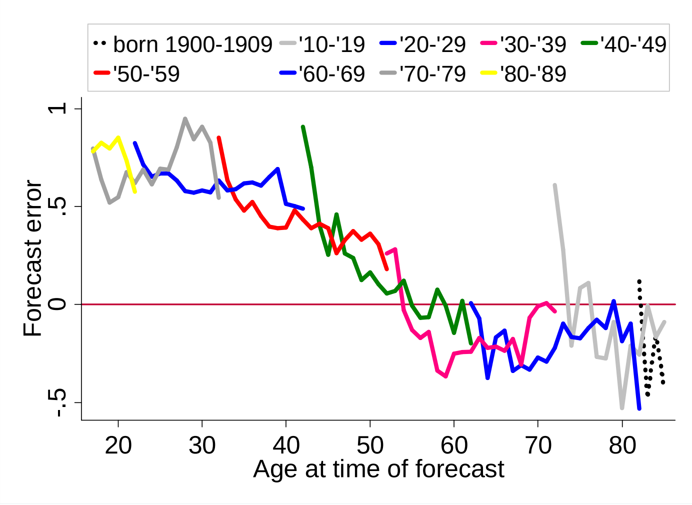
Notes: Average forecast errors over age are plotted for the overall sample and when excluding survey participants' first two interviews in the SOEP.

Figure A4: Forecast errors over time by region



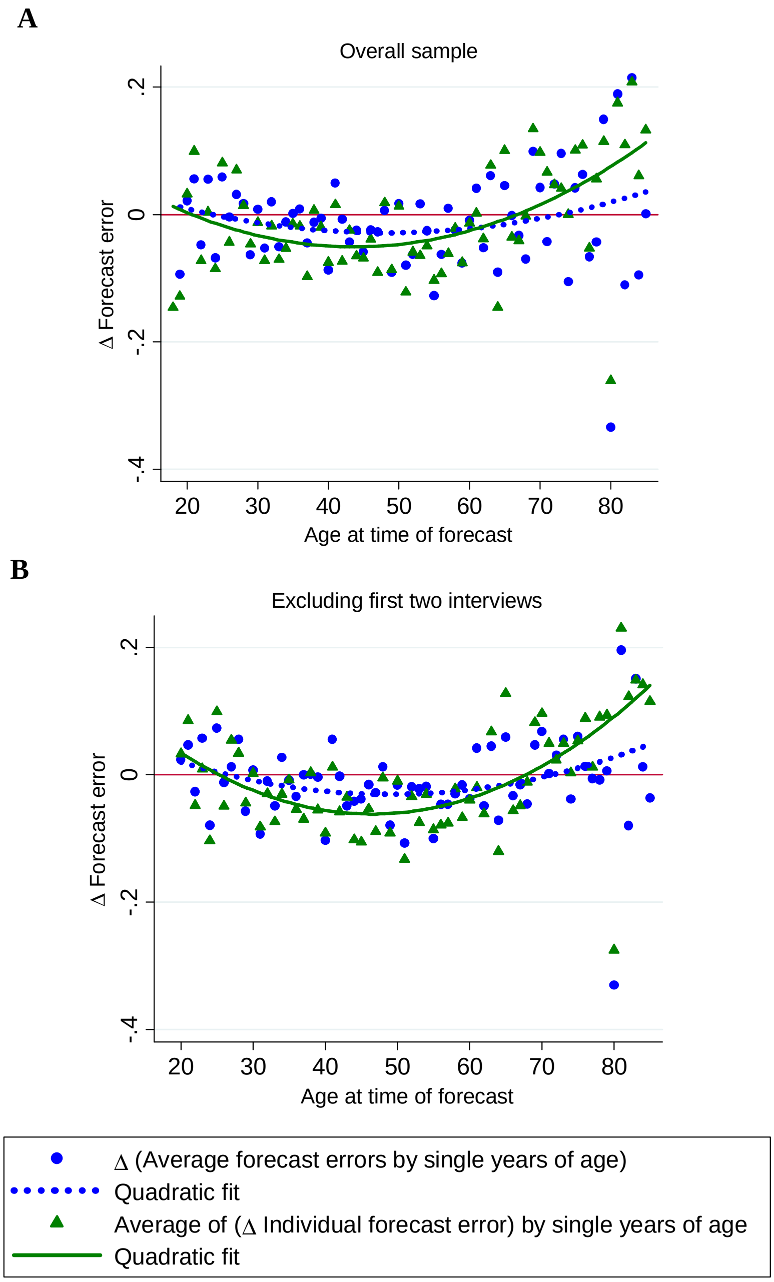
Notes: Average life satisfaction five-year forecast errors plotted by the year of the forecast separately for East and West Germany.

Figure A5. Forecast errors collapsed by age and birth cohort.



Notes: Average forecast errors over age plotted separately by 10-year birth cohorts. For further notes see Figure 1.

Figure A6: Changes in forecast errors over age



Notes: Circles display the change in average forecast errors over age, i.e. they are the year-to-year change in the age pattern shown in Figure 1B. The dotted line provides a quadratic fit and can be interpreted as the first derivative of the pattern in Figure 1B. Triangles represent the age average of individual first differences in forecast errors. For example, the triangle at age 40 is the change in forecast errors between age 39 and age 40 averaged over all people for which forecast errors are observed at ages 39 and 40.

Figure A8: Annual household income over age (25 to 70) by education

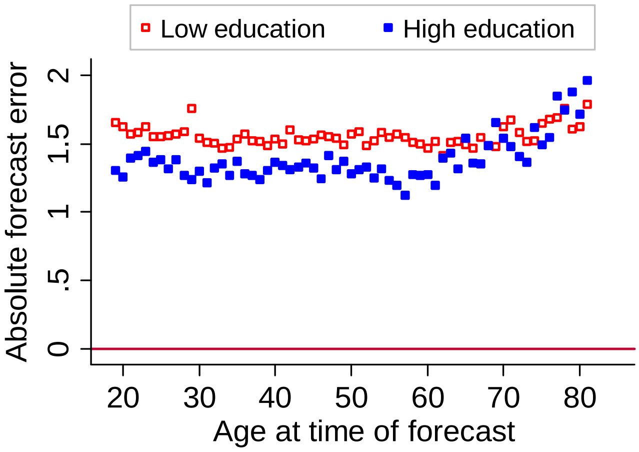
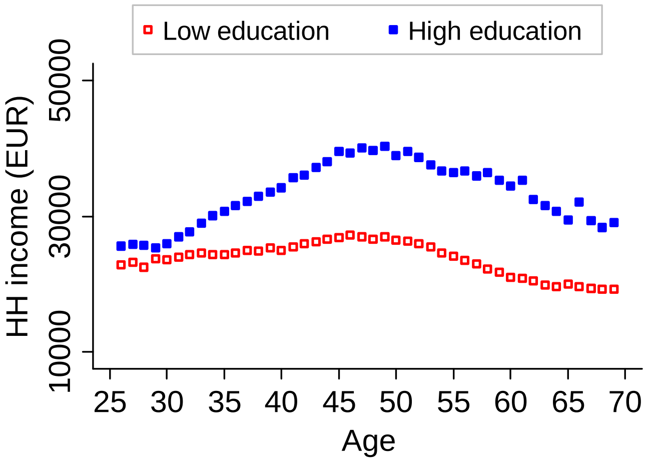


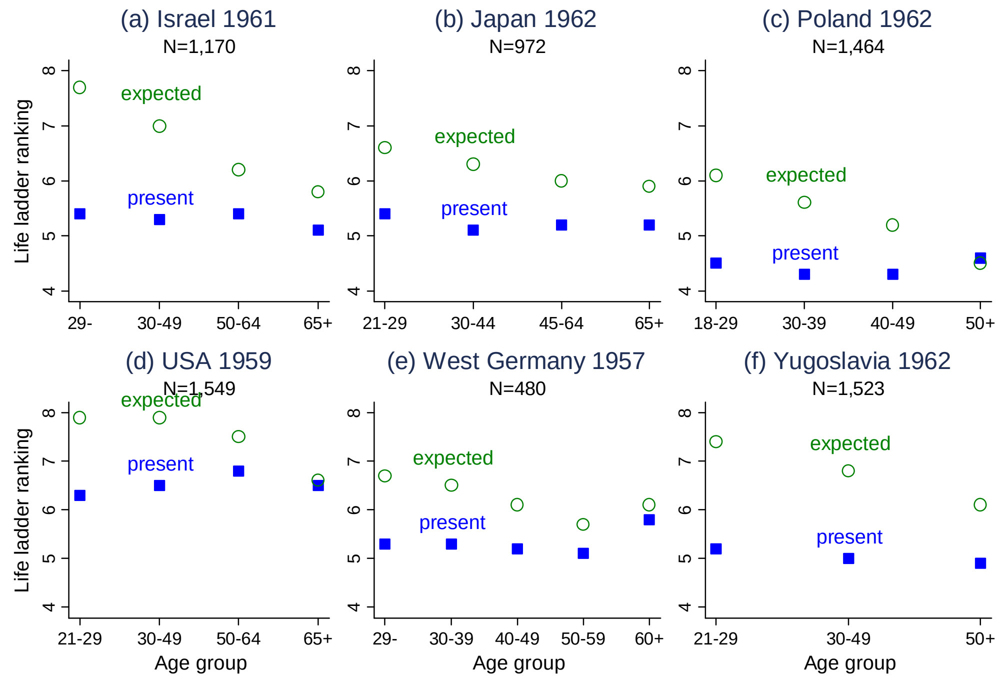
Figure A7. Absolute forecast errors over age by education.

Notes: Average *absolute* forecast errors over age by education. Forecast errors equal expected life satisfaction minus realized life satisfaction in t+5. Low education refers to less than 11 years of schooling and high education to more than 12.5 years. Corresponding numerical values are reported in the online appendix.



Notes: Average annual household income in nominal Euros over age by education. Low education refers to less than 11 years of schooling and high education to more than 12.5 years.

Figure A9: Cantril data on present and expected life ladder rankings in six developed countries around 1960.



Data source: Cantril (1965), pp. 365-77.

Notes: Average expected and present life ladder rankings by age groups in six developed countries are suggestive of a strongly positive expectation bias in young adulthood which decreases with age. There is little evidence of an age U-shape in life ladder rankings and of negative forecast errors in old age. This could be due to (i) the particular wellbeing measure used, (ii) time effects common to these countries around 1960 or (iii) the small sample size which might hide minor patterns. Notice that the data come from a single cross-section so that these pattern are not definitve evidence of about actual forecast errors. The numbers underlying these figures are taken from Cantril (1965), pp. 365-377.

For a further description and an insightful interpretation of these data see Easterlin (2001). Easterlin interprets the gap between expected and present life ladder ranking with misprediction of hedonic adaptation to income. People do not foresee that their aspiriations increase over age along with their incomes so that they expect to have higher rankings in the future while actual life ladder rankings remain constant.

The exact wording of the life ladder ranking question is:
"Please imagine a ladder with steps numbered from zero at the bottom to 10 at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you.
- On which step of the ladder would you say you personally feel you stand at this time?- On which step do you think you will stand about five years from now? "

II. Online Appendix Tables

Table A1. Means of expected and current life satisfaction and forecast errors over age with standard errors (numerical values underlying Fig. 1)

	Expected life satisfaction for t+5		Current life satisfaction		Forecast error (=Expected-Current[t+5])		
	Mean	SE(mean)	Mean	SE(mean)	Mean	SE(mean)	Mean/Current[t+5]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
age=17	7.854	0.050	-	-	0.792	0.065	0.112
age=18	7.777	0.045	-	-	0.702	0.058	0.099
age=19	7.616	0.044	-	-	0.608	0.055	0.087
age=20	7.677	0.041	-	-	0.630	0.051	0.089
age=21	7.715	0.039	-	-	0.685	0.047	0.098
age=22	7.711	0.037	7.062	0.054	0.638	0.047	0.090
age=23	7.745	0.034	7.075	0.045	0.693	0.044	0.098
age=24	7.684	0.034	7.008	0.043	0.625	0.041	0.089
age=25	7.709	0.033	7.047	0.041	0.684	0.040	0.097
age=26	7.679	0.032	7.029	0.039	0.680	0.039	0.097
age=27	7.685	0.031	7.073	0.037	0.711	0.038	0.102
age=28	7.676	0.030	7.052	0.035	0.728	0.036	0.105
age=29	7.623	0.031	7.059	0.035	0.665	0.037	0.096
age=30	7.604	0.029	7.025	0.034	0.673	0.035	0.097
age=31	7.552	0.029	7.000	0.033	0.620	0.034	0.089
age=32	7.511	0.030	6.974	0.032	0.640	0.034	0.093
age=33	7.440	0.031	6.948	0.031	0.589	0.034	0.086
age=34	7.406	0.030	6.957	0.031	0.577	0.033	0.085
age=35	7.368	0.031	6.930	0.032	0.579	0.035	0.085
age=36	7.338	0.030	6.932	0.030	0.587	0.034	0.087
age=37	7.259	0.031	6.871	0.031	0.542	0.034	0.081
age=38	7.196	0.032	6.851	0.031	0.530	0.034	0.080
age=39	7.200	0.032	6.829	0.031	0.524	0.035	0.079
age=40	7.072	0.033	6.789	0.031	0.437	0.036	0.066
age=41	7.088	0.033	6.750	0.031	0.486	0.036	0.074
age=42	7.046	0.034	6.717	0.031	0.479	0.038	0.073
age=43	6.996	0.035	6.666	0.032	0.436	0.037	0.066
age=44	6.927	0.036	6.676	0.033	0.411	0.039	0.063
age=45	6.880	0.037	6.634	0.033	0.352	0.039	0.054
age=46	6.865	0.038	6.601	0.034	0.328	0.040	0.050
age=47	6.800	0.039	6.567	0.035	0.301	0.041	0.046
age=48	6.804	0.039	6.560	0.035	0.307	0.041	0.047
age=49	6.760	0.040	6.516	0.036	0.216	0.042	0.033
age=50	6.750	0.040	6.528	0.037	0.233	0.043	0.036
age=51	6.782	0.040	6.537	0.038	0.153	0.042	0.023
age=52	6.704	0.040	6.499	0.039	0.090	0.040	0.014
age=53	6.709	0.040	6.498	0.038	0.107	0.041	0.016
age=54	6.686	0.041	6.544	0.038	0.082	0.043	0.012
age=55	6.648	0.041	6.517	0.038	-0.046	0.041	-0.007
age=56	6.658	0.041	6.629	0.037	-0.108	0.043	-0.016
age=57	6.658	0.040	6.614	0.038	-0.099	0.042	-0.015
age=58	6.659	0.041	6.602	0.038	-0.123	0.042	-0.018

age=59	6.598	0.042	6.604	0.038	-0.199	0.042	-0.029
age=60	6.597	0.042	6.694	0.037	-0.208	0.041	-0.031
age=61	6.614	0.042	6.767	0.037	-0.167	0.043	-0.025
age=62	6.631	0.043	6.757	0.036	-0.220	0.042	-0.032
age=63	6.679	0.045	6.781	0.037	-0.159	0.046	-0.023
age=64	6.610	0.046	6.797	0.037	-0.249	0.047	-0.036
age=65	6.591	0.049	6.805	0.037	-0.204	0.050	-0.030
age=66	6.617	0.049	6.781	0.038	-0.206	0.049	-0.030
age=67	6.589	0.051	6.850	0.038	-0.239	0.055	-0.035
age=68	6.508	0.053	6.837	0.042	-0.308	0.057	-0.045
age=69	6.619	0.057	6.860	0.042	-0.209	0.060	-0.031
age=70	6.575	0.059	6.795	0.045	-0.167	0.063	-0.025
age=71	6.572	0.061	6.823	0.045	-0.209	0.066	-0.031
age=72	6.574	0.063	6.827	0.049	-0.161	0.064	-0.024
age=73	6.617	0.069	6.816	0.052	-0.065	0.068	-0.010
age=74	6.580	0.070	6.828	0.055	-0.171	0.076	-0.025
age=75	6.572	0.077	6.742	0.058	-0.129	0.084	-0.019
age=76	6.484	0.081	6.781	0.060	-0.067	0.092	-0.010
age=77	6.394	0.087	6.736	0.061	-0.133	0.097	-0.020
age=78	6.420	0.098	6.682	0.066	-0.176	0.106	-0.027
age=79	6.521	0.103	6.751	0.070	-0.027	0.115	-0.004
age=80	6.467	0.118	6.702	0.076	-0.361	0.127	-0.053
age=81	6.340	0.126	6.550	0.082	-0.172	0.142	-0.026
age=82	6.389	0.146	6.527	0.090	-0.282	0.150	-0.042
age=83	6.315	0.172	6.597	0.095	-0.067	0.193	-0.011
age=84	6.169	0.189	6.548	0.106	-0.162	0.208	-0.026
age=85	6.177	0.186	6.828	0.106	-0.162	0.223	-0.025
age=86	-	-	6.512	0.129	-	-	-
age=87	-	-	6.671	0.141	-	-	-
age=88	-	-	6.382	0.148	-	-	-
age=89	-	-	6.331	0.180	-	-	-
age=90	-	-	6.338	0.199	-	-	-
overall N	132,609		132,609		132,609		

Table A2. Means of forecast errors over age and time/region with standard errors (numerical values underlying Fig. 3, panel A and B)

Sample	Forecast error									
	1991-1993		1994-1997		1998-2002		East-Germany		West-Germany	
	Mean (1)	SE(mean) (2)	Mean (3)	SE(mean) (4)	Mean (5)	SE(mean) (6)	Mean (7)	SE(mean) (8)	Mean (9)	SE(mean) (10)
age=17	0.865	0.113	0.643	0.098	0.906	0.131	0.839	0.136	0.774	0.073
age=18	0.821	0.104	0.473	0.092	0.826	0.102	0.654	0.109	0.722	0.068
age=19	0.842	0.106	0.212	0.092	0.775	0.086	0.634	0.105	0.598	0.064
age=20	0.593	0.091	0.331	0.093	0.882	0.081	0.579	0.103	0.651	0.059
age=21	0.726	0.088	0.567	0.084	0.742	0.073	0.574	0.088	0.731	0.055
age=22	0.652	0.081	0.495	0.091	0.730	0.072	0.649	0.089	0.634	0.055
age=23	0.665	0.081	0.541	0.079	0.824	0.069	0.662	0.078	0.704	0.052
age=24	0.651	0.076	0.447	0.072	0.760	0.065	0.608	0.082	0.631	0.047
age=25	0.705	0.074	0.583	0.067	0.763	0.066	0.661	0.079	0.691	0.046
age=26	0.720	0.073	0.507	0.066	0.810	0.064	0.667	0.080	0.684	0.045
age=27	0.676	0.076	0.550	0.062	0.881	0.062	0.705	0.080	0.713	0.043
age=28	0.647	0.075	0.526	0.063	0.947	0.053	0.782	0.075	0.713	0.041
age=29	0.731	0.081	0.430	0.064	0.808	0.053	0.588	0.078	0.688	0.042
age=30	0.674	0.076	0.403	0.059	0.871	0.052	0.723	0.075	0.657	0.039
age=31	0.610	0.077	0.373	0.059	0.805	0.049	0.707	0.073	0.592	0.039
age=32	0.662	0.078	0.436	0.062	0.766	0.048	0.607	0.073	0.651	0.039
age=33	0.608	0.076	0.295	0.062	0.768	0.049	0.528	0.074	0.609	0.039
age=34	0.536	0.073	0.328	0.060	0.744	0.047	0.603	0.067	0.569	0.038
age=35	0.592	0.078	0.274	0.066	0.749	0.048	0.634	0.068	0.558	0.041
age=36	0.648	0.078	0.375	0.065	0.680	0.046	0.605	0.066	0.581	0.040
age=37	0.651	0.081	0.291	0.065	0.635	0.045	0.621	0.066	0.511	0.040
age=38	0.517	0.082	0.318	0.063	0.650	0.047	0.575	0.066	0.512	0.040
age=39	0.536	0.083	0.236	0.066	0.682	0.048	0.557	0.069	0.511	0.041
age=40	0.545	0.086	0.148	0.067	0.557	0.050	0.494	0.068	0.412	0.043
age=41	0.587	0.083	0.309	0.072	0.537	0.048	0.522	0.068	0.470	0.043
age=42	0.509	0.080	0.237	0.077	0.583	0.051	0.599	0.070	0.426	0.044
age=43	0.526	0.079	0.187	0.075	0.521	0.051	0.522	0.070	0.399	0.044
age=44	0.405	0.085	0.154	0.077	0.549	0.054	0.531	0.075	0.360	0.046
age=45	0.298	0.099	0.080	0.070	0.526	0.052	0.336	0.074	0.359	0.046
age=46	0.508	0.098	0.167	0.073	0.359	0.055	0.360	0.080	0.315	0.047
age=47	0.407	0.097	0.046	0.078	0.408	0.055	0.251	0.078	0.321	0.048
age=48	0.562	0.095	-0.002	0.080	0.373	0.055	0.359	0.078	0.285	0.048
age=49	0.272	0.089	0.097	0.087	0.248	0.057	0.067	0.084	0.275	0.048
age=50	0.350	0.091	-0.130	0.088	0.355	0.057	0.150	0.079	0.268	0.050
age=51	0.183	0.085	-0.129	0.088	0.276	0.056	-0.083	0.082	0.248	0.048
age=52	0.052	0.087	-0.075	0.080	0.199	0.054	0.051	0.084	0.106	0.046
age=53	0.065	0.083	-0.166	0.076	0.313	0.059	0.084	0.084	0.117	0.046
age=54	-0.030	0.088	-0.165	0.075	0.330	0.063	0.019	0.080	0.107	0.050
age=55	-0.059	0.087	-0.242	0.076	0.109	0.057	-0.115	0.079	-0.016	0.048
age=56	-0.188	0.093	-0.307	0.076	0.086	0.061	-0.127	0.081	-0.100	0.050
age=57	0.083	0.100	-0.339	0.072	-0.006	0.060	-0.256	0.074	-0.028	0.051
age=58	0.089	0.114	-0.596	0.078	0.077	0.054	-0.273	0.077	-0.054	0.051
age=59	-0.162	0.108	-0.495	0.082	-0.057	0.054	-0.481	0.080	-0.071	0.049
age=60	-0.058	0.109	-0.398	0.085	-0.166	0.052	-0.372	0.075	-0.133	0.050
age=61	-0.105	0.115	-0.556	0.092	-0.033	0.053	-0.326	0.074	-0.094	0.053

age=62	-0.148	0.100	-0.540	0.095	-0.123	0.053	-0.333	0.073	-0.167	0.052
age=63	-0.093	0.107	-0.405	0.094	-0.081	0.060	-0.178	0.081	-0.151	0.056
age=64	-0.377	0.111	-0.468	0.092	-0.119	0.061	-0.332	0.084	-0.212	0.056
age=65	-0.066	0.117	-0.437	0.095	-0.138	0.068	-0.310	0.091	-0.158	0.060
age=66	0.064	0.113	-0.432	0.099	-0.183	0.064	-0.288	0.092	-0.171	0.057
age=67	-0.223	0.138	-0.405	0.102	-0.162	0.073	-0.220	0.105	-0.246	0.064
age=68	-0.119	0.139	-0.452	0.109	-0.307	0.075	-0.367	0.106	-0.284	0.067
age=69	-0.051	0.149	-0.498	0.110	-0.129	0.080	-0.187	0.125	-0.217	0.068
age=70	0.013	0.147	-0.446	0.122	-0.104	0.084	-0.126	0.120	-0.181	0.074
age=71	-0.156	0.156	-0.299	0.123	-0.188	0.089	0.082	0.128	-0.307	0.076
age=72	-0.158	0.174	-0.317	0.127	-0.086	0.080	-0.129	0.132	-0.172	0.073
age=73	-0.092	0.208	-0.156	0.129	-0.012	0.085	-0.133	0.128	-0.042	0.080
age=74	-0.211	0.259	-0.187	0.145	-0.155	0.093	-0.095	0.140	-0.196	0.090
age=75	0.038	0.236	-0.205	0.173	-0.126	0.105	0.065	0.169	-0.190	0.097
age=76	-0.135	0.248	0.020	0.198	-0.085	0.113	0.089	0.189	-0.110	0.105
age=77	-0.322	0.301	-0.071	0.213	-0.105	0.114	0.008	0.162	-0.176	0.117
age=78	-0.506	0.242	-0.060	0.277	-0.122	0.128	0.170	0.213	-0.280	0.121
age=79	-0.083	0.250	-0.284	0.276	0.061	0.145	-0.084	0.256	-0.010	0.128
age=80	-0.088	0.277	-0.797	0.284	-0.303	0.165	-0.036	0.252	-0.469	0.147
age=81	0.000	0.305	-0.818	0.304	0.018	0.186	0.139	0.287	-0.271	0.163
age=82	0.036	0.257	-0.971	0.290	-0.018	0.224	0.034	0.266	-0.386	0.179
age=83	-0.250	0.437	0.052	0.329	-0.063	0.286	0.171	0.483	-0.139	0.206
age=84	-0.143	0.597	-0.176	0.347	-0.160	0.282	-0.441	0.412	-0.083	0.240
age=85	-0.278	0.718	-0.195	0.344	-0.113	0.312	-0.875	0.460	0.000	0.252
overall N	29,309		38,347		64,953		37,070		95,539	

Table A3. Means of forecast errors over age and gender/education with standard errors (numerical values underlying Fig. 3, panel C and D)

Sample	Forecast error							
	Male		Female		Low education		High education	
	Mean (1)	SE(mean) (2)	Mean (3)	SE(mean) (4)	Mean (5)	SE(mean) (6)	Mean (7)	SE(mean) (8)
age=17	0.927	0.091	0.663	0.092	0.804	0.065		
age=18	0.855	0.080	0.553	0.082	0.715	0.059	0.500	0.866
age=19	0.746	0.078	0.477	0.077	0.625	0.059	0.667	0.201
age=20	0.852	0.080	0.450	0.065	0.646	0.064	0.477	0.111
age=21	0.770	0.073	0.627	0.061	0.730	0.068	0.745	0.088
age=22	0.714	0.070	0.578	0.062	0.488	0.075	0.765	0.078
age=23	0.785	0.065	0.619	0.059	0.631	0.075	0.806	0.073
age=24	0.607	0.061	0.640	0.055	0.476	0.073	0.740	0.071
age=25	0.670	0.058	0.696	0.054	0.672	0.071	0.784	0.069
age=26	0.625	0.055	0.730	0.055	0.615	0.069	0.795	0.063
age=27	0.694	0.056	0.727	0.052	0.626	0.068	0.779	0.066
age=28	0.674	0.052	0.779	0.050	0.668	0.066	0.682	0.060
age=29	0.601	0.053	0.726	0.051	0.698	0.074	0.678	0.058
age=30	0.670	0.049	0.676	0.050	0.565	0.066	0.709	0.058
age=31	0.671	0.050	0.571	0.047	0.483	0.067	0.633	0.055
age=32	0.560	0.048	0.719	0.049	0.512	0.065	0.719	0.060
age=33	0.496	0.048	0.679	0.049	0.464	0.065	0.754	0.059
age=34	0.576	0.048	0.578	0.046	0.434	0.066	0.610	0.056
age=35	0.595	0.049	0.564	0.050	0.473	0.067	0.687	0.060
age=36	0.570	0.049	0.604	0.047	0.504	0.069	0.663	0.054
age=37	0.529	0.049	0.556	0.048	0.408	0.066	0.627	0.056
age=38	0.518	0.047	0.542	0.049	0.398	0.066	0.544	0.056
age=39	0.522	0.050	0.526	0.049	0.461	0.063	0.532	0.061
age=40	0.515	0.052	0.367	0.051	0.263	0.067	0.429	0.063
age=41	0.490	0.053	0.483	0.050	0.382	0.064	0.529	0.066
age=42	0.462	0.055	0.494	0.051	0.467	0.069	0.510	0.066
age=43	0.496	0.054	0.382	0.051	0.379	0.066	0.475	0.067
age=44	0.352	0.058	0.463	0.053	0.312	0.065	0.493	0.071
age=45	0.256	0.055	0.444	0.055	0.325	0.064	0.448	0.071
age=46	0.396	0.057	0.263	0.057	0.358	0.068	0.369	0.072
age=47	0.286	0.058	0.315	0.058	0.275	0.066	0.341	0.077
age=48	0.297	0.059	0.316	0.057	0.341	0.066	0.416	0.075
age=49	0.204	0.060	0.227	0.058	0.181	0.064	0.387	0.082
age=50	0.211	0.061	0.254	0.059	0.309	0.063	0.291	0.077
age=51	0.183	0.058	0.124	0.060	0.114	0.063	0.230	0.079
age=52	0.058	0.055	0.125	0.059	0.151	0.059	-0.051	0.083
age=53	0.075	0.057	0.140	0.059	0.106	0.059	0.066	0.084
age=54	0.073	0.061	0.090	0.060	0.087	0.061	0.060	0.086
age=55	-0.093	0.058	0.004	0.058	-0.069	0.058	-0.113	0.083
age=56	-0.162	0.059	-0.053	0.061	-0.107	0.060	-0.167	0.084
age=57	-0.198	0.057	0.005	0.062	-0.098	0.058	-0.059	0.079
age=58	-0.130	0.059	-0.116	0.061	-0.126	0.058	-0.022	0.094
age=59	-0.223	0.060	-0.175	0.059	-0.223	0.056	-0.183	0.089
age=60	-0.201	0.060	-0.216	0.057	-0.188	0.056	-0.274	0.092
age=61	-0.116	0.062	-0.215	0.061	-0.135	0.057	-0.221	0.091

age=62	-0.341	0.062	-0.107	0.057	-0.197	0.054	-0.300	0.103
age=63	-0.147	0.064	-0.169	0.066	-0.088	0.059	-0.341	0.119
age=64	-0.228	0.066	-0.268	0.066	-0.194	0.061	-0.520	0.104
age=65	-0.214	0.075	-0.195	0.067	-0.126	0.064	-0.606	0.132
age=66	-0.111	0.070	-0.290	0.068	-0.121	0.064	-0.445	0.116
age=67	-0.158	0.079	-0.304	0.075	-0.153	0.070	-0.416	0.134
age=68	-0.369	0.081	-0.259	0.079	-0.187	0.071	-0.554	0.145
age=69	-0.222	0.093	-0.198	0.078	-0.160	0.076	-0.444	0.156
age=70	-0.187	0.096	-0.151	0.083	-0.081	0.082	-0.348	0.158
age=71	-0.233	0.096	-0.192	0.090	-0.123	0.084	-0.313	0.151
age=72	-0.097	0.096	-0.206	0.086	-0.127	0.081	-0.227	0.168
age=73	-0.096	0.104	-0.045	0.090	0.037	0.087	-0.099	0.161
age=74	-0.292	0.122	-0.094	0.097	-0.082	0.093	0.076	0.219
age=75	-0.142	0.135	-0.122	0.108	-0.049	0.109	-0.337	0.218
age=76	-0.122	0.153	-0.036	0.115	0.088	0.114	-0.380	0.238
age=77	-0.249	0.138	-0.077	0.128	-0.095	0.119	-0.153	0.317
age=78	-0.436	0.173	-0.043	0.132	-0.204	0.129	-0.809	0.345
age=79	-0.308	0.193	0.125	0.142	0.110	0.129	-0.707	0.386
age=80	-0.320	0.178	-0.384	0.172	-0.259	0.155	-0.857	0.394
age=81	-0.320	0.200	-0.093	0.190	-0.111	0.167	-0.464	0.505
age=82	-0.222	0.267	-0.309	0.182	-0.311	0.187	-0.947	0.449
age=83	-0.385	0.417	0.063	0.212	0.137	0.238	-1.250	0.674
age=84	-0.705	0.367	0.055	0.249	0.218	0.271	-0.600	0.779
age=85	-0.444	0.379	-0.053	0.273	0.023	0.282	-0.636	0.717
overall N	63,108		69,501		60,865		30,044	

Table A4. Means of absolute and binary forecast errors over age with standard errors (Fig. 2 and 4)

	Absolute forecast errors				Binary indicator of positive errors		Binary indicator of negative errors	
	Low education		High education					
	Mean	SE(mean)	Mean	SE(mean)	Mean	SE(mean)	Mean	SE(mean)
	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)
age=17	1.593	0.048			0.542	0.016	0.215	0.013
age=18	1.625	0.042	1.500	0.289	0.539	0.014	0.223	0.011
age=19	1.655	0.042	1.307	0.153	0.514	0.013	0.260	0.011
age=20	1.623	0.045	1.253	0.082	0.524	0.013	0.246	0.011
age=21	1.573	0.048	1.397	0.066	0.530	0.012	0.238	0.010
age=22	1.583	0.052	1.415	0.058	0.533	0.012	0.239	0.010
age=23	1.624	0.053	1.441	0.054	0.546	0.011	0.232	0.009
age=24	1.552	0.051	1.368	0.054	0.521	0.011	0.233	0.009
age=25	1.551	0.051	1.383	0.052	0.525	0.010	0.225	0.009
age=26	1.560	0.048	1.317	0.048	0.539	0.010	0.221	0.008
age=27	1.571	0.049	1.383	0.051	0.544	0.010	0.216	0.008
age=28	1.589	0.046	1.271	0.046	0.531	0.009	0.204	0.008
age=29	1.756	0.053	1.238	0.044	0.527	0.009	0.223	0.008
age=30	1.540	0.047	1.296	0.045	0.529	0.009	0.216	0.008
age=31	1.510	0.047	1.213	0.041	0.513	0.009	0.225	0.008
age=32	1.503	0.045	1.321	0.047	0.515	0.009	0.231	0.008
age=33	1.469	0.046	1.352	0.046	0.509	0.009	0.233	0.008
age=34	1.477	0.047	1.267	0.042	0.492	0.009	0.238	0.008
age=35	1.536	0.047	1.372	0.045	0.507	0.009	0.249	0.008
age=36	1.568	0.048	1.282	0.040	0.509	0.009	0.242	0.008
age=37	1.521	0.046	1.271	0.042	0.492	0.009	0.250	0.008
age=38	1.515	0.045	1.237	0.042	0.489	0.009	0.246	0.008
age=39	1.488	0.043	1.302	0.045	0.485	0.009	0.268	0.008
age=40	1.535	0.045	1.362	0.043	0.469	0.009	0.272	0.008
age=41	1.498	0.045	1.340	0.050	0.472	0.009	0.262	0.008
age=42	1.603	0.048	1.312	0.050	0.463	0.009	0.277	0.008
age=43	1.531	0.046	1.326	0.048	0.455	0.009	0.273	0.008
age=44	1.521	0.045	1.361	0.052	0.459	0.010	0.284	0.009
age=45	1.536	0.044	1.320	0.052	0.448	0.010	0.293	0.009
age=46	1.567	0.048	1.243	0.054	0.436	0.010	0.291	0.009
age=47	1.555	0.045	1.412	0.054	0.427	0.010	0.312	0.009
age=48	1.543	0.046	1.312	0.054	0.431	0.010	0.293	0.009
age=49	1.492	0.044	1.373	0.060	0.413	0.010	0.315	0.010
age=50	1.571	0.042	1.283	0.053	0.427	0.010	0.321	0.010
age=51	1.590	0.043	1.311	0.056	0.409	0.010	0.335	0.010
age=52	1.488	0.041	1.329	0.059	0.387	0.010	0.338	0.010
age=53	1.522	0.039	1.250	0.062	0.383	0.010	0.343	0.010
age=54	1.586	0.042	1.319	0.060	0.385	0.010	0.355	0.010
age=55	1.549	0.039	1.233	0.059	0.368	0.010	0.377	0.010
age=56	1.574	0.040	1.195	0.061	0.352	0.010	0.385	0.010
age=57	1.547	0.039	1.125	0.057	0.344	0.010	0.379	0.010
age=58	1.510	0.040	1.276	0.070	0.331	0.010	0.395	0.010
age=59	1.498	0.039	1.266	0.063	0.337	0.010	0.405	0.010
age=60	1.468	0.038	1.274	0.067	0.329	0.010	0.405	0.010
age=61	1.516	0.039	1.193	0.067	0.321	0.010	0.401	0.010

age=62	1.416	0.038	1.393	0.072	0.322	0.010	0.407	0.011
age=63	1.513	0.040	1.431	0.087	0.334	0.011	0.404	0.011
age=64	1.519	0.042	1.315	0.075	0.317	0.011	0.422	0.012
age=65	1.495	0.044	1.538	0.097	0.329	0.012	0.398	0.012
age=66	1.470	0.043	1.360	0.080	0.332	0.012	0.412	0.012
age=67	1.545	0.048	1.354	0.099	0.320	0.012	0.422	0.013
age=68	1.489	0.049	1.487	0.106	0.310	0.013	0.417	0.014
age=69	1.483	0.053	1.657	0.099	0.316	0.013	0.416	0.014
age=70	1.627	0.056	1.540	0.105	0.336	0.014	0.401	0.014
age=71	1.674	0.056	1.482	0.100	0.344	0.014	0.406	0.015
age=72	1.582	0.053	1.404	0.120	0.339	0.015	0.399	0.015
age=73	1.514	0.059	1.366	0.108	0.368	0.016	0.372	0.016
age=74	1.523	0.064	1.619	0.150	0.347	0.017	0.400	0.018
age=75	1.647	0.076	1.495	0.158	0.341	0.018	0.395	0.018
age=76	1.681	0.076	1.544	0.167	0.377	0.020	0.380	0.020
age=77	1.689	0.080	1.847	0.205	0.363	0.020	0.419	0.021
age=78	1.757	0.082	1.745	0.259	0.368	0.023	0.425	0.023
age=79	1.608	0.087	1.878	0.271	0.371	0.024	0.383	0.024
age=80	1.627	0.113	1.714	0.300	0.305	0.025	0.429	0.027
age=81	1.789	0.109	1.964	0.347	0.364	0.028	0.414	0.029
age=82	1.739	0.129	1.579	0.336	0.312	0.030	0.457	0.033
age=83	1.932	0.157	2.125	0.507	0.416	0.037	0.376	0.036
age=84	2.020	0.181	1.667	0.659	0.318	0.038	0.435	0.040
age=85	1.908	0.193	1.909	0.436	0.315	0.041	0.438	0.044
overall N	60,865		30,044		132,609		132,609	

III. Derivation of equation (3)

(A1) $$LS_t = v_t(x_t) - \rho_t \sum_{\tau=0}^{t-t0} \left[E_{t-\tau-1} LS_{t-\tau} - LS_{t-\tau}\right]$$

Assuming that no forecast error is made about the initial period, i.e. $E_{t0-1}LS_{t0} - LS_{t0} = 0$, implies $LS_{t0} = v_{t0}(x_{t0})$. Further, I assume that satisfaction derived from current life circumstances stays constant over age, so that $v_t(x_t) = \bar{v} = v_{t0}(x_{t0}) = LS_{t0}$.

(A2) $$LS_t = LS_{t0} - \rho_t \sum_{\tau=0}^{t-t0} \left[E_{t-\tau-1} LS_{t-\tau} - LS_{t-\tau}\right]$$

Substituting expected life satisfaction by equation (A2), i.e. $E_{t-\tau-1}LS_{t-\tau} = (1+\omega_{t-\tau-1})LS_{t-\tau-1}$, gives

$$\begin{aligned} LS_t = LS_{t0} - \rho_t \sum_{\tau=0}^{t-t0} \left[(1+\omega_{t-\tau-1})LS_{t-\tau-1} - LS_{t-\tau}\right] = \\ = LS_{t0} - \rho_t \big[\ (1+\omega_{t-1})LS_{t-1} - LS_t + \\ + (1+\omega_{t-2})LS_{t-2} - LS_{t-1} + \\ + (1+\omega_{t-3})LS_{t-3} - LS_{t-2} + \\ + \ldots + \\ + (1+\omega_{t0+1})LS_{t0+1} - LS_{t0+2} + \\ + (1+\omega_{t0})LS_{t0} - LS_{t0+1} + \\ + E_{t0-1}LS_{t0} - LS_{t0}\ \big] \end{aligned}$$

The last two terms represent the forecast error about the initial period which is assumed to be zero. Canceling out terms in the brackets results in

$$\begin{aligned} LS_t = LS_{t0} - \rho_t \left[\sum_{\tau=1}^{t-t0} \omega_{t-\tau} LS_{t-\tau} - LS_t + LS_{t0}\right] = \\ = (1-\rho_t)LS_{t0} + \rho_t LS_t - \rho_t \sum_{\tau=1}^{t-t0} \omega_{t-\tau} LS_{t-\tau} \end{aligned}$$

Solving for current life satisfaction LS_t yields

(A3) $$LS_t = LS_{t0} - \frac{\rho_t}{1-\rho_t} \sum_{\tau=1}^{t-t0} \omega_{t-\tau} LS_{t-\tau}$$

IV. Regret parameter $\rho \to 1$ in a generalized model with time-varying life circumstances

With a regret parameter close to one, small shocks in the valuation of current life circumstances lead to extreme ("manic/depressive") life satisfaction values. This is shown in a generalized model with time-varying life circumstances.

As in the baseline model, life satisfaction is defined:

(A4) $$LS_t = v_t(x_t) - \rho_t \sum_{\tau=0}^{t-t0} \left[E_{t-\tau-1} LS_{t-\tau} - LS_{t-\tau}\right]$$

Again, no error is made about the initial period, i.e. $E_{t0-1}LS_{t0} - LS_{t0} = 0$, so $LS_{t0} = v_{t0}(x_{t0})$.

But now we allow for unexpected changes in the satisfaction derived from current life circumstances, $v_t(x_t)$. To simplify the argument we set the optimism parameter to zero, so that expected life satisfaction equals current life satisfaction.

(A5) $$E_t LS_{t+1} = LS_t$$

Substituting (A5) into (A4) yields

$$\begin{aligned}
LS_t &= v_t(x_t) - \rho_t \sum_{\tau=0}^{t-t0} \left[LS_{t-\tau-1} - LS_{t-\tau}\right] = \\
&= v_t(x_t) - \rho_t \big[\ (LS_{t-1} - LS_t + \\
&\quad + LS_{t-2} - LS_{t-1} + \ldots \\
&\quad \ldots + LS_{t0} - LS_{t0+1} + \\
&\quad + E_{t0-1}LS_{t0} - LS_{t0}\ \big]
\end{aligned}$$

The last two terms represent the forecast error made in period *t0-1* about period *t0* life satisfaction which is assumed to be zero (as in the baseline model). Canceling out terms results in

$$LS_t = v_t(x_t) + \rho_t LS_t - \rho_t LS_{t0}$$

Solving for current life satisfaction LS_t yields

(A6) $$LS_t = \frac{v_t(x_t) - \rho_t LS_{t0}}{1-\rho_t} = LS_{t0} + \frac{v_t(x_t) - LS_{t0}}{1-\rho_t}$$

With a regret parameter close to one a minimal increase of $v_t(x_t)$ over the baseline life satisfaction level leads to an explosion of current life satisfaction ("manic state"), while a slight decrease has the opposite effect ("depressive state"):

$$\lim_{\rho_t \to 1}[LS_t \mid v_t(x_t) > LS_{t0}] = \infty$$

$$\lim_{\rho_t \to 1}[LS_t \mid v_t(x_t) < LS_{t0}] = -\infty$$