Adaptation, Anticipation and Social Interaction in Happiness:
An Integrated Error-Correction Approach

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Abstract

In the literature on happiness hedonic adaptation, anticipation and social-reference effects are studied in isolation from each other, although they are strongly interrelated. This study improves on that by an integrated investigation of the implications of these three phenomena for the dynamics of individual life satisfaction. The focus is on income and working hours, but we control for similar dynamics with respect to a large set of control variables. To render estimation of the huge life satisfaction equation feasible we transform it into an error-correction model. This provides direct estimates of short and long-run effects of the various variables. Our results for GSOEP panel data for the years 1984-2007 indicate significantly positive short and long-run effects of income on life satisfaction with incomplete hedonic adaptation. Social reference income has a significantly negative impact in the long run, but not in the short run. Consequently, absolute income is insignificant in the long term. Surprisingly, actual working time has intrinsic utility in the short and long term. An interesting difference between men and women is that women display significant hedonic adaptation to income, but no significant effect of social reference income, whereas the reverse holds for men. Furthermore, people with higher incomes are more sensitive to their long-run level of social reference income, but less sensitive to expected income shocks than people with lower incomes.

1. Introduction

When a person experiences an improvement in her condition of life, she first feels happier by that. However, what she tends not to foresee, is that after some time she will get used to it, which will push her happiness back towards its original level. This phenomenon of hedonic adaptation has been extensively investigated by psychologists (see Frederick and Loewenstein, 1999, for a survey), and more recently by economists as well. In particular, in the empirical literature on the relationship between individual life satisfaction and income, it has been found that a person's life satisfaction depends not only positively on her current level of income, but also negatively on her level of income in the past (Di Tella et al., 2007; Weinzierl, 2006). This implies hedonic adaptation to changes in income. A second central finding on the happiness-income relation is that a person's life satisfaction depends on the level of her income relative to the average income in her social reference group rather than the absolute level of her income (McBride, 2001; Ferrer-i-Carbonell, 2005; Luttmer, 2005; Vendrik and Woltjer, 2007). Both phenomena are important since they impose positional externalities and myopic habit formation effects on consumption and labour supply decisions. From a social-welfare point of view, these effects may lead to inefficiently high consumption levels and hence inefficiently high working hours to finance such consumption expenses (Layard, 2005a, 2005b). In addition, both phenomena can explain why in the last sixty years average happiness in developed countries has risen only little or not at all despite massive rise in real income (which is referred to as the Easterlin paradox; Easterlin, 1974, 1995).

However, the empirical literature that deals with these phenomena displays important lacunas. First, almost all studies investigate hedonic adaptation and social-reference effects with respect to income in isolation from each other.[1] This is a potentially serious limitation since past income and social-reference income are strongly correlated to each other. Second, very few studies control for the impact of future income, while Di Tella et al. (2007) have found evidence that people already become happier when they expect a rise in their income in the coming year. Third, studies that analyze the impact of social-reference income typically assume that this impact is contemporaneous. This is not obvious at all since the impact may well be delayed (as in the catching-up-with-the-Joneses effect on consumption, see Ljunqvuist and Uhlig, 2000). Fourth, most studies implicitly assume that there are no adaptation and social-reference effects with respect to working hours or leisure. This is a potentially serious omission since such effects would have direct implications for the inefficiency of labour supply and consumption decisions (see, e.g., Asch, 2007, and Choudhary, 2007). Fifth, as far as adaptation and anticipation to income changes is modeled, this is not controlled for dynamics in other variables.[2] Just like hedonic adaptation to income implies a difference between its short and long-run effects on happiness, there may also be different short and long run effects on happiness of changes in

[1] The only microeconometric exception that we know is the study of Weinzierl (2006).

[2] Di Tella et al. (2007) control for the dynamics in a variable for job status, but not for that in other control variables.

social reference income, working hours, average working hours in the social reference group (social reference hours), and all kinds of objective living conditions like unemployment, layoffs, marriage, divorce, and birth of first child (Clark et al., 2006b). When current values of control variables are correlated with current income, by implication lags and leads of these control variables are correlated with lags and leads of income as well and should therefore be controlled for.

This study improves on all these limitations by simultaneously estimating short and long-run effects on life satisfaction of income, social reference income, working hours and social reference hours, while controlling for the short and long-run dynamics of life satisfaction with respect to a large set of control variables. A general methodological problem in estimating these dynamics is how many lags of the explanatory variables should be included in the life satisfaction equation. This involves a pernicious trade-off since including more lags to make the estimation more reliable also leads to a larger loss of panel observations. The solution that we choose for this problem is following the conventional econometric practice of assuming a distributed-lags specification with exponentially declining weights. Further assuming that this lag structure is (approximately) the same for all variables we can apply a Koyck transformation to the distributed-lags specification. This results in an autoregressive life satisfaction equation with one-year-lagged life satisfaction as an additional explanatory variables and only one-year lags and leads of the other explanatory variables (besides the current values). This leaves us with enough panel observations to obtain significant coefficient estimates.

A complication with this approach is that in an estimation with individual fixed effects the lagged-life-satisfaction variable is correlated to the error term, which gives rise to a so-called Nickell bias in the coefficient estimate (Nickell, 1981). Therefore, we instrument lagged life satisfaction with a selected set of two-year lags of the explanatory variables and estimate the autoregressive life satisfaction with the generalized method of moments (GMM). Moreover, to obtain direct estimates of short and long-run effects of the various variables on life satisfaction, we rewrite the autoregressive equation in error-correction form and estimate the life satisfaction in that form as well. This form allows for a neat separation between short-run shock effects of changes in exogenous variables on life satisfaction on the one hand and adjustment of life satisfaction to a long-run equilibrium given by long-run level effects on the other hand.

We employ the German Socio Economic Panel (SOEP) spanning the years 1984-2007 with a focus on Western Germany. The life satisfaction variable is measured on a 0-10 scale. For the income variable data on after-tax annual household income are used, which are divided by the consumer price and an appropriate “equivalence-scale” factor to obtain a measure of real individual income. Next, following Weinzierl (2006), this annual income is smoothed by taking its three-years moving average to transform the income variable into a better proxy for permanent income or consumption. Social-reference income and social-reference hours are constructed as the average income and average working hours in individual-specific reference groups, which are defined as peer groups of similar age and education, having the same sex and living in the same region of Western Germany (North, Middle or South; cf. Ferrer-i-Carbonell, 2005; Vendrik and Woltjer, 2007; Weinzierl, 2006). Working hours are included both linearly and quadraticly to make the specification sufficiently flexible.

The main results are as follows. First, we find strongly significant and positive short-run effects of future as well as current income on life satisfaction and strongly significant hedonic adaptation to income. However, this adaptation is not complete since income has still a significant and sizable effect on life satisfaction in the long run. Second, social reference income has a significantly negative and strong effect in the long run, but not in the short run. This implies a significantly positive relative income effect of the same size[3] in the long, but not in the short run, whereas the absolute income effect is weakly significant in the short, but not in the long run. Third, a surprising finding with respect to actual working hours is a positive intrinsic utility of working time (net of leisure) in the short as well as long term. This intrinsic utility reaches maxima for 35 hours per week in the short run and for 29 hours in the long run. Fourth, coefficients of social reference working hours are not significant.

We also conducted estimations for men and women, separately, and for people with high versus low levels of incomes. An interesting difference between the results for men and women is that women display highly significant hedonic adaptation to income, but no significant social reference effect with respect to income[4], whereas men display no significant hedonic adaptation, but a strong and weakly significant social reference effect. Furthermore, people with high incomes are strongly sensitive to their long-run level of social reference income, but not to expected income shocks, whereas the reverse holds for people with low incomes. Finally, adding lags and two-year leads of shock terms of the exogenous variables to the life satisfaction equation to account for deviations from the assumed uniform lag structure did not lead to qualitatively different estimation results.

The organization of this paper is as follows. Section 2 presents the basic life satisfaction equation and its transformations in estimation equations in autoregressive and error-correction form. In Section 3 the data and variables used are described. Section 4 discusses the estimation results for the whole sample and Section 5 those for the subsamples. Section 6 concludes.

2. Methodology

2.1. Basic life satisfaction equation

The life satisfaction equation that we employ as the basic model has the following form:

[3] Relative income is the ratio of income to social reference income. The absolute income effect is the effect of income when controlling for relative income instead of social reference income.
[4] Cf. Mayraz et al. (2009).

$$S_{it} = \alpha_{+1} \ln Y_{it+1} + \alpha_0 \ln Y_{it} + \sum_{s=0}^{\infty} \alpha_{-1} \lambda^s \ln Y_{it-1-s} + \beta_{+1} \ln Y^r_{it+1} + \beta_0 \ln Y^r_{it} + \\ + \sum_{k=0}^{\infty} \beta_{-1} \lambda^k \log Y^r_{it-1-k} + \gamma_{+1} X_{it+1} + \gamma_0 X_{it} + \sum_{l=0}^{\infty} \gamma_{-1} \lambda^l X_{it-1-l} + f_i + e_{it}. \tag{1}$$

Here S_{it}, Y_{it}, and Y^r_{it} represent individual life satisfaction, smoothed household-equivalent income and social reference income, respectively, of individual i in year t. Vector X_{it} includes employment (dummy variable), actual working hours, actual working hours squared, and a large set of control variables. The Greek symbols represent parameters, f_i stands for an individual fixed effect which controls for any unobserved time-invariant individual-specific effects like personality characteristics, and e_{it} is an error term which is assumed to be homoscedastic and free of serial correlation. We include one-year forward values Y_{it+1}, Y^r_{it+1} and X_{it+1} of income, social reference income and the other variables to account for anticipation effects.[5] Furthermore, adaptation effects are modeled by distributed lags of income, social reference income and the other variables with weights that decline exponentially with uniform factor λ ($0 \le \lambda < 1$). This structure allows applying a Koyck transformation to the model (see below), which reduces the number of lags to one, and hence greatly increases the number of panel observations that can be used in the estimations.

The future and current-year coefficients in equation (1) indicate the short-run shock effects of the variables. When the signs of the past-year coefficients are opposite to those of the current-year coefficients, they represent the effects of *hedonic adaptation*. On the other hand, when they have the same sign as the current-year coefficients, the opposite of hedonic adaptation occurs, which we call *hedonic reinforcement*. The long-run level effects of changes in variables are given by the sum of short-run and hedonic adaptation or reinforcement effects, i.e. by the sum of forward, current and past-year coefficients of the variables.[6] Writing the sum of past-year coefficients of income $\sum_{s=0}^{\infty} \alpha_{-1} \lambda^s$ as $\alpha_{-1} \sum_{s=0}^{\infty} \lambda^s = \alpha_{-1}/(1-\lambda)$ and analogously the sums of past-year coefficients of reference income and the control variables as $\beta_{-1}/(1-\lambda)$ and $\gamma_{-1}/(1-\lambda)$, respectively, the long-run level effects of changes in these variables as indicated by the parameters α^*, β^* and γ^* are represented by:

$$\alpha^* = \alpha_{+1} + \alpha_0 + \frac{\alpha_{-1}}{1-\lambda}, \quad \beta^* = \beta_{+1} + \beta_0 + \frac{\beta_{-1}}{1-\lambda}, \quad \gamma^* = \gamma_{+1} + \gamma_0 + \frac{\gamma_{-1}}{1-\lambda}. \tag{2}$$

[5] We restrict to one-year leads since two-years leads of the independent variables could be rejected in our estimations.
[6] The long-run level effect of a variable is the effect of a change in the value of that variable in the long-run equilibrium in which the future, current and past-year values of the variable are equal to each other.

The magnitude of adaptation or reinforcement with respect to a variable is then determined as the difference between the long-run effect and the sum of the short-run effects of that variable.

Since equation (1) is not amenable to panel estimation because of its large number of lags, it will not be estimated as it is. We estimate two distinct equations derived from the basic equation, the first one being an autoregressive equation and the second one representing an error-correction model. The autoregressive equation is obtained by a Koyck transformation. Then, the autoregressive equation is further transformed into an error-correction equation by the use of a difference operator and the introduction of an error-correction term to make an explicit distinction between short and long-run effects of changes in the exogenous variables.

2.2. Estimation equations

The first equation to be estimated is an autoregressive equation with only one lag (and lead) which is derived from equation (1) by the use of a Koyck transformation. . The distributed lags in equation (1) can be expressed in terms of the lag operator L as $\alpha_{-1}\sum_{i=0}^{\infty}(\lambda L)^i \ln Y_{tt-1} = \alpha_{-1}\ln Y_{it-1}/(1-\lambda L)$, and analogously for the parameters β_{-1} and γ_{-1}. Then applying the Koyck transformation 1 – λL to each side of equation (1) and rearranging terms, the distributed-lags equation is transformed into the following autoregressive equation:

$$\begin{aligned} S_{it} &= \alpha_{+1}\ln Y_{it+1} + \alpha_0^a \ln Y_{it} + \alpha_{-1}^a \ln Y_{it-1} + \beta_{+1}\ln Y_{it+1}^r + \beta_0^a \ln Y_{it}^r + \beta_{-1}^a \ln Y_{it-1}^r \\ &+ \gamma_{+1}X_{i,t1} + \gamma_0^a X_{it} + \gamma_{-1}^a X_{it-1} + \lambda S_{it-1} + f_i^a + \varepsilon_{it}^a, \end{aligned} \tag{3}$$

where

$$\alpha_0^a = \alpha_0 - \lambda\alpha_{+1}, \qquad \alpha_{-1}^a = \alpha_{-1} - \lambda\alpha_0, \tag{4a}$$

$$\beta_0^a = \beta_0 - \lambda\beta_{+1}, \qquad \beta_{-1}^a = \beta_{-1} - \lambda\beta_0, \tag{4b}$$

$$\gamma_0^a = \gamma_0 - \lambda\gamma_{+1}, \qquad \gamma_{-1}^a = \gamma_{-1} - \lambda\gamma_0, \tag{4c}$$

$$f_i^a = (1-\lambda)f_i, \qquad \varepsilon_{it}^a = \varepsilon_{it} - \lambda\varepsilon_{it-1}. \tag{4d}$$

Equation (3) is estimated and the resulting coefficient estimates are used to obtain the corresponding coefficient estimates of equation (1), based on the set of relations given by equations (4a)-(4c).[7]

[7] In comparison to equation (1), the current and past-year coefficients of the independent variables in equation (3) now differ by terms proportional to λ. This is due to the fact that parts of the current and past-year effects of the independent variables are now given by past, future and current-year effects, respectively, that run via the lagged life satisfaction term in equation (3). Thus, a higher life satisfaction due to, e.g., an anticipated income rise now feeds back to a higher life satisfaction in the current year. Adding these indirect effects to the direct effects of the independent variables in equation (3) yields the total effects given in equation (1).

A more direct and illuminating way of estimating the short and long-run effects of the independent variables on life satisfaction than by means of the autoregressive equation (3) is achieved by rewriting equation (3) in error-correction form. Such an error-correction model (ECM) allows for a neat separation between short-run shock effects of changes in exogenous variables on life satisfaction on the one hand and adjustment of life satisfaction to a long-run equilibrium given by long-run level effects on the other hand. Rewriting equation (3) in terms of first differences and lagged levels of the variables results in the following ECM specification:

$$\begin{aligned} \Delta S_{it} &= \alpha_{+1}\Delta \ln Y_{it+1} + \alpha_0^e \Delta \ln Y_{it} + \beta_{+1}\Delta \ln Y_{it+1}^r + \beta_0^e \Delta \ln Y_{it}^r + \gamma_{+1}\Delta X_{i,t+1} + \gamma_0^e \Delta X_{it} \\ &- \rho(S_{it-1} - \alpha^* \ln Y_{it-1} - \beta^* \ln Y_{it-1}^r - \gamma^* X_{it-1} - f_i) + \varepsilon_{it}^a, \end{aligned} \tag{5}$$

where $\Delta \ln Y_{it+1} = \ln Y_{it+1} - \ln Y_{it}$, and analogously for the other variables, and where

$$\alpha_0^e = \alpha_0 + (1-\lambda)\alpha_{+1}, \quad \beta_0^e = \beta_0 + (1-\lambda)\beta_{+1}, \quad \gamma_0^e = \gamma_0 + (1-\lambda)\gamma_{+1}, \tag{6a}$$

$$\rho = 1 - \lambda . \tag{6b}$$

The future and current-year coefficients in equation (5) indicate the short-run shock effects of changes in the variables. However, note that the current-year shock effects as indicated by the parameters in equation (6a) differ from those according to equation (1) by an additional term proportional to $1-\lambda$ (note that λ is smaller than 1). The past-year coefficients α^*, β^* and γ^* now represent the long-run level effects of the variables and, together with the individual-specific baseline level f_i of life satisfaction, they determine the long-run equilibrium level of life satisfaction as a function of the explanatory variables.[8] The difference between lagged life satisfaction and this long-run equilibrium level is referred to as the error. This error is caused by shocks in the exogenous variables leading to a new long-run equilibrium level of life satisfaction and is corrected towards zero by a gradual adjustment of life satisfaction to this new equilibrium level. The speed of adjustment is given by the parameter ρ, which equals 1 minus the distributed-lags parameter λ in equation (1). Thus, the adjustment of life satisfaction to its long-run equilibrium is slower as hedonic adaptation and reinforcement take more time to work out. The total strength of these effects is again determined as the difference between the long-run and the sum of the short-run effects of the pertinent variable.

However, since the current shock effects of the exogenous variables are now measured in a somewhat different way than in equation (1) (see above), the estimates of the total magnitudes of adaptation and reinforcement will deviate as well. These deviations occur since the parameters in

[8] Note that as far as the long-run coefficients are significantly different from zero, they imply a direct rejection of the psychological set-point theory of happiness according to which, after a shock in a person's objective life conditions, her happiness always returns to the same individual-specific baseline level (here represented by f_i).

equation (6a) correct for adaptation to an anticipated future shock that already takes place in the current year. Thus, if a person anticipates that her income will rise in the next year, she will already feel happier by that expectation in this year, but on the other hand these feelings will already start to adapt in the year that her income rise actually takes place, so in the current year of the income rise. The size of this adaptation is given by -ρ times the rise in life satisfaction in the previous year (S_{it-1} in equation (5)) due to the anticipation, so by $-\rho\alpha_{+1}$ times the rise in ln(income). This effect lowers the total effect of the current income rise as described by α_0 in equation (1), while in fact it should be counted as part of the total adaptation effect. The ECM measures for the current income shock effect and total adaptation effect correct for this flaw by adding $\rho\alpha_{+1} = (1-\lambda)\alpha_{+1}$ to the magnitudes of both effects (and *mutatis mutandis* for the other variables).

The Easterlin paradox suggesting that real income growth is not accompanied with happiness growth is a major challenge that the happiness literature faces (see Sect. 3 for details). We reexamine the paradox by estimating the effects of absolute and relative income, the latter being defined as the ratio of income and social reference income or, in logarithmic form, as the difference between the logarithm of income and the logarithm of reference income *lnY*-*lnY*^{r}. If absolute income is insignificant in the long run, then the Easterlin paradox can be explained. We add and subtract $\beta_{+1}\ln Y_{t+!}$, $\beta_t \ln Y_t$, and $\beta^* \ln Y_{t-1}$ into the ECM specification (5) and rewrite it in terms of absolute and relative income variables leading to the following specification:

$$\begin{aligned} \Delta S_{it} &= \alpha_{+1}^{ab}\Delta \ln Y_{it+1} + \alpha_0^{ab}\Delta \ln Y_{it} + \beta_{+1}^{re}\Delta(\ln Y_{it+1} - \ln Y_{it+1}^r) + \beta_0^{re}\Delta(\ln Y_{it} - \ln Y_{it}^r) + \\ &\gamma_{+1}\Delta X_{i,t1} + \gamma_0^e \Delta X_{it} - \rho(S_{it-1} - \alpha^{ab*}\ln Y_{it-1} - \beta^{re*}(\ln Y_{it-1} - \ln Y_{it-1}^r) - \gamma^* X_{it-1} - f_i) + \varepsilon_{it}^a, \end{aligned} \tag{7}$$

where

$$\alpha_{+1}^{ab} = \alpha_{+1} + \beta_{+1}, \qquad \alpha_0^{ab} = \alpha_0^e + \beta_0^e, \qquad \alpha^{ab*} = \alpha^* + \beta^*, \tag{8a}$$

$$\beta_{+1}^{re} = -\beta_{+1}, \qquad \beta_0^{re} = -\beta_0^e, \qquad \beta^{re*} = -\beta^*. \tag{8b}$$

Equations (8a) imply that the short and long-run absolute-income effects are zero if the corresponding social-reference effects are equal in size to the income effects in equation (5). Equations (8b) indicate that the short and long-run relative-income effects are the opposite of the corresponding social-reference effects. The magnitudes of hedonic adaptation or reinforcement with respect to absolute and relative income are again given by the difference between the long-run effect and the sum of the short-run effects of these income variables.

Thus, we have obtained one autoregressive level equation (3) and two error-correction equations (5) and (7) to be estimated. However, before estimating these equations in full, we first estimated restricted variants of equations (3) and (5) in order to investigate the sensitivity of especially the income coefficients to adding successively more control variables and to allow a comparison with effect estimates from less complex dynamic specifications in the literature. In particular, Section 4 will first present estimates of variants without social reference income to be better able to compare our results with those from the literature on hedonic adaptation. We will start with the static variant of equation (3) with no lags and leads and will then successively add one-year-lagged income, one-year-lead income, one-year-lags and leads of all variables, and lagged life satisfaction to the estimated equation. This will allow us to investigate how the estimates of the income coefficients change as we add more control variables. Next, Section 4 will discuss the estimates for error-correction equation (5) without and with social reference income as well as the estimated effects of absolute and relative income according to equation (7).

2.3. Estimation procedure

In theory, the discrete scale of the life satisfaction variable can best be addressed by an ordered probit or logit estimation. The happiness literature, however, shows that a straightforward and more easily interpretable ordinary least squares (OLS) estimation yields results that are very similar to those from probit or logit estimation (Ferrer-i-Carbonell and Frijters, 2004; Clark et. al., 2008; Senik, 2009). Therefore, in the analysis OLS and, in the case of instrumental variables, generalized-method-of-moments (GMM) estimation, with individual fixed effects is used. We estimate the error-correction equations in the following linear form:

$$\begin{aligned}\Delta S_{it} &= \alpha_{+1}\Delta \ln Y_{it+1} + \alpha_0^e \Delta \ln Y_{it} + \beta_{+1}\Delta \ln Y_{it+1}^r + \beta_0^e \Delta \ln Y_{it}^r + \gamma_{+1}\Delta X_{i,t+1} + \gamma_0^e \Delta X_{it} \\ &- \rho S_{it-1} + \tilde{\alpha}^* \ln Y_{it-1} + \tilde{\beta}^* \ln Y_{it-1}^r + \tilde{\gamma}^* X_{it-1} + f_i^a + \varepsilon_{it}^a, \end{aligned} \quad (9)$$

where $\tilde{\alpha}^* = \rho\alpha^*$, $\tilde{\beta}^* = \rho\beta^*$, and $\tilde{\gamma}^* = \rho\gamma^*$. We can then derive estimates of the long-run level effects α^*, β^*, and γ^* by dividing the estimates of $\tilde{\alpha}^*$, $\tilde{\beta}^*$, and $\tilde{\gamma}^*$ by the estimate of ρ .

Equations (3), (5) and (7) suffer from an endogeneity problem since lagged life satisfaction appears as an explanatory variable in them. In a panel-data model with individual fixed effects a lagged dependent variable is correlated with the time means of the disturbance ε_{it}^a, , making the within estimator of the lagged-dependent-variable coefficient biased and inconsistent (the so-called Nickell bias; see Nickell, 1981). In addition, the disturbance ε_{it}^a, will tend to be serially correlated over time as a result of the Koyck transformation (see eq. (4d))). This will render lagged life satisfaction correlated with the disturbance. Therefore, we instrument lagged life satisfaction with a set of two-year lags of the control variables.[9] This set of (excluded) instruments is subjected to three tests: (i) an under-identification LM test of the relevance of the instruments (sufficient correlation with the endogenous regressor). (ii) the Hansen overidentification test of the validity of the instruments (sufficient absence of correlation with the error term), (iii) the weak identification test of Stock and Yogo (2005) of the strength of the instruments. Since the instruments set, in the estimations, turned out to pass the first two tests, but not the last one, we selected a set of sufficiently strong instruments by successively dropping the most insignificant excluded instruments in the first-stage regression equation one by one until a satisfactory value of the Cragg-Donald F-statistic was reached. The resulting set of instruments was then used in estimating the equation by GMM.

We also test for first-order serial correlation in the disturbance ε_{it}^{a}. We conduct pooled OLS regressions (with fully robust standard errors) of the time-demeaned residuals from the within-estimation on their one-year lagged values, and then test whether the estimated coefficient of the lagged residual significantly deviates from the serial correlation in the time-demeaned residuals under the null hypothesis of no first-order serial correlation in ε_{it}^{a} (see Wooldridge, 2002, Sect. 10.5.4). The serial correlation in the time-demeaned residuals under this null hypothesis is equal to *-1/(T-1)*, where *T* is equated to the average number of subsequent years that the individuals are in the sample (about 7). If this hypothesis is rejected, we report fully robust standard errors of the coefficient estimates of the life satisfaction equation that correct for any heteroscedasticity and serial correlation in the disturbance.

3. Data, variables and Easterlin Paradox

3.1. Data and variables

This section presents the database used for all estimations, namely The German Socio-Economic Panel Study (SOEP). SOEP is a yearly survey that follows about 11,000 households and 20,000 individuals in Germany. The panel we have at our disposal covers the years 1984-2007 for West Germany and 1991-2007 for East Germany. The panel was started in 1984. We focus on West Germany because of the longer time series and different background and experiences of people in West as compared to East Germany. We further restrict the sample to persons from 26 to 60 years old as for younger and older ages income is a less good proxy for consumption. We excluded individuals with a non-German nationality because these individuals might have their home-country nationals rather than German nationals in their social reference group. Self-employed persons are also excluded

[9] One-year lags of the control variables are already included in the equations and higher-than-two years lags are not used since that would reduce the number of observations. We neither did use two-years-lagged life satisfaction as instrument (as proposed by Anderson and Hsiao (1982) for first-difference equations) since in the level equations that we estimate two-years-lagged life satisfaction is correlated with the fixed-effect component of the error term as well and since in the first-difference versions of these equations this variable is correlated to the error due to second-order serial correlation in this first-differenced error (consistent with equation (4d)).

because they are more reluctant to state their income and tend to underreport their incomes (e.g. Joulfaian and Rider, 1998, for the U.S.). The sample we use includes about 93,000 individuals who stayed on average almost seven years in the sample.

The dependent variable is life satisfaction which is quantified on a 0-10 scale in response to the survey question “How satisfied are you at present with your life, all things considered?” A value of zero represents complete dissatisfaction while a value of ten represents complete satisfaction with life in general. The main explanatory variables are post-government household income, social reference income and actual working hours. Post-government household income is the sum of household labour earnings, household asset income, household private transfers, household public transfers, household social security pensions, total household taxes, and household private retirement income. This household income variable is divided by the consumer price index to obtain real household income corrected for inflation. Then, to convert real household income into real individual income, we divide each household’s real income by its appropriate equivalence-scale factor taken from the OECD. Next, following Weinzierl (2006), the annual real income variable is smoothed by taking its three-year moving average to transform it into a better proxy for permanent income or consumption. The same procedure is applied to other income variables, i.e. social reference income and dividend income.

Social reference income is the average income in the individual-specific reference group, which is defined as a group of people with similar age and education, having the same gender and living in the same region of Germany (North, Middle or South).[10] The width of the age bracket of the reference groups is assumed to increase with the age of the individual since older people tend to have wider reference groups in terms of age. Everybody between 26 and 35 years old is supposed to have a reference group of people from two years younger to two years older than him/her. If you are between 36 and 45 years old your reference group consists of people from three years younger to three years older than you. Finally, if you are between 46 and 59 years old you compare yourself with others between four years younger and older than you.

Education is another identifier in the reference group profile and is based on institutional years of education, which range from 7 to 18 years. These years of education are determined as the sum of institutional schooling years from 7, for no degree, to 13, for a high-school degree, and occupational training years from 1.5, for an apprenticeship, to 5, for a university degree. We distinguish four different educational categories. The first category consists of individuals with no or a lower school degree with less than 10 years of education. The second category has a technical school degree in addition to a lower school degree with 10 to 11 years. The third category has an apprenticeship in addition to a high school degree with 11.5 to 14.5 years, and the fourth category comprises individuals

[10] North region states are Berlin (West), Schleswig-Holstein, Hamburg, Lower Saxony and Bremen; Middle region states are Nord-Rhein-Westfalen, Hessen and Rheinland Pfalz-Saarland; South region states are Baden-Wuerttemberg, Bavaria.

with a higher technical college or university degree with 15 to 18 years. The actual-working-hours variable indicates information on actual working hours in the week preceding the interview.

Apart from the explanatory variables we controlled for dividend income, dummies for labour force status (voluntary non-working, the reference case, in education-training, maternity leave, military-community service, involuntary unemployed, irregularly employed, employed), a dummy for type of employment contract (permanent contract, the reference case, temporary contract), tenure, dummies for occupational position (blue collar, the reference case, white collar, managerial, trainee, civil), age, years of education, dummies for health satisfaction (0-10, value 8 as the reference case), numbers of adults and children in the household, dummies for relationship status (married, the reference case, separated with partner, separated without partner, single with partner, single without partner, divorced with partner, divorced without partner, widow with partner, widow without partner, spouse living abroad), dummies for household type (couple without children, the reference case, 1-person household, single parent, couple with children younger than or equal to 16, couple with children older than 16, couple with children younger than or equal to and older than 16, multiple generation household, other), dummies for state of residence (Nord-Rhein-Westfalen, the reference case, Berlin(West), Schleswig-Holstein, Hamburg, Lower Saxony, Bremen, Hessen, Rheinland Pfalz-Saarland, Baden-Wuerttemberg, Bavaria), state-specific time trends, and year dummies.

3.2. Easterlin Paradox

In his seminal paper in 1974, Easterlin showed that average life satisfaction in the US had remained flat since World War II despite a considerable rise in real income in that period. This is a paradoxical finding as in a cross-section for any particular year, an individual with a higher income declares a higher life satisfaction than an individual with a lower income. This Easterlin paradox has been reproduced for many developed countries.[11] In particular, Figures 1 and 2 show that it holds for our West-German sample. In Figure 1 mean life satisfaction of West-Germans between 1984 and 2007 follows a significantly downward trend (-1.2%) even though mean real net income increases on average in the same period (1.1%).[12] On the other hand, Figure 2 reveals a significantly positive logarithmic relationship between mean real net income per income decile and mean life satisfaction per income decile. While the significantly downward trend in mean life satisfaction over the time period is specific for West Germany in this time period (and may be due to adverse non-pecuniary effects of the reunification with East Germany), the absence of an upward trend is in line with the pattern for other developed countries.

[11] See, however, Stevenson and Wolfers (2008) and Inglehart et al. (2008) for counterevidence.

[12] Figure 1 also suggests cyclical co-movements of fluctuations in mean income and mean life satisfaction. The fluctuations in mean life satisfaction even seem to predate somewhat those in mean income, which indicates anticipation effects of income or unemployment on life satisfaction. Thus, there seem to be anticipatory and current income effects that do not, however, translate into permanently different levels of life satisfaction.

Insert Figures 1 and 2

One explanation that has been proposed for the Easterlin paradox is the hypothesis that people derive satisfaction from their level of income (or consumption) relative to that of others, but not from their absolute level of income. When incomes rise over time everybody becomes richer, so if the income distribution does not change relative incomes remain the same, leaving everybody remains at the same happiness level. On the other hand, in the cross-section richer people are happier because their incomes are higher relative to those of others. A second possible explanation for the Easterlin paradox is that people fully adapt to rises in their income over time, but that they do not adapt to a higher relative position (Di Tella and McCulloch, 2008; Di Tella et al, 2007). In that case, these income rises only have temporary positive effects on happiness, which do not lead to an upward trend in the average happiness level. On the other hand, in the cross-section richer people are happier as they do not adapt to the higher status that is associated with a higher (relative) income. In Section 4.2 we will test both explanations for the paradox in terms of absolute and relative income effects.

4. Estimation results

4.1. Estimation results for the autoregressive equation

This section presents estimation results for equation (3) without reference income along with four preceding equations as shown in Table 1. The first column of Table 1 presents the results of a static specification which includes only the current-year variables. This specification corresponds to equation (3) without reference income and with all lagged and lead coefficients restricted to be zero. All coefficients are significant.[13] The income coefficient is significantly positive and somewhat larger than what is usually found with individual fixed effects for Western Germany.[14] This is probably due to the smoothing of our income variable. The positive sign of the coefficient of working week (i.e. the number of hours worked per week as a fraction of a full-time working week of 40 hours) is unexpected since neoclassical labour supply theory assumes that time devoted to labour has a negative marginal utility at given income due to the reduction of leisure. Thus, working week has a positive marginal utility which, however, diminishes by virtue of the negative coefficient of working week squared. Ultimately, the marginal utility becomes negative, but this only occurs beyond a surprisingly high 43

[13] The standard errors of the coefficient estimates in Table 1 are fully robust to any heteroscedasticity and serial correlation in the disturbance as the coefficients of regressions of the residuals on their one-year lags indicate serial correlation in the time-demeaned disturbance that is significantly different from its serial correlation under the null hypothesis of no serial correlation in the disturbance (-1/(1-T) = -0.18; see Sect. 3.2).

[14] For instance, Di Tella et al. (2007) estimate an income coefficient of 0.20 for Western Germany from 1984 to 2000.

hours per week (se = 3.4; p=0.000).[15] The resulting hump shape of life satisfaction as a function of working week and working week squared is displayed in Figure1. For comparison, Figure 1 also shows the typical shape of a negative utility function of working hours according to neoclassical labour supply theory. Only for high working hours beyond 43, where marginal life satisfaction becomes negative, this shape is consistent with our estimation results.

Insert Table 1

Apart from the variation of life satisfaction with working week, there are also fixed effects of working *per se* on life satisfaction as indicated by the coefficients of the current employment and involuntary unemployment dummies (with voluntary non-participation to the labour force as the reference case). The fixed effect of employment is significantly negative (as shown in Figure 1). This estimate is primarily driven by women entering or leaving the labour force and might be related to fixed costs of commuting. It is, however, dominated by the positive utility of working hours between 16 and 71 hours (see Figure 1). Moreover, in addition to this intrinsic utility of working, a job yields, of course, utility by means of the income it generates. The effect of this income on life satisfaction is implied by the income coefficient, but the size of the generated income, and hence the gain in life satisfaction, depends on the hourly wage. This hourly wage we do not know, but in Section 6 we will estimate the size and shape of the average total utility function of working hours including its financial component. For the moment, we can conclude that the estimates in column (1) suggest that, for working hours between 16 and 71, the "intrinsic" life satisfaction of individuals entering and leaving the labour force was, on average, higher when they were working than when they were not working. Note, however, that this is an average result that is not inconsistent with some individuals becoming happier from taking a job, but other individuals becoming happier from quitting their job.

Insert Figure 3

On the other hand, when people lost their job against their will and became involuntarily unemployed, they incurred a sizable and significant negative effect on their life satisfaction, as indicated by the coefficient of current unemployment in column (1) and as illustrated by Figure 1. Note that this effect holds at given income, and hence only represents the large non-pecuniary costs of unemployment. The total loss of life satisfaction due to these non-pecuniary costs when a full-time-working person became unemployed is given in Figure 1 by the difference between the life-satisfaction level when working 40 hours and the life-satisfaction level when being unemployed

[15] Remarkably, estimating the same equation for men and women separately yields the same optimal numbers of hours of 37 (±4 for men and ±7 for women), which is lower than the estimated optimal 43 hours for the full sample (but not significantly).

(where both levels are defined relative to the reference case of voluntary non-participation). This difference can easily be seen to equal the sum of the coefficients of working hours, working hours squared and employment minus the coefficient of unemployment: 0.512-0.240-0.120+0.577 = 0.73. The large size of this effect is in line with what is found in the literature on unemployment and happiness (Clark and Oswald, 1994; Winkelmann and Winkelmann, 1998; Clark et al. 2008; Finbarr et al., 2008).

In column (2) we relax the restriction $\alpha_{-1} = 0$ and add the variable past income to the specification presented in column (1). As expected, we find a negative coefficient estimate for this one-year-lagged income variable due to hedonic adaptation (or habituation) with respect to income. Furthermore, the size of the coefficient of current income is considerably larger than the coefficient in the static model of column (1) due to the control for past income. The current-income coefficient 0.38 indicates the short-run effect of a change in income on life satisfaction, while the long-run impact of income can be derived from equation (2) for $\alpha_{+1} = \lambda = 0$ as $\alpha^* = \alpha_0 + \alpha_{-1} = 0.25$, which is significant. Thus, the long-run effect of income on life satisfaction is significantly lower than its short-run effect due to hedonic adaptation. However, this adaptation is not complete since there is still a significant long-run effect left. Furthermore, note that this long-run effect is almost equal in size to the current-income coefficient in column (1). This suggests that the current-income-coefficient estimate in the static model measures the long-run rather than the short-run effect of income on life satisfaction. The signs of the other coefficients are the same as in column (1) and their sizes are similar with small (but insignificant) decreases in the optimal number of working hours and the current unemployment coefficient.

In addition to past income, future income may also play a role in the relationship between income and life satisfaction since people may anticipate future changes in their income and, as a result of such a prospect, already feel better or worse. To account for this possibility, we add one-year-forward income to the estimation equation. This yields a highly significant positive coefficient 0.18 of future income in column (3), which is almost as high as the current-income coefficient 0.20. It indicates that the average West-German person in the sample period already experienced half of the positive (negative) effect of an income rise (fall) on her life satisfaction in anticipation to the actual rise (fall) one year later. Accordingly, the current-income coefficient in column (3) is half as high as that in column (2). Furthermore, the past-income coefficient is considerably smaller in size as compared to column (2) and less significant (p = 0.04).[16] The long-run effect of income is now given by equation (2) for $\lambda = 0$, i.e. by $\alpha^* = \alpha_{+1} + \alpha_0 + \alpha_{-1} = 0.29$, which is again significant and somewhat

[16] The smaller sizes of the current and past-income coefficients are both due to positive serial correlation of income over time. Hence, if we do not control for future income, the estimated positive effects of a higher current income at given past income and of a lower past income at given current income will pick up the positive effect of a higher future income at given current income. This statistical implication does not require a behavioural argument like that of Weinzierl (2006, Sect. 5.2) that current rises in income evoke an expectation of future income rises.

higher than the estimate in the absence of future income in column (2). The future and current-income coefficients can each be considered as distinct short-run effects, which sum up to the total short-run income effect 0.38. The long-run income effect 0.29 is obviously lower than this due to hedonic adaptation as indicated by the past-income coefficient -.09. The coefficients of the other variables in column (3) are similar to those in the previous column.

In column (4) we control for future and past-year values of all variables other than income (including the control variables not shown in Table 1). As a result, all income effects somewhat decrease in size, but their level of significance is similar. Thus, these income effects are only slightly sensitive to controlling for future and past-year values of the control variables. Regarding these variables Table 1 shows the following pattern. Future and past working week and future working week squared have insignificant coefficients, while the coefficient of past working week squared is significant and negative. Summing up the future and current-working-week and working- week-squared coefficients, we get significant short-run coefficients 0.435 and -0.221, respectively, which are considerably lower than the corresponding current-working-week and working-week-squared coefficients in column (3) and which imply an optimal number of 38 hours worked per week in the short run. On the other hand, the long-run effects of working week and working week squared, which follow from equation (2) with $\lambda = 0$ for the γ parameters, are larger than the short-run effects and imply an optimal number of 34 hours worked per week in the long run. This is considerably smaller than the optimal number of working hours in the short run. Moreover, the latter number is considerably lower than the optimal number of working hours in column (3) without controls for the lags and leads of all control variables. Regarding employment, we see that future and past employment have significantly negative and sizable coefficients. The current-employment coefficient is now insignificant, but together with the future-employment coefficient it implies a significantly negative short-run effect -0.127 of employment, which is, however, smaller than the long-run effect -0.263. Consider a housewife who takes a job of 32 hours per week (which is close to the average number 29.4 of hours of working women in the sample). Apart from the utility of the income that she earns in this job, her life satisfaction will then go up by $-0.127+0.435*0.8-0.221*0.8^2 = 0.080$ in the short run, but go down by $-0.263+0.581*0.8-0.341*0.8^2 = -0.016$ in the long run. However, both effects and their difference -0.096 are insignificant. For involuntary unemployment the coefficients exhibit a similar, but more significant dynamic pattern with the highly significant and large short-run effect -0.619 being smaller than the equally significant and even larger long-run effect -.741. The total non-pecuniary losses of life satisfaction when a full-time-working person became unemployed can then again be calculated as the sums of the coefficients of working hours, working hours squared and employment minus the coefficient of unemployment, yielding 0.71 in the short run and 0.72 in the long run. The difference between the short and long-run losses is insignificant. Hence, our estimates indicate that when a Western-German citizen became unemployed, his life satisfaction strongly went down in the short run, and at least remained at the lower level in the long run. This lack of hedonic adaptation to unemployment has also been found by Clark et al. (2008) for West-German men, but not by Angeles (2009) for British individuals.

The next step is adding one-year lagged life satisfaction to the equation. This variable results from the Koyck transformation of the distributed-lags equation (1) into the autoregressive equation (3), and hence represents the effects of all more-than-one-year lags of the independent variables in the former equation. The resulting estimates are presented in column (5) of Table 1. Recall, however, that social reference income is not yet included. To avoid Nickell bias in the coefficient estimate for lagged life satisfaction, this variable is instrumented by a set of two-years-lagged values of the control variables (see Sect. 2 for details). This set of (excluded) instruments passed the under-identification LM test at p = 0.00, implying that the set of excluded instruments is relevant. The set of (excluded) instruments also passed the Hansen over-identification test at p = 0.45, meaning that we cannot reject the null hypothesis that the set of instruments is valid. However, since the instruments were not sufficiently strong according to the weak identification test of Stock and Yogo (2005), we selected a set of sufficiently strong instruments by successively dropping the most insignificant excluded instruments in the first-stage regression equation one by one until a satisfactory value of the Cragg-Donald F-statistic was reached (20.4).[17] The resulting equation was estimated using the generalized method of moments (GMM).

For current and past values of the variables in Table 1, column (5) does not report the estimated coefficients of the autoregressive equation (3), but implied estimates of corresponding coefficients of the underlying distributed-lags equation (1) (without social-reference income). For current values the reported coefficients are the parameters α_0 and γ_0, while for past values the implied estimates of the sums $\alpha_{-1}/(1-\lambda)$ and $\gamma_{-1}/(1-\lambda)$ of the past-year coefficients of income and the control variables (except social reference income) in equation (1) are presented. These estimates are obtained by using equations (4a) and (4c).[18] For future values of the variables the estimates of the parameters α_{+1} and γ_{+1} are reported. The long-run effects are again given by equations (2).

Column (5) shows that past-year life satisfaction is significant with a highly significant and sizable positive effect 0.43 on current-year life satisfaction. This coefficient is much higher than the coefficient estimate that is obtained when lagged life satisfaction is not instrumented (0.05). This finding highlights the severity of the endogeneity or Nickell bias and the importance of treating lagged life satisfaction as endogenous. Moreover, all income coefficients except future income are lower in size compared to their counterparts in the previous restricted specifications. In particular, the coefficient of past income is no longer significant (p = 0.14). Thus, although both the short and long-

[17] The selected instrument variables are two-year lags of the number of children, the unemployment dummy, three household-type dummies (one-person household, single parent, and couple with children younger than 16), and the dummies for four different health-satisfaction levels on a [0,10] scale (1, 2, 9, and 10).

[18] Equations (4a) imply $\alpha_0 = \alpha_0^a + \lambda\alpha_{+1}$ and $\alpha_{-1}/(1-\lambda) = (\alpha_{-1}^a + \lambda\alpha_0)/(1-\lambda)$. Analogous relations follow from equations (4c).

run income effects continue to be significant with the latter being higher than the sum of the former effects, this difference is not significant. Therefore, we can no longer reject the null hypothesis of no hedonic adaptation to changes in income.

The effects of future working week and working week squared in column (5) are smaller in size than those in column (4), whereas the current, past and long-run effects are larger. The current and long-run effects are again significant, and past working week squared is again insignificant. The implied optimal number of hours worked per week is 36 in the short run and 31 in the long run, so both lower than those obtained without controlling for lagged life satisfaction. The fixed effect of future and current employment and all the effects of involuntary unemployment are somewhat smaller in size than those in column (4), whereas the past employment and the long-run employment effects are somewhat larger. The coefficients of both past employment and past involuntary unemployment are still significant ($p = 0.017$ and 0.085, respectively), so in both cases there are significant indications of hedonic reinforcement with respect to these variables.

Our estimates of dynamic income effects can be compared with those of Di Tella et al. (2007) and Di Tella and MacCulloch (2008) who analyze hedonic adaptation to income for GSOEP data for West Germany from 1984 to 1997. In the former study individual life satisfaction is regressed on current and one-to-four-years-lagged levels of net real household income while controlling for current and lagged values of a variable for job status, current values of control variables, and individual fixed effects. In the latter study this analysis is repeated for one-to-seven lags in income without control for job status. In contrast to our results, both studies find significant hedonic adaptation to income the size of which is about 80% of the current income effect in the 2008 study. Moreover, the remaining long-run income effect is insignificant ($p = 0.33$ in the 2008 study). We, on the contrary, find evidence for a sizable income effect in the long run which is significant at the 1% significance level and which is almost 80% as large as the total short-run effect.[19] Possible reasons for this discrepancy in results are the following. First, contrary to Di Tella et al., we control for future income, which has a suppressing effect on the past-income coefficient for hedonic adaptation. Second, by including lagged life satisfaction in our regressions, we control for more-than-one-year lags of not only income, but also all other variables in the regression. Third, our regressions span the time period from 1984 to 2007, while the time period considered by Di Tella et al. only extends to 2000. Fourth, to minimize the loss of panel observations we impose a uniform structure of exponentially declining weights on the coefficients of lagged income (and the other variables) that makes our specification more restrictive. This may affect our results. Both this possibility and the effect of a longer estimation period will be further investigated in Section 5.2.

[19] Our estimate 0.33 of the total short-run effect of income is also larger than estimate 0.10+(0.24-0.10)=0.24 from Table 3, column (3) of Di Tella and MacCulloch (2008), but this is probably due to the fact that our income measure is a three-years moving average, and hence varies less than unsmoothed income.

4.2. Estimation results for the error-correction equation

This section presents estimation results for error-correction (ECM) equation (5) without and with social reference income and for ECM equation (7) with relative income. These results are shown in Table 2. Just like autoregressive equation (3), we estimate the ECM equations by the GMM method with individual and time-fixed effects. The short-run shock effects of the exogenous variables in the ECM equations are given by the estimated coefficients of the differenced variables while the long-run level effects of the exogenous variables are given by the estimated coefficients of the lagged exogenous variables in ECM equation (9) in linear form divided by the speed-of-adjustment coefficient ρ of lagged life satisfaction. The current and future shock effects in Table 2 capture the effects of changes in variables from the previous to the current year and from the current to the next year, respectively, and they sum up to the total short-run shock effect.

Insert Table 2

The first column of Table 2 presents results for ECM equation (5) in which the social-reference-income coefficients are restricted to be zero. Autoregressive equation (3) and ECM equation (5) without social reference income have the same set of explanatory variables, but represent different approaches to analyse the short versus long-run effects of the variables of interest (see Sect. 2.2). Hence, the estimates in column (1) of Table 2 are comparable to those in column (5) of Table 1.

The coefficient of past life satisfaction in column (1) indicates a moderately high speed of adjustment ρ of 0.57, which equals one minus the coefficient λ of past life satisfaction in column (5) of Table 1 (see eq. (6b)). This implies that after exogenous shocks life satisfaction adjusted to its new long-run equilibrium value for (on average) 0.573+0.573*(1-0.573) = 0.611+0.238 = 82% of its deviation from that equilibrium within two years. The future and long-run effects of all the explanatory variables are similar to those in column (5) of Table 1, as they should be (see eqs. (3), (5) and (2)), but the current and adaptation/reinforcement effects differ as the current effects in the ECM do not include the effects of hedonic adaptation to the anticipated shocks in the current year (see eq. (6a) and the explanation in Sect. 2.2). In particular, the current income effect 0.25 is now much larger than its estimate 0.15 in column (5). Accordingly, the income adaptation effect -0.174, i.e. the difference between the long-run and total short-run income effects, now includes the adaptation to future income, and hence is much larger in size than the partial income adaptation effect -0.074 in column (5) of Table 1, and strongly significant. Thus, according to the more complete measure in column (1) of Table 2 there is significant hedonic adaptation with respect to income. On the other hand, contrary to the findings of Di Tella et al. (2007, 2008), this adaptation is still incomplete because of the remaining significant long-run income effect 0.25. The degree of this adaptation is 0.174/(0.171+0.253) = 41% of the total short-run effect 0.42.

The estimated coefficients of current working week and current working week squared differ only little from those in column (5) of Table 1 as the future shock effects of these variables are only small, and hence have only small adaptation effects. As a result, the total reinforcement effects do not differ much from those in column (5) in Table 1 and remain insignificant. Additionally, the short-run optimal number of working hours 34 is similar to its estimate 36 in column (5). The current employment effect remains insignificant. Accordingly, the reinforcement has become much weaker and insignificant due to the inclusion of the adaptation to the anticipated employment shock. Finally, the current involuntary-unemployment effect has become more strongly negative and the significant reinforcement in column (5) of Table 1 has turned into an insignificant adaptation by the inclusion of the adaptation to the anticipated unemployment shock. In general, by including the effects of adaptation to anticipated shocks, the adaptation/reinforcement measures in the ECM approach give a more adequate picture of the total hedonic adaptation to or reinforcement of short-run shocks in the long run.

Column (2) of Table 2 presents results for equation (5) with social reference income. With this specification we investigate the effects of social reference income on life satisfaction and on the sizes of the coefficient estimates in column (1), with a special focus on the income variables. Interestingly, the coefficients of social reference income show insignificant short-run effects[20], but a significant and sizable negative effect in the long run. This result improves on estimates in the literature (McBride, 2001; Ferrer-i-Carbonell, 2005; Luttmer, 2005; Vendrik and Woltjer, 2007; Weinzierl, 2006) in three important ways. First, it makes a distinction between short and long-run effects of social reference income, whereas in the literature only current effects of social reference income are estimated. Just as the current income effect in the static equation of column (1) of Table 1 is similar to the long-run income effect in column (2) of Table 1, the strong effects of current social reference income in the existing studies correspond to the long-run effect in our error-correction model.[21] Second, in contrast to these studies, we control for the effects of expectations with respect to future income changes. If such expectations are not controlled for, they may be picked up by the social reference income variable, implying a positive bias in its coefficient (Clark et al., 2006a, p.50; cf. Senik, 2004). Third, we control for adaptation to income.[22]

Considering the other coefficients in column (2), we see that the speed-of-adjustment coefficient of past life satisfaction is somewhat higher than in column (1). This also holds for the effect of a future income shock, which is consistent with the positive correlation of income expectations with social reference income alluded to above. Accordingly, the estimated strength of

[20] The total short-run effect as given by the sum of future and current effects is insignificant as well (p=0.600).
[21] Estimating a static equation corresponds to estimating a long-run relation in the context of an ECM. The latter estimation constitutes the first stage of the two-stage Engle-Granger procedure of estimating an ECM.
[22] Weinzierl (2006) is the only study that also controls for adaptation to income. However, he includes only the one-year lag of income in his regression equation, whereas we control for higher-order lags of income and the other variables via the lagged-life-satisfaction variable.

hedonic adaptation with respect to income is also larger. Remarkably, all the coefficients of working week and working week squared are smaller in size than those in column (1). Thus, without control for social reference income these working time variables pick up some part of the effects of social reference income, These differences result in a higher short-run optimal number of working hours per week (36) than its counterpart in column (1) (34) and a somewhat lower long-run optimal number of hours (30). The corresponding short and long-run curves of intrinsic utility of positive working hours are shown in Figure 4. Although the differences between these two curves are not significant, they suggest that the intrinsically optimal number of working hours is lower in the short run than in the long run. Also note that the maximal levels of the intrinsic utilities are now negative (around -0.06), but insignificantly different from zero. Thus, on average, the "intrinsic" life satisfaction of individuals entering and leaving the labour force was not higher or lower when they were working than when they were not working (cf. the beginning of Sect. 4.1). Finally, the short and long-run effects of employment and involuntary unemployment are rather similar to those in column (1) with a somewhat larger long-run effect of involuntary unemployment.

Insert Figure 4

The long-run effect of social reference income (-0.27) is similar in size to the long-run effect of one's own income (0.25). This implies that relative income, i.e. income divided by reference income or ln(income) – ln(reference income) in logarithmic form, is much more important than absolute income in the long run. This holds as the relative income effects are just the opposite of the reference- income effects (0.27 in the long-run) and as the absolute income effects are given by the differences between the "total" income effects and the relative income effects (0.25-0.27 = -0.02 in the long run) (see eqs. (8a) and (8b)). These effects are shown in column (3) of Table 2, where the coefficient estimates and standard errors for the other variables are identical to those in column (2). Interestingly, the current absolute income effect is significantly positive while the future and long-run absolute income effects are insignificant. Hence, changes in absolute income have a significantly positive total effect of 0.36 in the short run (future plus current effect), but no significant effect (-0.01) in the long run. This suggests that adaptation with respect to absolute income is complete (though it is not complete with respect to "total" income = absolute income + relative income!). On the other hand, changes in relative income have insignificant effects in the short run, but a significantly positive and sizable effect in the long run. Thus, when people received a rise in their wage, they were first happier because of the higher wage in comparison to their previous wage, but later on they got used to that and only remained happier when their wage turned out to be higher in comparison to that of others.

This combination of results with respect to absolute and relative income effects can explain the Easterlin paradox as illustrated for West Germany in Section 3.2. This explanation is more adequate and subtle than the two explanations for the paradox that have been advanced in the literature so far (see Sect. 3.2). The first explanation is based on the hypothesis that the absolute income effect on life satisfaction is insignificant, whereas the relative income effect is significant. However, our results for West Germany suggest that this only holds in the long run and not in the short run. The second possible explanation is that people fully adapt to rises in their income over time, but that they do not adapt to a higher relative position. However, our results suggest that people do not fully adapt to rises in their income, but only to rises in their *absolute* income. Therefore, to explain the Easterlin paradox we need a more sophisticated line of arguments that can be interpreted as a synthesis of the two explanations in the literature. This line of arguments departs from the observation that if the income distribution does not change, relative incomes remain the same over time, and that rises in absolute income only have short-run shock effects. In the long run individual life satisfaction will tend to return to its original level due to adaptation, but when steady economic growth leads to a continuous rise in absolute income the downward movements of life satisfaction will be counteracted by continuous upward shock effects of new income rises. At some point these opposite forces will balance and stabilize on a flat time path of life satisfaction that is somewhat above its long-run equilibrium level at the given constant relative incomes. Taking into account that there is a slight downward trend in mean life satisfaction in Figure 1, Appendix A derives that the upward distance between the time path of mean life satisfaction and its long-run equilibrium trajectory is on average 0.006, and so is very small.

An important general implication of the significant long-run effects on life satisfaction of relative income, working week, working squared, employment, involuntary unemployment and many control variables (especially subjective health) is a direct rejection of the psychological setpoint theory according to which, after a shock in a person's objective conditions of life, her happiness always returns to the same individual-specific baseline level (as represented by the individual fixed effect in equation (7)).

5. Subsample and robustness results for the error-correction equation

5.1. Subsample estimation results for the error-correction equation

This section presents coefficient estimates for error-correction equation (5) across different sub-groups. This allows us to investigate whether these estimates are similar to those for the full sample and the other subsamples or whether there are some interesting differences between the sub-groups. We consider a coefficient estimate for a subsample as similar or consistent to the estimate of the same coefficient for the full sample if the coefficient estimate for the subsample is not significantly different from the estimate for the full sample. The sub-groups are men versus women, a high versus low-income group, and the observations in the first half versus the second half of the sample period. The high-income group consists of individuals with income levels higher or equal to the median income and the low-income group consists of individuals with income levels below the median income. We consider these two sub-groups primarily to examine whether richer people are more sensitive to social-reference income than poorer people, as sometimes suggested in the literature (see, e.g., McBride, 2001) The two different time periods are [1984-1995] and [1996-2007] . Comparing estimates for these sub-periods with each other and with those for the full sample allows us to test whether the effects found are stable over time. The results for the six sub-groups are displayed in Table 3.

Insert Table 3

Columns (1) and (2) present the results for the male and female subsamples. The adjustment coefficient for men is larger in size than those for women and the full sample. The short and long-run effects of income are also stronger for men than for women and the full sample. Furthermore, income adaptation is insignificant for men in contrast to women and the full sample. Social reference income has, just as for the full sample, insignificant short-run effects for both men and women, but different from the full sample it has insignificant long-run effect for men, and women. Thus, an interesting difference between the results for men and women is that women display highly significant hedonic adaptation to income, whereas men display no significant hedonic adaptation. Important implications of these different patterns for men and women are that the total short-run absolute income effect (i.e. the sum of future and current differences between the income and reference income effects) is weakly significantly positive for men (p = 0.10), but insignificant for women, while the relative income effect is insignificantly both for men and women. In combination with the latter finding, the insignificance of the absolute-income effect in the long run for both men and women explains the Easterlin paradox for men, but only the flat pattern of the development of average life satisfaction over time for women.[23]

Remarkably, all the coefficient estimates for working week are insignificant for men and all the coefficient estimates for working week squared are insignificant for women. Still, the coefficients for women imply significant and plausible short and long-run optimal number of working hours for the intrinsic utility of 38.0 (±15.1) and 27.7 (±6.4) hours per week, respectively (but insignificantly different). On the other hand, for men the insignificantly positive total short-run effect of working week (0.155) in combination with the insignificantly negative total short-run effect of working week squared (-0.187) implies insignificant optimal working hours in the short run of 16.7 (±28.5), while the long-run optimal number of hours is significantly positive (23.5).

For the fixed effect of employment there are some interesting differences between men and women. For men the current employment effect is significantly and strongly positive, whereas for women there is a significantly negative and sizable effect of future employment similar to that for the full sample. In the long run the positive effect of employment for men becomes insignificant, whereas

[23] Note that an explanation of the positive correlation between income and life satisfaction in the cross section requires a significantly positive relative-income effect (see Sect. 3).

the negative employment effect for women becomes significant (p = 0.03) and slightly stronger, as in the full sample. In both cases, as in the full sample, there are no significant indications of hedonic adaptation or reinforcement. For involuntary unemployment there are significantly negative and large effects in the short and long run for both the male and female subsamples, as for the full sample. However, the magnitudes of these effects are larger in absolute value for men, especially in the long run. Still, as in the full sample, there are no significant indications of hedonic adaptation (for women) or reinforcement (for men).

Columns (3) and (4) present the results for the high and low-income subsamples. The adjustment coefficient of low-income group is larger in size than those for the high-income group and the full sample. The future-income shock effect is also stronger for low-income group than for high-income group and the full sample. On the other hand, the current-income shock effect is the strongest for high-income group among all. Interestingly, we find that high-income group cares only about current income changes while low-income group cares about both the future and current income changes almost equally. The long-run income effect in low-income group is slightly larger in size than its high-income group counterpart but both effects are smaller in size than the one in the full sample. Income adaptation is significantly negative in both groups and it is stronger in high-income group than in low-income group and the full sample. Unlike the full sample, the effect of reference income is insignificant in low-income group. Both the total short and the long-run social reference effects are significant in high-income group while only the long-run effect is significant in the full sample. Additionally, social reference income effects are stronger for high-income group than for the full sample. The same pattern is also observed with respect to relative income. Both the total short and long-run relative income effects are significantly positive in the high-income subgroup while these effects are insignificant in the low-income subgroup. High and low-income subgroups have a common result showing that the effect of absolute income is insignificant long run. The short-run absolute income effect is significantly positive in the low-income group only. The relative-income based explanation is relevant to solve the Easterlin paradox in the case of high-income group but only partially relevant in the case of low-income group.

Working week and working week squared effects are found only in the low income group similar to the full sample and these effects are much stronger in low-income group. Moreover, both the total short and long-run effects are significant in low-income group while only the long-run effect is significant in the full sample. In fact, intrinsic utility of working hours is the strongest in low-income group among all others. Based on working week variable coefficient estimates, short-run optimal number of working hours for high and low income groups are 10.8 (±57.6) hours and 41.4 (±4.6) hours, respectively. Long-run optimal number of working hours for high and low income groups are 22.4 (±10.4) hours and 36.7 (±3.5) hours, respectively. Results regarding employment and involuntary unemployment effects are stronger in absolute value in low-income group than in high-income counterpart.

Columns (5) and (6) present the results for the sub-periods [1984-1995] and [1996-2007]. When we employ only the second 11 years of full sample period then, the adjustment coefficient slightly increases in size than those for the sub-period [1985-1995] and the full sample. The total short-run effect of income is stronger for the second sub-period than for the first and the full sample. On the other hand, the long-run effect of income is stronger for the first sub-period than for the second and the full sample. Income adaptation is insignificant for the first sub-period in contrast to the second and the full sample. Social reference income has no significant effect in the second sub-period while both the total short and long-run effects of social reference income are significantly negative in the first sub-period. Social reference income effects are much stronger for the first sub-period than the effect found in the full sample. In fact, these effects are the strongest among all counterparts in the remaining subsamples and there is no evidence for significant adaptation with respect to this negative effect. Accordingly, neither total short nor long-run effect of relative income is significant in the second sub-period while they are both significantly positive in the first sub-period. Absolute income has no significant effect in the first sub-period while total short-run effect of absolute income is significantly positive in the second sub-period. As a result the relative income effect explains the Easterlin paradox for the first 11 years but not for the last 11 years of the full sample.

Optimal working hours in each sub-period is quite different. The optimal number of working hours in the short run for the first sub-period is 21.6 (±36.7) hours while for the second sub-period it is 40 (±8.9) hours. In the long run for the first 11 years we find that working 21.5 (±12.4) hours per week is optimal while for the last 11 years it is 33.4 (±8.1) hours per week. In both sub-periods we find significantly negative involuntary unemployment effect in the short and the long run without any adaptation. However, the magnitude of these effects is larger in the first sub-period.

5.2. Robustness

This section analyses the robustness of the results for the baseline ECM specification in column 2 of Table 2. We first introduce lagged shock terms in addition to current and future shock terms in order to relax the assumption of a uniform lag structure for all explanatory variables in the baseline model. We continue the robustness analysis with a specification where we introduce two-years future shock terms into the baseline specification. The third specification is the baseline specification excluding the health satisfaction dummies. Finally, we complete the analysis with the baseline specification in which age and age squared variables are replaced by age-class dummies.

Our baseline model can allow for infinitely many lags by assuming a uniform lag structure. We relax this assumption by introducing lagged shock terms into the baseline model and check the robustness of our results. Table 4 presents the main variables. In the extended ECM the coefficient estimate of lagged life satisfaction we observe changes in coefficient sizes but all these estimates lie within the confidence interval of the baseline model. As a result, we conclude that the coefficient estimates in the baseline model and the extended ECM are not statistically different. Importantly, even when the uniform lag structure assumption is relaxed we still do not find complete income adaptation in the long run in contrast to Di Tella et al. (2007, 2008).[24]

Another robustness check is introducing two-years future shock terms in to the baseline model. All changes with respect to the main variables are still within the confidence intervals of the baseline estimates so we conclude that the baseline estimates are robust. Additionally, the null hypothesis that the two-years future shock term coefficients of income, reference income, working week and working week squared, employment dummy and unemployment dummy are equal to zero is not rejected.

In the baseline model we controlled for health satisfaction as changes in health satisfaction over time may affect both income and life satisfaction, and hence create a spurious correlation between these variables. However, health satisfaction may also be a channel by which changes in (absolute) income allows higher expenditures on health care. Controlling for health satisfaction then leads to an underestimation of (absolute-) income effects. To test whether this might be the case, we estimate the baseline ECM without the health satisfaction dummies as controls. This did not lead to significantly different results suggesting that the baseline ECM results are robust.

Our estimates of the effects of social reference income are plagued by multicollinearity with other variables like age and education level. In particular, the age variables pose a problem. To assess the sensitivity of the reference-income coefficients to the multicollinearity with these variables, we replace age and age squared by three age-class dummies, one for individuals between 26 and 35, one for individuals between 36 and 45 and one for individuals between 46 and 60. These age classes are the same classes we use in the definition of our social reference group. We find that the reference-income estimates are not sensitive to replacing age and age squared by the age class dummies.

6. Total utility of working hours

This section introduces the total utility function of working hours and presents the optimum number of working hours for the full sample and the sub-samples based on it. The total utility consists of the intrinsic utility of working hours plus the utility of income generated by working hours. We dropped the income variables out so that the working hours and working hours squared variables capture the effect of income implied by the number of working hours. We approximate the short-run total working-hours utility function by estimating the ECM equation (5) without the income variables and the long-run total working-hours utility function by estimating the ECM equation (7) without the absolute income variables.

We expect to find higher number of working hours using the total utility function. For the full sample our expectation is realized for the short-run optimum number of working hours which has

[24] The result also holds when unsmoothed income is employed instead of smoothed income.

increased to 38.4 (±5.3) hours while the long-run optimum stays the same at 30.5 (±3.5) hours per week (see Figures 5 and 6). Figure 5 shows that the short-run intrinsic utility optimum is lower than the short-run total utility optimum. We find that for men it is optimal to work 20.6 (±26.0) hours per week in the short-run and 24.0 (±11.3) hours per week in the long-run. When we consider total utility function instead of intrinsic utility function, women increase the short-run optimal number of working hours to 43.4 (±17.7) hours per week on the one hand and decrease the long-run optimal number of working hours to 27.9 (±6.4) hours per week on the other hand. For the high-income subsample the short-run optimum increases to 13.7 (±64.8) while the long-run optimum stays almost the same at 22.2 (±10.6) hours per week. For the low-income subsample relatively high short-run optimum number of hours, based on intrinsic utility function, further increases to 42.3 (±4.6) when total utility function is employed. The long-run optimum number of working hours remains at the same level at 36.8 (±3.5) hours per week for the low-income subsample. For the first sub-period [1985-1995] the short-run optimum number of working hours, based on total utility function, is 29.5 (±22.5) hours per week while the long-run optimum is 21.2 (±12.7) hours per week. Finally, for the second sub-period [1996-2006] the short-run optimum number of working hours, based on total utility function is 43.2 (±9.8) hours per week and the long-run optimum is 34.5 (±8.0) hours per week.

Insert Figures 5 and 6

We observe that using total utility function instead of intrinsic utility function with respect to working hours has influence over the short-run results. When total utility function is considered, the short-run estimates of optimum number of working hours increase in all samples while the long-run results mostly stay the same. Total utility function reveals that the short-run individual optimum (38.4) is higher than the long-run social optimum (30.5) meaning that individuals fail to anticipate hedonic income adaptation and choose longer working hours. Data confirms that individuals are short-sighted since the estimated short-run optimum (38.4 hours) is comparable to the actual working hours (36.4 hours) of the working individuals in the data. We conclude that West Germans work too hard in the short run given the average level of labour demand between 1984 and 2007. This finding, even though the difference between individual and social optimum working hours is not statistically significant, illustrates Layard’s argument that relative income concerns increases working hours above the social-welfare optimum.

It is important to note that short-run absolute income effect on life satisfaction is significantly positive. This finding implies that temporary life satisfaction gains are possible by working 3 hours worth of overtime. However, this overtime work duration should not be longer than 3 months to prevent the downward trend in life satisfaction due to hedonic income adaptation. Additionally, it is socially optimal to resume overtime work every 2 or 3 months. As a conclusion, we find that an alternating cycle of 3 hours’ overtime work is socially optimal. Under the light of these, socially optimum working increases to incorporate the extra gain of overtime work and it is approximated to 30.3 hours per week as the average of the short and the long-run social optimum.

From social-welfare point of view optimum working hours per week is at 30.5 hours. On the other hand, we find that individual optimum occurs at 38.4 hours per week. We can calculate the socially efficient consumption and/or income tax rate that maintains the social optimum. In the case of a 100% tax rate all financial utility of working will be removed and individuals decide how many hours to work based on intrinsic utility of working. Given the assumption that individuals are short-sighted then working hours per week will equal the short-run optimum of intrinsic utility function, i.e. 35.5 hours per week. Hence, 100% tax rate is not high enough to maintain the social optimum and the corrective tax rate should be higher than 100%.[25] The implied tax rate is much higher than the existing rate of 60% (income tax of 40% and VAT of 20%) and would represent complete income redistribution.

The result suggesting a corrective tax rate of more than 100% is due to the presence of relatively high intrinsic utility of working compared to financial utility. However, intrinsic utility is estimated conditional on existing tax rates and hence it is misleading to assume that intrinsic utility will remain at the same level when tax rates are increased. The level of intrinsic utility is not independent of the associated extrinsic reward, wage income in this case. Intrinsic motivation is crowded out by introducing inappropriate extrinsic reward, e.g. offering money to blood donors, as well as eliminating appropriate extrinsic rewards. In the case of working hours intrinsic utility might decrease due to elimination of an appropriate extrinsic reward due to increased tax rates. Social welfare will fail to improve if intrinsic utility of working decreases when a corrective tax increase is implemented. As a result intrinsic-motivation problems of high taxation should be taken into account in derivations of efficient tax rate.

7. Conclusion

This study has investigated hedonic adaptation, anticipation and social-reference effects on life satisfaction in the context of an integrated dynamic life satisfaction equation. The focus was on income and working hours, but we controlled for similar dynamics with respect to a large set of control variables. To render estimation of this huge equation feasible we transformed it into an autoregressive equation, and further into an error-correction equation. Estimation of these equations for GSOEP panel data for the years 1984-2007 yielded estimates of short and long-run effects of income, social reference income, working hours, employment, involuntary unemployment and the control variables on life satisfaction. These estimates indicate significant short and long-run effects of

[25] We compute that the corrective tax rate to decrease working hours per week from 31.5 hours to 30.3 hours is 162%. The tax rate increases substantially even though the difference between individual and social optimum is relatively low because financial utility of working is much lower than intrinsic utility of working.

income on life satisfaction with incomplete hedonic adaptation. Social reference income has a significant impact in the long run, but not in the short run. Consequently, absolute income is insignificant in the long term. Surprisingly, actual working time has a positive intrinsic utility with an optimum for 35 hours worked per week in the short run and 29 hours per week in the long run.

For the first time in the life satisfaction literature we employ an error-correction approach to model life satisfaction. This paper is an improvement in terms of modeling because an ECM is the most relevant model to simultaneously analyze the distinct short and long-run effects. The literature so far employed static models with lagged variables of income. This approach is clearly restrictive and less intuitive. When compared with a static model an ECM gives more information on the dynamics of any variable of interest. This paper further contributes to the literature by the fact that we control simultaneously for lags and leads of all control variables and the lagged life satisfaction. Notably, the baseline ECM results are robust to relaxing the uniform lag or lead structure assumption, not controlling for health satisfaction and possible multicollinearity between social reference income and age.

We also estimated the error-correction equation for the subsamples men versus women, high versus low income earners, and the sub-periods 1985-1995 versus 1996-2006. An interesting difference that we found between men and women is that women display significant hedonic adaptation to income, but no significant (long-run) social reference effect with respect to income, whereas the reverse holds for men. The same opposition holds for the 1996-2006 versus 1985-1995 periods with significant hedonic adaptation in the former period and a significant social reference income effect in the latter period. Finally, people with higher incomes are more sensitive to their long-run level of social reference income, but less sensitive to expected income shocks than people with lower incomes.

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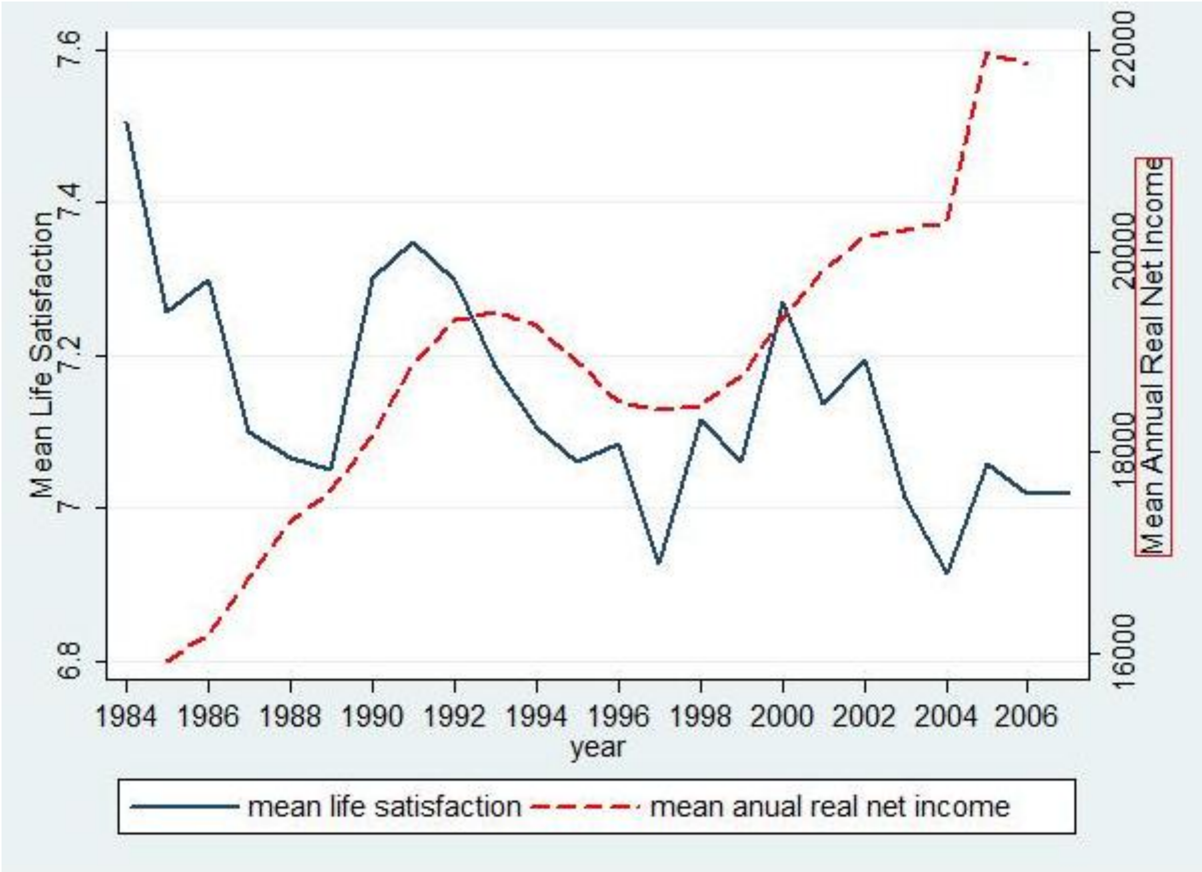
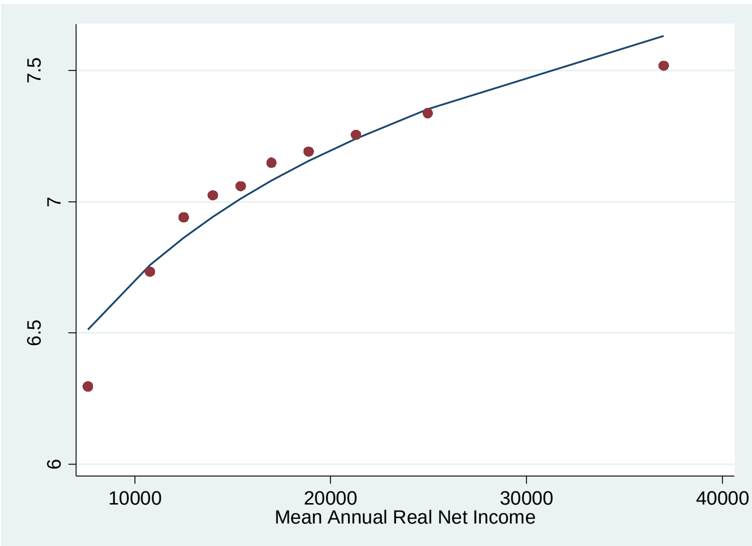
Figure 1: Mean Life Satisfaction and Mean Annual Real Net Income of West Germans of 26-60 Years Old between 1984 and 2007



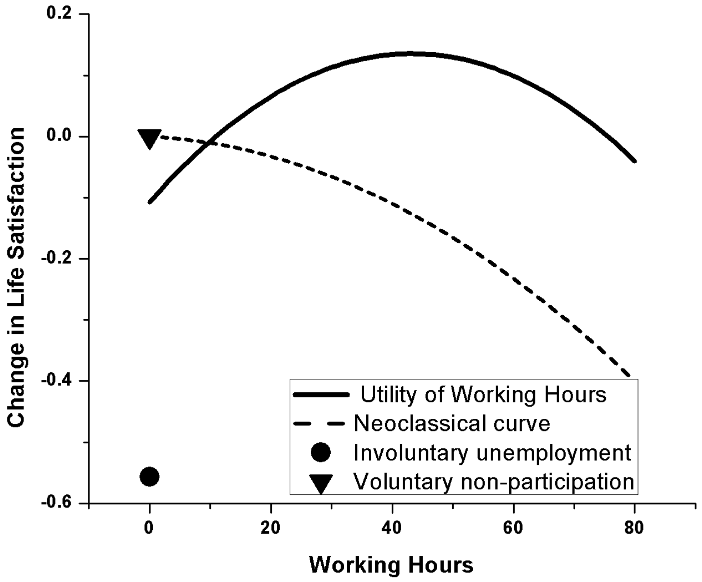
Notes: Annual real net income is three-years moving average, and hence runs from 1985 to 2006. The fitted regression line for the time trend in average life satisfaction is 7.293 – 0.012 t. The fitted regression line for the time trend in the logarithm of average income is 9.699 + 0.011 t.

Figure 2: Mean Life Satisfaction and Mean Annual Real Net Income per Income Decile for a Cross-Section of West Germans of 26-60 Years Old in 1995



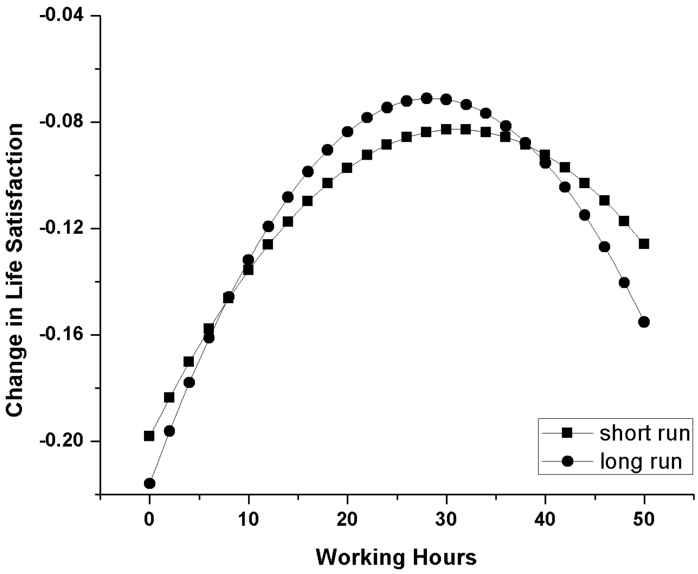
Note: The fitted regression line is 0.707 $\ln Y_t$ + 0.190.

Figure 3: Intrinsic Utility Function of Working Hours



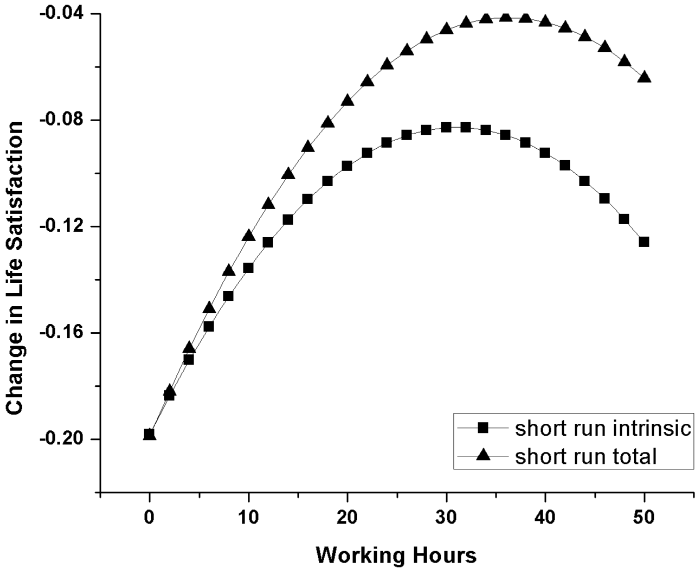
Notes: The graphs are based on the estimation results for static equation (1). The intrinsic utility function of working hours (h) is given by -0.120 + (0.512/40)h – (0.240/1600)h^2 = -0.120 + 0.0128 h - 0.00015 h^2. The coefficient estimate of the employment dummy serves as constant.

Figure 4: Short and Long-Run Intrinsic Utility Functions of Working Hours



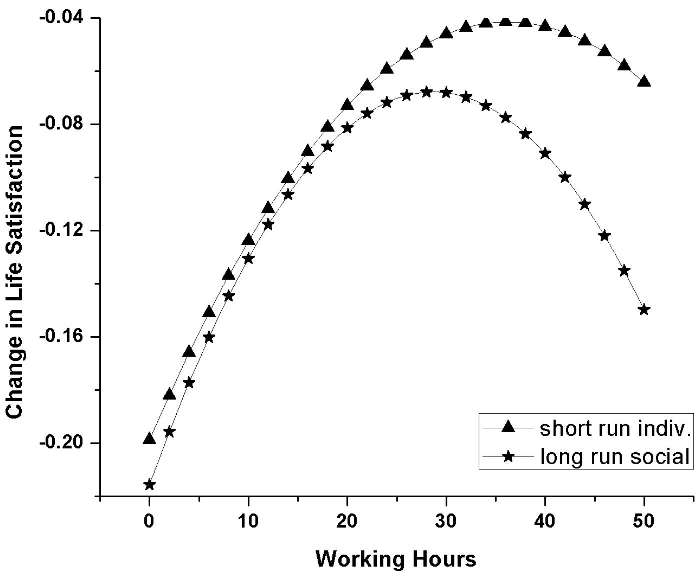
Notes: The graphs are based on the estimation results for ECM equation (5). The short-run intrinsic utility function of working hours (h) is given by -0.220 + (0.486/40)h – (0.274/1600)h^2 = -0.220 + 0.0122 h - 0.00017 h^2. The long-run intrinsic utility function of working hours is given by -0.298 + 0.0164 h - 0.00027 h^2. The coefficient estimates of the employment dummies serve as constants.

Figure 5: Short-Run Intrinsic and Total Utility Functions of Working Hours



Notes: The short-run total utility curve is based on estimation results for the ECM equation (5) excluding income variables. The equation for the short run total utility is -0.221 + (0.541/40) h – (0.282/1600) h^2 = -0.221 + 0.0135 h - 0.00018 h^2. The short-run intrinsic utility curve is based on the estimation results for the ECM equation (5). The short-run intrinsic utility function of working hours (h) is given by -0.220 + (0.486/40)h – (0.274/1600)h^2 = -0.220 + 0.0122 h - 0.00017 h^2.The coefficient estimate of employed dummy serves as constant.

Figure 6: Short-Run Individual and Long-Run Social Utility Functions of Working Hours



Notes: The short-run curve is based on estimation results for the ECM equation (5) excluding income variables. The long-run curve is based on estimation results for the ECM equation (7) excluding absolute income variables. The short-run total utility function of working hours is -0.221 + (0.541/40) h – (0.282/1600) h^2 = -0.221 + 0.0135 h - 0.00018 h^2. The long-run total utility function of working hours is -0.299 + 0.0166 h - 0.00027 h^2. The coefficient estimate of employed dummy serves as constant.

Table 1: Estimation results for the static, dynamic and autoregressive equations

Dependent Variable: Life Satisfaction (0-10)	(1) $\alpha_{+1}=\alpha_{-1}=$ $\beta_{+1}=\beta_{-1}=$ $\gamma_{+1}=\gamma_{-1}=$ $\lambda=0$	(2) $\alpha_{+1}=$ $\beta_{+1}=\beta_{-1}=$ $\gamma_{+1}=\gamma_{-1}=$ $\lambda=0$	(3) $\beta_{+1}=\beta_{-1}=$ $\gamma_{+1}=\gamma_{-1}=$ $\lambda=0$	(4) $\lambda=0$	(5)
Past life satisfaction					0.427***
					(0.072)
Future income			0.183***	0.168***	0.172***
			(0.051)	(0.051)	(0.054)
Current income	0.263***	0.384***	0.201***	0.194***	0.153**
	(0.032)	(0.046)	(0.067)	(0.067)	(0.063)
Past income		-0.131***	-0.096**	-0.090**	-0.074
		(0.043)	(0.047)	(0.046)	(0.051)
Long-run income		0.253***	0.288***	0.272***	0.251***
		(0.034)	(0.040)	(0.041)	(0.050)
Future working week				-0.068	-0.008
				(0.106)	(0.111)
Current working week	0.512***	0.535***	0.541***	0.503***	0.503***
	(0.095)	(0.101)	(0.107)	(0.103)	(0.103)
Past working week				0.146	0.280
				(0.100)	(0.171)
Long-run working week				0.581***	0.775***
				(0.177)	(0.239)
Future working week squared				0.010	-0.032
				(0.061)	(0.063)
Current working week squared	-0.240***	-0.261***	-0.260***	-0.231***	-0.242***
	(0.053)	(0.057)	(0.061)	(0.059)	(0.059)
Past working week squared				-0.121**	-0.227**
				(0.058)	(0.102)
Long-run working week squared				-0.341***	-0.500**
				(0.103)	(0.141)
(Short-run) optimal number of working hours	42.6***	41.0***	41.6***	39.5***	36.2***
	(3.4)	(3.8)	(3.4)	(5.1)	(3.8)
Long-run optimal number of working hours				34.1***	31.0***
				(3.3)	(3.0)
Future employment				-0.138***	-0.132***
				(0.050)	(0.050)
Current employment	-0.120**	-0.124**	-0.138***	0.011	-0.007
	(0.047)	(0.049)	(0.023)	(0.050)	(0.050)
Past employment				-0.114**	-0.186**
				(0.047)	(0.078)
Long-run employment				-0.263***	-0.325***
				(0.080)	(0.104)
Future involuntary unemployment				-0.210***	-0.193***
				(0.040)	(0.041)
Current involuntary unemployment	-0.577***	-0.540***	-0.531***	-0.409***	-0.395***
	(0.043)	(0.045)	(0.048)	(0.045)	(0.046)
Past involuntary unemployment				-0.122***	-0.120*
				(0.042)	(0.070)
Long-run involuntary unemployment				-0.741***	-0.708***
				(0.076)	(0.100)
R-squared	0.243	0240	0.237	0.278	0.018
Serial correlation coefficient	0.026***	0.026***	0.030***	0.021***	-0.335***
Number of individuals	13648	12399	10809	10769	9482
Number of observations	95958	84524	74089	73452	71937

Notes: OLS estimates for columns (1) to (4), GMM estimates with fixed effects for column (5). *** significant at 1%; ** significant at 5%; and * significant at 10%. Robust standard errors clustered for person number are reported in brackets below the coefficient estimates.

Table 2: Estimation Results for the error-correction models

Dependent Variable: Change in Life Satisfaction (0-10)	(1)	(2)		(3)
Past life satisfaction shock	-0.573***	-0.580***		-0.580***
	(0.072)	(0.072)		(0.072)
Future income shock	0.171***	0.197***	**Future absolute income shock**	0.157
	(0.054)	(0.053)		(0.121)
Current income shock	0.253***	0.246***	**Current absolute income shock**	0.201*
	(0.049)	(0.053)		(0.122)
Long-run income	0.249***	0.252***	**Long-run absolute income**	-0.014
	(0.050)	(0.052)		(0.156)
Income adaptation	-0.174***	-0.191***	**Absolute income adaptation**	-0.372**
	(0.054)	(0.056)		(0.168)
Future reference income shock		-0.040	**Future relative income shock**	0.040
		(0.110)		(0.110)
Current reference income shock		-0.045	**Current relative income shock**	0.045
		(0.111)		(0.111)
Long-run reference income		-0.266*	**Long-run relative income**	0.266*
		(0.148)		(0.148)
Reference income adaptation		-0.181	**Relative income adaptation**	0.181
		(0.159)		(0.159)
Future working week shock	-0.014	-0.007		0.007
	(0.111)	(0.114)		(0.114)
Current working week shock	0.496***	0.493***		-0.493***
	(0.124)	(0.128)		(0.128)
Long-run working week	0.764**	0.657***		-0.657***
	(0.238)	(0.241)		(0.241)
Working week adaptation	0.281	0.170		-0.170
	(0.181)	(0.182)		(0.182)
Future working week squared shock	-0.029	-0.025		0.025
	(0.063)	(0.065)		(0.065)
Current working week squared shock	-0.258***	-0.249***		0.249***
	(0.070)	(0.072)		(0.072)
Long-run working week squared	-0.494***	-0.433***		0.433***
	(0.141)	(0.141)		(0.141)
Working week squared adaptation	-0.208*	-0.159		0.159
	(0.108)	(0.107)		(0.107)
(Short-run) optimal number of working hours	33.7***	35.5***		35.5***
	(4.6)	(5.1)		(5.1)
Long-run optimal number of working hours	30.9***	30.3***		30.3***
	(3.0)	(3.6)		(3.6)
Future employment shock	-0.131***	-0.134***		0.134***
	(0.050)	(0.052)		(0.052)
Current employment shock	-0.082	-0.086		0.086
	(0.059)	(0.060)		(0.060)
Long-run employment	-0.321***	-0.298***		0.298***
	(0.104)	(0.104)		(0.104)
Employment adaptation	-0.108	-0.078		0.078
	(0.086)	(0.086)		(0.086)
Future involuntary unemployment shock	-0.193***	-0.183***		0.183***
	(0.041)	(0.044)		(0.044)
Current involuntary unemployment shock	-0.504***	-0.511***		0.511***
	(0.057)	(0.059)		(0.059)
Long-run involuntary unemployment	-0.708***	-0.732***		0.732***
	(0.100)	(0.102)		(0.102)
Involuntary unemployment adaptation	-0.010	-0.038		0.038
	(0.074)	(0.076)		(0.076)
R-squared	0.458	0.462		0.462
Serial correlation coefficient	-0.335***	-0.331***		-0.331***
Number of individuals	9482	9097		9097
Number of observations	71937	68320		68320

Notes: GMM estimates with fixed effects for columns (1) to (5). Column (1) represents the ECM without social reference income, column (2) represents the ECM with social reference income, and column (3) represents the ECM with relative income. *** significant at 1%; ** significant at 5%; and * significant at 10%. Robust standard errors clustered for person number are reported in brackets below the coefficient estimates.

Table 3: Subsample estimation results for the ECM with reference income

Dependent Variable Change in Life Satisfaction (0-10)	(1) Male	(2) Female	(3) High Income	(4) Low Income	(5) 1985-1995	(6) 1996-2006
Past life satisfaction	-0.710***	-0.572***	-0.571***	-0.621***	-0.582***	-0.590***
	(0.127)	(0.103)	(0.121)	(0.095)	(0.098)	(0.116)
Future income shock	0.282***	0.169***	0.124	0.207***	0.205**	0.188**
	(0.095)	(0.063)	(0.099)	(0.068)	(0.083)	(0.077)
Current income shock	0.217**	0.263***	0.294***	0.199***	0.201**	0.285***
	(0.094)	(0.066)	(0.099)	(0.075)	(0.082)	(0.076)
Long-run income	0.360***	0.213***	0.193*	0.222***	0.281***	0.235**
	(0.086)	(0.063)	(0.112)	(0.080)	(0.100)	(0.092)
Income adaptation	-0.140	-0.219***	-0.225**	-0.185**	-0.125	-0.238***
	(0.105)	(0.068)	(0.103)	(0.074)	(0.093)	(0.084)
Future reference income shock	-0.033	-0.065	-0.256*	0.107	-0.409**	0.120
	(0.151)	(0.157)	(0.138)	(0.185)	(0.214)	(0.132)
Current reference income shock	-0.024	-0.074	-0.209	0.068	-0.363*	0.119
	(0.164)	(0.156)	(0.142)	(0.192)	(0.220)	(0.139)
Long-term reference income	-0.290	-0.213	-0.441**	-0.118	-0.639**	-0.108
	(0.191)	(0.206)	(0.203)	(0.239)	(0.292)	(0.213)
Reference income adaptation	-0.232	-0.074	0.005	-0.293	0.133	-0.347
	(0.225)	(0.220)	(0.212)	(0.271)	(0.290)	(0.215)
Future working week shock	-0.166	-0.041	-0.071	0.188	-0.106	-0.032
	(0.204)	(0.157)	(0.154)	(0.173)	(0.176)	(0.165)
Current working week shock	0.322	0.359*	0.111	1.066***	0.200	0.577***
	(0.254)	(0.185)	(0.182)	(0.200)	(0.205)	(0.196)
Long-run working week	0.418	0.448	0.351	1.275***	0.324	0.492
	(0.425)	(0.328)	(0.381)	(0.347)	(0.397)	(0.367)
Working week adaptation	0.262	0.131	0.311	0.021	0.230	-0.053
	(0.285)	(0.258)	(0.263)	(0.278)	(0.273)	(0.267)
Future working week squared shock	0.020	-0.033	0.004	-0.105	0.020	-0.002
	(0.100)	(0.101)	(0.086)	(0.102)	(0.102)	(0.092)
Current working week squared shock	-0.206*	-0.200	-0.078	-0.501***	-0.107	-0.270**
	(0.120)	(0.122)	(0.100)	(0.117)	(0.116)	(0.109)
Long-run working week squared	-0.355*	-0.324	-0.313	-0.695***	-0.302	-0.294
	(0.204)	(0.215)	(0.221)	(0.203)	(0.230)	(0.212)
Working week squared adaptation	-0.168	-0.157	-0.239	-0.089	-0.215	0.022
	(0.141)	(0.169)	(0.154)	(0.169)	(0.162)	(0.151)
(Short-run) optimal number of working hours	16.7	38.0**	10.8	41.4***	21.6	40.0***
	(28.5)	(15.1)	(57.6)	(4.6)	(36.7)	(8.9)
Long-run optimal number of working hours	23.5**	27.7***	22.4**	36.7***	21.5*	33.4***
	(11.7)	(6.4)	(10.4)	(3.5)	(12.4)	(8.1)
Future employment shock	-0.033	-0.134**	-0.201***	-0.158**	-0.114	-0.110
	(0.130)	(0.061)	(0.077)	(0.073)	(0.080)	(0.074)
Current employment shock	0.335**	-0.100	-0.114	-0.221***	-0.030	-0.079
	(0.168)	(0.072)	(0.098)	(0.083)	(0.093)	(0.092)
Long-run employment	0.187	-0.258**	-0.325*	-0.432***	-0.232	-0.162
	(0.266)	(0.122)	(0.181)	(0.136)	(0.170)	(0.165)
Employment adaptation	-0.115	-0.024	-0.010	-0.053	-0.088	0.027
	(0.208)	(0.100)	(0.142)	(0.114)	(0.130)	(0.116)
Future involuntary unemployment shock	-0.230***	-0.126**	-0.231***	-0.146**	-0.235***	-0.149**
	(0.079)	(0.057)	(0.066)	(0.060)	(0.073)	(0.061)
Current involuntary unemployment shock	-0.530***	-0.353***	-0.506***	-0.467***	-0.605***	-0.463***
	(0.120)	(0.074)	(0.098)	(0.080)	(0.095)	(0.087)
Long-run involuntary unemployment	-0.910***	-0.406***	-0.754***	-0.706***	-1.024***	-0.572***
	(0.169)	(0.136)	(0.181)	(0.135)	(0.170)	(0.164)
Involuntary unemployment adaptation	-0.150	0.073	-0.017	-0.093	-0.185	0.039
	(0.166)	(0.091)	(0.130)	(0.100)	(0.141)	(0.108)
R-squared	0.507	0.459	0.458	0.490	0.479	0.475
Serial correlation coefficient	-0.246***	-0.335***	-0.355***	-0.340***	-0.358***	-0.386***
Number of individuals	4330	4767	5377	5327	4814	6985
Number of observations	32359	35938	34631	32465	31735	36084

Notes: GMM estimates with fixed effects for columns (1) to (6). *** significant at 1%; ** significant at 5%; and * significant at 10%. Robust standard errors clustered for person number are reported in brackets below the coefficient estimates.

Table 4: Estimation results for the ECM with lagged shock terms

Dependent Variable Change in Life Satisfaction (0-10)			
Past life satisfaction shock	-0.372*	**Future working week squared shock**	-0.014
	(0.209)		(0.074)
Future income shock	0.230***	**Current working week squared shock**	-0.215***
	(0.063)		(0.077)
Current income shock	0.212***	**Past working week squared shock**	-0.030
	(0.78)		(0.081)
Past income shock	0.026	**Long-run working week squared**	-0.427*
	(0.064)		(0.247)
Long-run income	0.280***	**Working week squared adaptation**	-0.168
	(0.92)		(0.250)
Income adaptation	-0.188*	**(Short-run) optimal number of working hours**	32.1***
	(0.110)		(7.0)
Future reference income shock	-0.085	**Long-run optimal number of working hours**	24.3***
	(0.130)		(8.7)
Current reference income shock	0.063	**Future employment shock**	-0.113*
	(0.129)		(0.059)
Past reference income shock	-0.021	**Current employment shock**	-0.047
	(0.139)		(0.070)
Long-run reference income	-0.215	**Past employment shock**	0.086
	(0.244)		(0.059)
Reference income adaptation	-0.215	**Long-run employment**	-0.378**
	(0.297)		(0.178)
Future working week shock	-0.038	**Employment adaptation**	-0.303
	(0.131)		(0.193)
Current working week shock	-0.430***	**Future involuntary unemployment shock**	-0.173***
	(0.137)		(0.052)
Past working week shock	0.024	**Current involuntary unemployment shock**	-0.461***
	(0.130)		(0.075)
Long-run working week	0.518	**Past involuntary unemployment shock**	-0.026
	(0.411)		(0.062)
Working week adaptation	0.102	**Long-run involuntary unemployment**	-0.622***
	(0.428)		(0.214)
		Involuntary unemployment adaptation	0.040
			(0.208)
R-squared	0.362		
Number of individuals	6492		
Number of observations	56509		

Notes: GMM estimates with fixed effects for. Table (4) presents the ECM equation (5) with lagged shock terms. *** significant at 1%; ** significant at 5%; and * significant at 10%. Robust standard errors clustered for person number are reported in brackets below the coefficient estimates.