Estimating linear birth cohort effects: revisiting the age-happiness profile

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Abstract

This paper provides a simple way of accounting for linear birth cohort effects, together with linear age and calendar time effects. It relies on the discreteness of the data and on the fact that not all individuals are born/interviewed in the same day. This creates an exogenous source of age variation within the same cohort that breaks the linear dependence between the three variables.

This method is applied to a happiness equation and shows that, once a linear birth cohort term is included in the regression equation, together with linear age and calendar time terms, the robustly found U-shape profile of happiness in age disappears.

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1 Introduction

The analysis of a phenomenon often requires a simultaneous account of birth cohort, age and calendar time measures. Such phenomena stem from studies in Epidemiology, Demographics and more recently, in Economics. For example, one can be interested in evaluating medical progress through the analysis of tuberculosis outcomes in successive generations; or to predict lung cancer incidence rates, given the changing smoking and cultural habits; or to disentangle the impact of mortality rate reduction at infancy, from overall decreases in mortality throughout time (see Susser (2001) and Holford (1983) for a brief discussion of the most influential papers in Demographics and Epidemiology). In Economics, one can be interested in predicting an individual wage profile, given the changing labor market conditions and changing composition of the supply side.

There is no reason to expect lifecycle profiles of any such phenomenon to be the same across different generations or cohorts, not even after macroeconomic shocks, which affect all members of the existing population equally, have been accounted for. However, because these three variables are linearly dependent[1], considering all of them simultaneously cannot be done without some arbitrary restrictions.

The main statistical methods used to address this issue rely on too stringent assumptions. One assumes the linear birth cohort effect is zero and only estimates higher order effects from the data (e.g. B. Fitzenberger and Schnabel (2001), Card and Lemieux (2000) and MaCurdy and Mroz (1995)). The other main method assumes birth cohort effects are homogenous within a given interval of birth years. Instead of conditioning on a function of birth year *per se*, one conditions on intervals containing more than one birth year, while age and calendar time are still measured in years. This has been the most widely used method. Examples are Card and Lemieux (2001), Freeman (1979), Easterlin (2001) and B. Fitzenberger and Schnabel (2001).

This paper proposes a method that seeks to identify the linear effects of all 3 factors simultaneously. It exploits the discreteness of the data and the fact that not all individuals are born/interviewed in the same day. As such, some individuals have had their birthday by the time of the interview while others have not. It is then possible to observe individuals belonging to the same birth

[1] Age a can be written as the difference between current time t and birth time c, as $a = t - c$. Hence $\lambda_a a + \lambda_t t + \lambda_c c = 0$ when $\lambda_a = \lambda_c = 1$ and $\lambda_t = -1$.

year cohort with different ages purely due to exogenous reasons. This creates an exogenous source of age variation within the same birth year cohort, which breaks the linear dependence between the three variables. These linear effects, as well as nonlinear effects are thus identified with very few parametric assumptions, even at the individual level.

This method is applied to a happiness equation. A U-shape age-happiness profile is often found in the literature (see e.g. Ferrer-i-Carbonell and Frijters (2004)). The initial decline in average happiness is attributed to overoptimistic expectations that when confronted with actual realizations, provoke disappointment when individuals reach their 30's or 40's. Afterwards, individuals adapt to present circumstances and restore initial happiness levels (Easterlin (2001)). However, these studies do not account for all 3 factors simultaneously. Either birth cohort or calendar time are omitted. When all 3 factors are included, the estimated profile's shape is not as robust. The next section describes the linear dependence problem and how each statistical method attempts to tackle it. Section 3 estimates an age-happiness profile applying the proposed method while section 4 concludes.

2 Estimating lifecycle effects

Individual i's birth year cohort c, current calendar time t and his current age a are structurally related through the following identity:

$$a_{it} = t - c_i \tag{1}$$

We are interested in the impact of all 3 factors age, cohort and time on a particular phenomenon of interest y. y can be earnings or skill-relative wages, consumption, savings, happiness, probability of cancer, mortality rate, etc.. Let's assume y is well described by a function of a, c and t and an additively separable well-behaved error term u:

$$y_{act} = f(a, c, t) + u = f(a_{ct}, t - a_{ct}, t) + u = g(a_{ct}, t) + u_{ct} \tag{2}$$

The main problem is to identify the linear effects of all the three variables on y, given their structural dependence[2]. Suppose we are interested in estimating

[2] This problem can always be solved if there is an available instrument for the variable whose effect we are particularly interested in. Or a proxy variable for one of the variables. An example

how y evolves as an individual ages. This lifecycle effect is, for a given cohort, the marginal impact of age on y. Analytically, this is the partial derivative of y with respect to age. However, because age and time grow at the same rate, this cannot be disentangled from cohort-specific time effects, as $g_a = \frac{\partial g}{\partial a}\big|_{c=t-a} = \frac{\partial g}{\partial t}\big|_{c=t-a}$.

Hence, omitting birth cohort biases the estimators of the age effect, in the following way:

$$\frac{\partial f^e}{\partial a} = \frac{\partial f^t}{\partial a} - \frac{\partial f}{\partial c}, \tag{3}$$

where the superscripts e and t stand for estimated and true lifecycle effect respectively. From Eq. 3, we see that, if the linear birth cohort effects are positive (negative), the linear age effect is underestimated (overestimated). Because the linear effects are estimated inconsistently, all higher order effects are also compromised. Hence the importance of estimating the linear effects in a reliable way. Before describing the procedure used in this paper to identify these linear effects, a brief summary of the main statistical approaches to deal with this problem is presented. They either assume the linear cohort effects away or define these three variables with different time spans.

2.1 Empirical specifications

Age, birth cohort and calendar time are usually observed discretely, on a yearly basis. Birth cohort c is defined as the year an individual is born and time t as the year of the survey. Age a is defined as the difference between c and t, as Eq. 1. However, it is worth pointing out that the relation described in Eq. 1 holds in continuous time only. Individuals do not have their age incremented just because the calendar year changed. Take individuals born in 1978 and in 1979 being observed in 1980. According to Eq. 1, individuals born in 1978 are all 2 years old and those born in 1979 are all 1 years old. However, individuals can have any age in the interval]0,2[if they are born in 1979 or any age between]1,3[

of such approach is Welch (1979). The parameter of interest is the cohort effect on individual career wage paths or lifecycle wages. Instead of using the year of birth, the cohort size and schooling were used assuming these are the means through which wages can be affected by individual cohorts. Clearly this methodology depends on whether such proxies or instruments are available in the data. For instance, when the parameter of interest is the lifecycle happiness, as it is the case in this paper, it is hard to think of a variable which could either be uncorrelated with happiness, given age, or which could include all the information of cohort or time.

if they are born in 1978. These intervals overlap in a one-year length interval. If variables are measured in yearly intervals and cohort is excluded altogether, on average, a high proportion of individuals is assigned to the wrong age group. If variables are measured with different time spans, the error incurred can be worse, as pointed out in Holford (1983).

One of the first attempts to explicitly account for all 3 variables simultaneously is the cohort table, illustrated in Table 1. Each row presents the evolution of the mean of the outcome variable of interest at a given age, **between** different cohorts. Each column instead reads the evolution of such mean **within** each cohort. Kermack, McKendrick, and McKinley (1934) notes that lifecycle comparisons across different cohorts could be observed diagonally. The cohort signalled in bold is 20 years old in year 1986, 21 years old in year 1987, and so on. This approach is however limited in the type of questions it can address. Next section describes the most frequent statistical approaches which allow for the inclusion of measures of all 3 variables in a regression equation.

Table 1: Average Happiness for all $(age, time)$ combinations - Cohort Table

	year of survey																		
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
20	7.26	**7.20**	7.30	7.24	7.38	7.29	7.06	6.95	7.02	7.25	7.14	7.19	7.28	7.11	7.32	6.86	7.07	7.10	6.99
21	7.28	7.49	**7.22**	7.26	7.30	7.37	7.23	6.99	7.01	6.98	7.05	7.24	7.23	7.04	7.20	7.19	7.14	6.89	7.18
22	6.83	7.33	7.18	**7.18**	7.50	7.50	7.04	6.90	6.96	6.97	7.19	7.21	7.17	7.24	7.21	7.28	7.21	6.82	6.93
23	7.06	7.44	7.21	7.19	**7.14**	7.40	7.20	7.12	7.11	7.08	7.04	6.98	7.18	7.07	7.27	6.96	7.18	7.21	6.93
24	7.58	7.28	7.28	7.09	7.32	**7.36**	7.30	6.96	6.94	7.07	7.00	7.05	7.07	7.11	7.15	7.38	7.20	7.15	7.10
25	7.22	7.54	7.24	7.15	7.04	7.58	**7.13**	7.18	7.20	7.05	7.03	7.06	7.08	7.12	7.09	7.14	7.33	7.23	6.96
26	6.89	7.55	7.24	7.13	7.03	7.36	6.89	**7.11**	7.11	7.07	7.11	7.20	6.94	7.16	7.09	7.18	7.03	7.05	7.03
27	7.26	7.05	7.16	7.22	7.10	7.49	6.89	6.91	**6.93**	7.02	7.12	7.12	7.00	7.27	7.38	7.01	7.19	6.94	6.80
28	7.18	7.19	6.97	7.14	7.28	7.39	6.95	6.99	7.05	**6.97**	7.10	7.10	6.87	7.16	7.27	7.34	7.18	7.16	7.10
29	7.25	7.30	7.26	7.01	7.15	7.44	6.87	6.93	6.87	6.83	**6.89**	6.98	7.11	7.04	7.13	7.12	7.34	6.97	6.94
30	7.23	7.30	7.25	7.10	6.98	7.31	6.91	6.86	6.93	6.89	6.97	**6.99**	6.81	7.10	7.15	7.19	7.12	7.08	7.01
31	7.24	7.26	7.14	7.13	7.25	7.11	6.87	6.92	6.83	7.00	6.92	7.11	**6.84**	7.04	7.20	7.03	7.24	7.19	7.11
32	7.42	7.31	7.05	7.09	7.08	7.38	6.66	6.71	6.81	6.67	7.08	6.88	6.78	**6.87**	7.10	7.12	7.04	7.00	7.01
33	7.10	7.47	7.34	7.19	7.02	7.24	6.88	6.64	6.78	6.87	6.87	6.96	6.76	6.92	**7.05**	7.03	7.15	6.95	6.89
34	7.19	7.28	7.22	7.21	7.18	7.18	6.72	6.90	6.69	6.56	6.87	6.88	6.75	6.89	7.01	**7.11**	7.14	7.07	6.80
35	7.33	7.40	7.04	7.18	7.08	7.36	6.76	6.77	6.94	6.66	6.96	7.00	6.70	7.08	6.92	6.90	**7.05**	6.99	6.82
36	7.36	7.41	7.10	6.89	7.01	7.42	6.67	6.77	6.68	6.76	6.90	6.98	6.88	6.80	6.91	7.03	7.03	**6.82**	6.96
37	7.44	7.33	7.15	7.12	7.15	7.32	6.95	6.74	6.72	6.47	6.90	6.75	6.93	6.94	6.86	6.93	6.97	6.83	**6.93**
38	7.04	7.30	7.14	7.28	7.00	7.11	6.87	6.91	6.87	6.77	6.66	6.96	6.67	6.93	7.00	6.88	7.02	6.88	6.80
39	7.15	7.18	7.10	7.17	7.06	7.24	6.60	6.71	6.93	6.70	6.86	6.60	6.87	6.76	7.04	7.02	7.03	6.90	6.68
40	7.26	7.12	7.06	6.75	7.23	7.43	6.68	6.76	6.79	6.80	6.77	6.75	6.43	6.85	6.84	6.90	6.91	6.64	6.88
41	7.19	7.20	6.98	7.33	7.28	7.54	6.96	6.70	6.82	6.68	6.85	6.68	6.58	6.60	6.93	6.79	6.89	6.72	6.73

Continued on next page

Table 1 – continued from previous page

	year of survey																		
42	7.24	7.27	7.03	7.23	7.43	7.21	7.10	7.10	6.69	6.85	6.68	6.72	6.61	6.78	6.57	6.73	6.81	6.78	6.51
43	7.32	7.14	6.96	6.95	7.12	7.23	6.77	6.94	6.95	6.68	6.70	6.76	6.72	6.76	6.67	6.61	6.88	6.65	6.45
44	7.11	7.24	7.16	7.13	6.67	7.42	6.86	6.77	6.62	6.81	6.67	6.69	6.45	6.74	6.63	6.75	6.52	6.74	6.46
45	7.34	7.12	7.22	6.91	6.77	7.04	6.93	6.97	6.73	6.84	6.82	6.73	6.60	6.67	6.85	6.67	6.70	6.32	6.60
46	7.17	7.32	6.88	6.97	7.04	7.19	6.74	6.96	6.75	6.49	6.91	6.66	6.72	6.67	6.48	6.62	6.56	6.68	6.26
47	7.33	6.97	7.12	6.94	7.18	7.11	6.77	6.81	6.92	6.82	6.55	6.79	6.57	6.67	6.74	6.47	6.77	6.60	6.43
48	7.20	7.21	6.99	7.13	7.08	7.22	6.87	6.64	6.77	6.93	6.70	6.64	6.71	6.52	6.88	6.67	6.58	6.51	6.26
49	7.25	7.23	7.04	6.93	7.03	7.21	6.63	6.74	6.54	6.79	6.92	6.67	6.52	6.68	6.74	6.83	6.55	6.33	6.18
50	7.42	7.02	7.07	7.06	6.94	7.27	6.89	6.69	6.69	6.46	6.72	6.69	6.42	6.54	6.52	6.66	6.84	6.33	6.34
51	7.03	7.07	6.69	7.01	7.09	7.27	6.89	6.70	6.56	6.80	6.48	6.92	6.65	6.34	6.68	6.34	6.77	6.68	6.41
52	6.69	6.99	6.99	6.71	7.04	7.08	6.85	6.82	6.70	6.64	6.65	6.45	6.54	6.69	6.54	6.48	6.54	6.66	6.58
53	6.95	7.04	6.89	6.99	6.64	7.13	6.71	6.76	6.75	6.59	6.70	6.70	6.23	6.74	6.68	6.49	6.42	6.39	6.59
54	7.09	7.04	6.62	6.90	6.83	6.71	6.43	6.77	6.63	6.74	6.55	6.67	6.41	6.41	6.71	6.75	6.81	6.31	6.47
55	7.46	7.09	6.96	6.86	6.86	7.04	6.61	6.72	6.59	6.75	6.52	6.52	6.69	6.72	6.46	6.75	6.80	6.58	6.19
56	7.31	7.44	7.20	7.15	6.87	6.95	6.93	6.56	6.63	6.46	6.71	6.57	6.47	6.64	6.76	6.41	6.71	6.77	6.54
57	7.26	7.25	7.34	6.62	6.99	6.97	6.51	6.73	6.75	6.64	6.64	6.64	6.59	6.68	6.66	6.69	6.41	6.55	6.47
58	7.13	7.26	7.22	7.23	6.77	7.24	6.89	6.70	6.76	6.49	6.74	6.68	6.55	6.64	6.64	6.57	6.97	6.37	6.48
59	7.50	7.14	7.12	7.26	7.09	6.99	7.02	6.91	6.49	6.92	6.66	6.88	6.69	6.55	6.62	6.45	6.63	6.68	6.40
60	7.23	7.66	7.38	7.08	7.25	7.50	7.02	7.13	6.79	6.47	6.82	6.65	6.92	6.97	6.70	6.73	6.85	6.39	6.51

MaCurdy and Mroz (1995), B. Fitzenberger and Schnabel (2001) and Card and Lemieux (2000) assume the linear birth cohort to be negligible and proceed to model and estimate higher order effects and interactions between all 3 factors. As already discussed, this procedure might render inconsistent estimates if the linear birth cohorts prove to be important.

Alternatively, Freeman (1979), Easterlin (2000) and Card and Lemieux (2001) define birth cohort as an interval of 5 consecutive birth years instead of one year only. Hence, individuals from the same cohort can have different ages, in any given year. However, it is hard to justify the choice of years that are included and excluded from each birth year bracket. Furthermore, it is hard to rationalize why the time span should vary among these three variables and, as discussed above, there is a high degree of error associated with this restriction.

To isolate age effects, it is also common to follow particular cohorts over time, either graphically or statistically, as Easterlin (2001). Figure 1 shows the lifecycle mean happiness for different cohorts and the overall happiness profile. The graphical analysis is very useful in establishing whether the cohort effect is relevant. If the lifecycle curves are mere horizontal shifts of each other, then the outcome of interest is well modelled conditional on age and calendar time only. This is not the case for this particular outcome where both the mean and the variation around the mean happiness is different for different cohorts. Despite the intuitive nature of the graphical approach, the problem of correctly identifying lifecycle effects persists because time effects cannot be dissociated from age effects. If different time spans are used, then we are back to the arbitrariness of choosing the intervals, as discussed above.

A somewhat different approach is followed by Clark (2002), which, using the fact that birth-cohort is an individual time invariant characteristic, performs within-groups on the happiness equation. However, because the age and the time growth rates are the same when defining age in the usual way, the age and the time effects are not separately identified either. Whatismore, given that the cohort effects are found by estimating the fixed effect itself, it will be a combination of not just all time invariant characteristics, but also of the average values of the time-varying regressors[3]. The cohort effect is also poorly estimated

[3]In the simplest model where $y_{it} = \alpha + \beta_a a_{it} + \beta_c c_i + \beta_t t + u_{it} + f_i$ is only a function of age, cohort and time, one can write $y_{it} = (\beta_a (a_{it} - \bar{a}_i) + \beta_t + (u_{it} - \bar{u}_i)) + (\alpha + \beta_a \bar{a}_i + \beta_c c_i + \beta_t \bar{t}_i + \bar{u}_i + f_i)$, where the time invariant component is the whole of the last term in brackets.

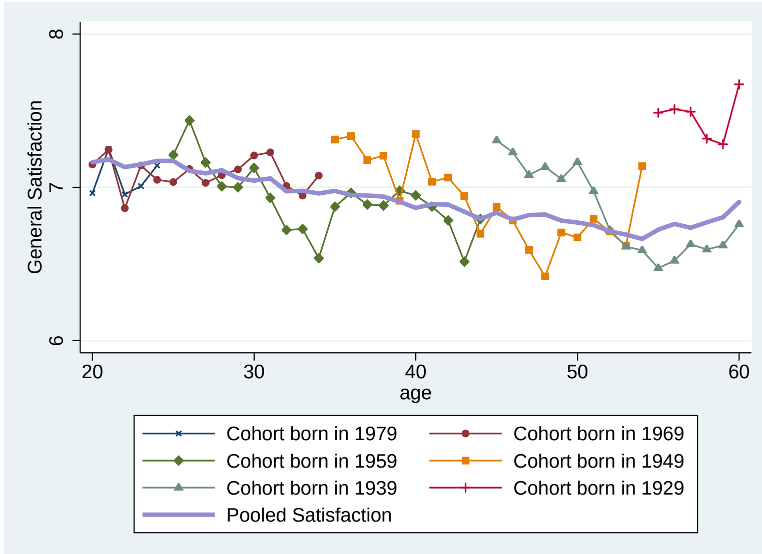

Figure 1: The happiness profile in age, following different cohorts

using this approach.

In this paper, all linear effects are estimated in a very simple way. To do so, age a has been redefined as an individual completed years of life. If an individual has had his birthday by the time the data are recorded, he is $t - c$ years old. If his birthday happens later in the year, he is just $t - c - 1$ years old. Therefore, depending on the exact time of the interview, individuals belonging to the same birth cohort have different ages in any given year. This exogenous variation in age breaks the linear dependence between age, cohort and time, even at the individual level. This definition allows Eq. 1 to hold exactly for those whose birthday happens in the day of the interview. On the contrary, the usual definition of age is only close to the true relation for those who happen to be born in the first days of the year and the error increases with the lateness of the day of birth. Therefore, defining age as completed years of age not only breaks the linear dependence between the 3 variables, but it is also a better measure of age given that data is only discretely observed.

To make this argument more precise, lets define the exact age at the time of the interview as

$$\text{age}_{\text{true}} = \text{current year} + s \text{ - (birth year} + b \text{)},$$

where s stands for the moment of the interview and b is the moment of birth.

Both variables are defined as a fraction of a given year and they are both defined in a unit interval, e.g. $s, b \in [0,1]$, where 0 means the beginning of a year and 1 the end of a year. While it is not controversial to assume $b \sim U(0,1)$, it is assumed that the moment of the interview is also equally likely in any day of the year for the sake of illustration, so that $s \sim U(0,1)$.

When age is defined as usual, i.e., as $\text{age}_{\text{usual}} = \text{current year - birth year}$, the underlying error is

$$\text{error}_{\text{usual}} = b - s \in [-1, 1]$$

Given the assumptions made on b and s, we know this error has zero mean and variance $\frac{1}{6}$[4].

However, when age is defined as completed years only, that is

$$\text{age}_{\text{completed}} = \begin{cases} \text{current year - birth year - 1} & \text{if} \quad s \leqslant b \\ \text{current year - birth year} & \text{if} \quad s > b \end{cases} \tag{4}$$

the underlying error is

$$\text{error}_{\text{completed}} = \begin{cases} b - s - 1 & \text{if} \quad s \leqslant b \\ b - s & \text{if} \quad s > b \end{cases} \in [-1, 0] \tag{5}$$

This error has mean $-\frac{1}{2}$ and variance $\frac{1}{18}$, i.e., this paper proposes an unbiased but lower variance estimator of age[5].

The next section describes the dataset used and explains how it allows for the identification of the linear effects of the three variables on the outcome of interest, in this case, individual self-reported happiness.

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[4]The joint density of $b-s$ is $f(b-s) = 1 - |b-s|$. Hence the expected value of the error associated with the usual definition of age is $\text{E}(\text{ error}_{\text{usual}}\ ) = \int_{-1}^{1} (b-s)\left[1 - |b-s|\right] d_{b-s} = 0$ and the variance is $\text{Var}(\text{error}_{\text{usual}}\ ) = \int_{-1}^{1} (b-s)^2 \left[1 - |b-s|\right] d_{b-s} = \frac{1}{6}$.

[5]The expected value was computed by solving $\text{E}(\text{error}_{\text{completed}}) = \text{E}\left[(b-s) - 1 | \, b-s \geqslant 0\right] P(b-s \geqslant 0) + \text{E}\left[b-s | \, b-s < 0\right] P(b-s < 0)$, and similarly for the variance.

3 An application: the age profile of happiness

3.1 Data

The German Socio-Economic Panel (GSOEP) records, for most respondents, both the date of birth of the interviewees and the date in which interviews are held. It can happen that in a given calendar year t, individuals born in the same year and thus belonging to the same birth cohort c have different **completed years** when interviewed, depending on whether they have had their birthday by the time of the interview. Hence age is defined as in Eq. 4.

As discussed in the previous section, this definition of age seems more natural given the discreteness of the data. If age is just defined as $t-c$, it is augmented by 1 just because the calendar year changed. This applies to all individuals, whether they are exactly $t-c$ years, $t-c-365$ days and almost 6 hours old or $t-c+365$ days and almost 6 hours old. By using the definition in Eq. 4, age effects are not confounded with artificial "year-shifting" effects. These are identified as long as the time of the interview is purely exogenous. Individuals interviewed after and before their birthday should be identical in all except their number of completed years.

Unfortunately, only the month of birth is observed while the day of birth would provide a more accurate definition of age. In practice, age ends up being defined as $t-c-1$ if the day of the interview is prior to the 15^{th} of the individual's month of birth and $t-c$ thereafter.

Figure 2 shows how interviews are spread throughout the year. Indeed, although they tend to be more concentrated in the first quarter, there is some variation in the month of the interview. One source of variation is purely exogenous and stems from the fieldwork design[6]. However, there are households being contacted more than once so that their interviews tend to be carried out later in the year. These individuals have typically higher valuation for time, which might undermine this identification strategy. Therefore, interviews carried out later in the year might be contaminated with these high valuation for time individuals. To circumvent this issue, the analysis was also carried out for the first months of each year, when the moment of the interview is most likely to be exogenous.

With age redefined as completed years of life, a happiness equation is estimated, controlling simultaneously for age, cohort and calendar time effects.

[6] I thank Jan Goebel from DIW Berlin for all the informational support regarding this issue.

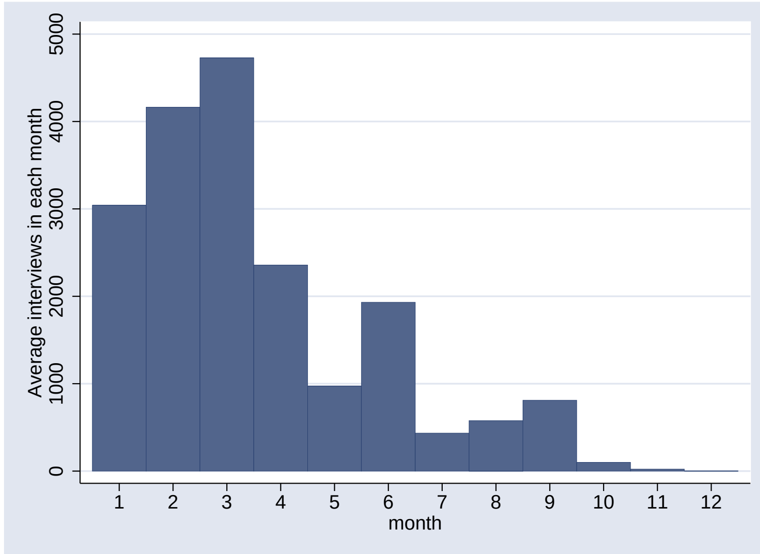

Figure 2: Average number of interviews conducted in each month over the 20-year period

Happiness is measured by the self-reported general satisfaction variable in the GSOEP. Interviewees are asked every year, at the end of the questionnaire, the following question:

> And finally, we would like to ask you about your satisfaction with your life in general. Please answer by using the following scale, in which 0 means totally unhappy, and 10 means totally happy.
>
> How happy are you at present with your life as a whole?

It is a discrete variable taking 11 equidistant values from 0 to 10. Figure 1 from section 2.1 plots the average happiness level for several cohorts, as their age varies between 20 and 60 years old. The unconditional age profile is also plotted for comparison. As discussed above, one immediately notes differences in the age profile across different cohorts, rendering the inclusion of all 3 factors in the happiness equation essential to consistently estimate any of the three effects. Furthermore, it seems to suggest that the age profiles are in fact decreasing and not the usual U-shaped profiles so often found in the literature. Easterlin (2001) explains this pattern as being driven by unadjusted aspirations, followed by adaptation to realized life path. He claims the main determinant of happiness is income. Even though average income increases over the lifecycle, he claims individuals set their aspirations so high that, on average, they are not met. This induces them to become more and more unhappy as their income trajectory becomes less uncertain. Once it is established, individuals gradually adapt to their realized *status quo* and restore some happiness.

A quadratic function in age has been the most widely used specification when estimating a happiness equation. Ferrer-i-Carbonell and Frijters (2004) reviews the results obtained from different estimation procedures. They conclude that the U-shape profile is a robust finding, whether one estimates an OLS, a fixed-effect or an ordered probit model. Combining the point estimates obtained from the age and the age squared coefficients, the age at which the minimum happiness is achieved ranges from 30 to 40 in most studies. When methods account for the categorical nature of the dependent variable together with individual fixed-effects, this result is not so clear[7]. In these cases however, age and time effects are not separably identified. The coefficients on age and age squared do not represent the pure lifecycle effect. Using within-groups estimation, Clark (2002) finds that the estimated fixed-effect is negatively correlated with happiness, i.e. those born earlier report higher happiness levels, and the estimated age-happiness profile is overall decreasing, in a somewhat convex way. The caveats of this approach have already been discussed and in fact, a negative age coefficient can be driven by time effects, whereas the true age effect is positive.

Even though Fig. 1 and Table 1 illustrate the differences across cohorts and thus the need to account for this factor when estimating lifecycle effects, it is however insufficient to conclude that the profiles are actually decreasing over time. Given that the identification strategy relies on variation in the month of the interview, it is important to account for aggregate shocks at the monthly level. This is to make sure the difference in happiness, observed between two age groups belonging to the same cohort, is not driven by aggregate macroeconomic factors before and after the interview.

3.2 Estimation Results

A happiness equation is estimated to analyse the impact of adequately accounting for age, birth cohort and calendar time. Age is defined according to Eq. **??**. Calendar time is measured with year dummies together with year $\times$ month interaction dummies. Because there are relatively few interviews in the last semester

[7]See e.g. (Ferrer-i-Carbonell and Frijters 2004) and (Winkelmann and Winkelmann 1998).

of each year, the year-month interactions use the last 6 months of each year as one category only. Cohort is the individual year of birth. The variable is normalised to be 1 for the first year of birth in the sample to avoid it being measured in a too large scale, compared to the remaining variables in the equation.

Because the month of birth is not available for everybody, practically 90000 (out of approximately 350000) observations are dropped. A fuller specification is estimated to account for the changing circumstances throughout an individual's lifecycle. These additional covariates are standard in this analysis and include gender, *bundesland*, nationality, marital status, number of members in the household, educational diploma, labor force status, household income and self-reported satisfaction with health. The latter is a categorical variable ranging from 0 to 10, where 10 represents an individual fully satisfied with his health and 0 an individual completely dissatisfied. Both the basic and the full specifications are run with and without conditioning on birth cohort, to analyze the impact of its inclusion in the remaining estimates. Robust standard errors are computed and errors are clustered at the individual level. In order to guarantee enough observations per cell, the sample is restricted to individuals of Turkish, Balkan[8], East German or West German background, and who stay in their initial *bundesland* throughout the sample period. Those who are still in schooling, on maternity leave, have been drafted or only have a very sporadic source of income are also excluded. Married but separated individuals are not accounted for either. Individuals are only followed after they have completed their 20 years of age and only until they reach 60 years of age. This is to prevent an over-representation of older individuals in the sample.

Table 2 presents the results. The first five columns assume happiness is only a function of age, birth cohort and calendar time. Column I reproduces the usual regression where birth cohort is omitted and age is approximated with a quadratic function. Column II further includes birth year brackets, as in Card and Lemieux (2001). Column III uses birth cohort dummies while column IV models birth cohort more parsimoniously with a quartic approximation. Column V takes the cohort specification of column IV and includes age dummies instead of the usual quadratic approximation. Columns VI - X repeat the first 5 columns but include additional covariates.

[8]The countries that used to form Yugoslavia are also grouped into one category, again for sample size considerations.

The benchmark model yields a U-shape happiness profile with respect to age. The coefficients of both age and age squared are statistically significant and the point estimate of the age of minimum happiness is 72 and 37 for the basic and the full specifications respectively. However, when birth cohort is included, this pattern disappears. The linear term is generally positive but seldom significant. Its estimate is nevertheless always larger than the benchmark estimates, which suggests positive birth cohort effects, i.e., younger cohorts reporting, on average, a higher satisfaction. In fact, all cohort specifications suggest that this is the case for the youngest cohorts, but cohorts born between late $1920'$s and early $1930'$s are unhappier than their earlier counterparts in the full model. One also notes that the model with cohort bands as in Card and Lemieux (2001) always yields lower estimates than all other models where cohort is accounted for with a yearly time span. This may be suggesting this measure of cohort is seriously contaminated with error and in fact, the conclusions taken from this model differ from any other.

On the contrary, the quadratic term tends to be statistically significant, even though the sign is not always the same. It is negative in the basic model and positive for the full specification. It is also worth noting that the age related coefficients are estimated very similarly regardless of whether one uses birth cohort dummies or a quartic polynomial. The time effects seem to be more sensitive though. All in all, the more parsimonious model is doing well, specially in estimating the coefficients of interest. The quadratic specification of age might not be sufficient though, which might partly explain the changing sign of the quadratic term. Figure 1 illustrates this point. The pooled happiness profile seems well-fitted with a quadratic function but the cohort-specific profiles are more irregular. Trying to fit a quadratic curve through each of these does not seem to be the best approximation[9]. The aim of this paper is however to show the impact of including the cohort variable measured in different ways, keeping everything else as similar as possible to other work in the area.

The estimates of the additional covariates do not yield surprising results[10]. The statistically robust results are presented next. Household net income has a very significant albeit small impact on happiness. A 2-member household is better off than a single unit household, even after conditioning on marital status.

[9]It is worth noting that these profiles are not necessarily similar to the true ones given that calendar time is not accounted for in the graph.

[10]These are available upon request.

The divorced individuals fare worst and the widowed are worse off than single individuals, even though age is in the equation. Households with 4 members or more are doing poorly, even after conditioning on income. The unemployed are the less happy group while the Full-time workers and the retired individuals are the happiest. Men are significantly less happy than women in approximately 0.1 units. According to similar studies, educational differences are not consistently significant. There are also important regional and nationality differences. Health is the most important factor in explaining happiness. The happiest with health report on average, over 0.35 units higher satisfaction with life as a whole.

All in all, estimating a happiness equation without conditioning on year of birth yields a robust U-shape profile. Once year of birth is accounted for, this pattern vanishes. Using the cohort brackets as in Card and Lemieux (2001) does not render any conclusive pattern while the remaining specifications seem to suggest an increasing lifecycle profile of happiness. This is not however statistically robust because for some specifications, the relationship between happiness and age is lost. Nevertheless, these results suggest the age coefficient estimates from previous work are in fact a combination of positive cohort effects and what seems to be positive age effects. Looking at the standard errors of the age coefficients, one further sees that the true explanatory power of age is very reduced, once year of birth is included in the analysis[11].

[11] A subjective evaluation of one's well-being depends on a myriad of factors. Some account of this issue is made by including the additional covariates known to change over the lifecycle and with a direct impact on happiness. Not all can be included and most likely, most of the determinants are not known to the econometrician. What we end up classifying as lifecycle effects might be a combination of these changing unobserved circumstances as one ages with the true age effect. This can in part explain the loss of explanatory power of this variable once additional covariates and year of birth is included. This however does not undermine the methodology presented and will not be discussed further.

Table 2: OLS estimates of a happiness equation, conditioning on age, birth cohort and calendar time

	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**
Age	-0.0289	0.0156	0.0943	0.0927		-0.0448	0.0031	0.0270	0.0263	
	(0.0054)**	(0.0092)	(0.0281)**	(0.0281)**		(0.0053)**	(0.0079)	(0.0216)	(0.0217)	
Age^2	0.0002	-0.0002	-0.0003	-0.0003		0.0006	0.0002	0.0001	0.0001	
	(0.0001)**	(0.0001)**	(0.0001)**	(0.0001)**		(0.0001)**	(0.0001)*	(0.0001)	(0.0001)	
Age 21					0.1111					0.0726
					(0.0465)*					(0.0437)
Age 31					0.9526					0.4819
					(0.3060)**					(0.2335)*
Age 41					1.6519					0.8001
					(0.5828)**					(0.4416)
Age 51					2.2019					1.0163
					(0.8611)*					(0.6521)
Age 60					2.9868					1.5717
					(1.1103)**					(0.8398)
Cohort				0.0694	0.1022				0.0053	0.0402
				(0.0347)*	(0.0349)**				(0.0271)	(0.0273)
$\text{Cohort}^2/100$				-0.1219	-0.2952				-0.0383	-0.2207
				(0.1274)	(0.1306)*				(0.1026)	(0.1054)*
$\text{Cohort}^3/1000$				0.0505	0.0845				0.0276	0.0626
				(0.0303)	(0.0310)**				(0.0244)	(0.0250)*
$\text{Cohort}^4/10000$				-0.0047	-0.0069				-0.0025	-0.0048
				(0.0025)	(0.0025)**				(0.0020)	(0.0020)*
Cohort $[1929, 1934[$		-0.1404					0.0041			

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Table 2 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
		(0.0945)					(0.0779)			
Cohort [1939, 1944[		-0.2271					-0.1411			
		(0.1334)					(0.1043)			
Cohort [1949, 1954[		-0.2120					-0.1275			
		(0.1987)					(0.1530)			
Cohort [1959, 1964[		-0.1070					-0.0045			
		(0.2681)					(0.2044)			
Cohort [1969, 1974[		0.1096					0.2312			
		(0.3360)					(0.2555)			
Cohort [1979, 1984[		0.1361					0.3957			
		(0.4045)					(0.3086)			
Cohort 1925			0.2470					-0.0834		
			(0.2659)					(0.2539)		
Cohort 1935			0.4905					-0.1467		
			(0.3808)					(0.3205)		
Cohort 1945			1.3054					0.1599		
			(0.6282)*					(0.4936)		
Cohort 1955			1.9669					0.3372		
			(0.8910)*					(0.6868)		
Cohort 1965			2.9082					0.7622		
			(1.1573)*					(0.8867)		
Cohort 1975			3.9962					1.3584		
			(1.4315)**					(1.0909)		
Cohort 1983			4.9440					1.8492		
			(1.6709)**					(1.3334)		

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Table 2 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
Year 1986	-4.0856	-4.0294	-3.8660	-2.3186	-3.7619	-1.8854	-1.8088	-1.7976	-1.3591	-1.3597
	(0.1658)**	(0.1746)**	(0.2023)**	(0.4742)**	(0.1908)**	(0.1307)**	(0.1360)**	(0.1576)**	(0.3608)**	(0.3613)**
Year 1991	0.0248	0.0051	-0.1544	1.3124	-0.1435	0.4815	0.4553	0.4128	0.8071	0.7961
	(0.1913)	(0.1928)	(0.2003)	(0.3434)**	(0.2005)	(0.1409)**	(0.1420)**	(0.1477)**	(0.2624)**	(0.2621)**
Year 1996	-0.3216	-0.3774	-0.8993	0.5764	-0.8863	0.3259	0.2693	0.1251	0.5187	0.5100
	(0.1704)	(0.1790)*	(0.2561)**	(0.2002)**	(0.2563)**	(0.1254)**	(0.1322)*	(0.1920)	(0.1542)**	(0.1541)**
Year 2001	-0.1216	-0.2271	-1.1225	0.3580	-1.1036	0.2565	0.1390	-0.1134	0.2834	0.2792
	(0.1692)	(0.1916)	(0.3701)**	(0.0715)**	(0.3701)**	(0.1239)*	(0.1416)	(0.2790)	(0.0590)**	(0.0589)**
Constant	7.7899	6.9954	2.2624	0.6856	3.6651	4.5709	3.5820	2.3820	1.9435	2.2842
	(0.1913)**	(0.4919)**	(1.7993)	(2.1938)	(1.2681)**	(0.1768)**	(0.3859)**	(1.3678)	(1.6620)	(1.2406)
R^2	0.02	0.02	0.03	0.02	0.02	0.29	0.30	0.30	0.30	0.30
Added covariates	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Shape of Profile	U-shaped	Decreasing	Increasing	Increasing	Increasing	U-shaped	Increasing	Unrelated	Unrelated	Increasing

Significance levels : $*$: 5% $**$: 1%

Robust standard errors in parentheses.

Additional covariates are gender, *bundesland*, nationality, marital status, educational diploma, labor force status, household income and self reported satisfaction with health and number of members in the household.

Omitted categories: 21 year olds, year 1984, January of every year, cohort born between $[1924, 1929[$, cohort born in 1924 and 1-member household.

3.3 Robustness Checks

The previous estimation results are subject to a number of criticisms. First of all and as already discussed, the randomness of the moment of the interview is only valid if all the interviewees answered the first time they are contacted[12]. Interviews being carried out later in the year might be contaminated with those individuals who are less available and with a higher valuation for time. Because of this, estimation is repeated for those that are interviewed only in the first months of the year. Along these lines, attrition can be a problem for exactly the same reasons. Those who drop out of the panel can have the same characteristics as the late interviewees. Estimations are thus repeated for those who stay in the panel for the whole 20 waves and also for those who answer the first and the last questionnaires. Finally, as mentioned before, age is defined in a way that matches the continuous measure only when the day of the interview is the actual birthday. However, only the month of the birth is known, which is why the middle day of the month is used as an age-defining threshold. The error incurred seems however to be of the classical type, e.g. uncorrelated with the remaining variables and the equation error term. An exception is the measure of cohort. By using the year instead of the moment of birth, there is also an error associated with this variable, which is correlated with the error associated with age. For this reason, and to reproduce Clark (2002)'s results, within-group estimation is carried out. Ordered probit estimation results are also presented to account for the ordinal nature of the variable and because it is still one of the main methods when estimating happiness equations.

3.3.1 Late interviews

The regressions are repeated for only the first months of the year. This aims to withdraw from the sample those individuals who have to be contacted more than once because their interviews tend to be concentrated later in the year. Tables 3, 4 and 5 show the estimated age-happiness profiles when only the first three, four and six months respectively are used for estimation. In short, results remain qualitatively the same, which indicates that this group of people does not seem to bias the estimates. The only difference is the conclusions drawn from the model with cohort brackets *à la* Card and Lemieux (2001). Using only the

[12] The number of attempts made for each interviewee is actually a piece of information which should be made public to validate this methodology.

first 3 or 4 months yields an inverted U-shape pattern, whereas using the first 6 months yields the same pattern as with the whole sample. Therefore, this seems to suggest that the proportion of late interviews in May and June might not be negligible anymore.

3.3.2 Attrition

The happiness equation is also estimated with a balanced sample to account for a possible selection bias. First only those individuals who answer all of the questionnaires are included and results are presented in Table 6. Only 2273 out of 33852 individuals satisfy this condition and so, the exercise is repeated with all the interviewees who answered the first and the last questionnaire. This more than doubles the number of individuals even though it is more likely that there are high-valuation type individuals in this sample. Table 7 shows the results. Again if significant, the relationship between age and happiness is positive. This holds for both the basic and the full specification.

3.3.3 Alternative Estimation Methods

Within Groups estimation is carried out. With age defined as in Eq. **??**, the age and calendar time no longer grow at the same rate at the individual level, which makes it possible to consistently estimate these two effects separately and thus, account for classical measurement error and individual time-invariant heterogeneity. The results only reproduce Clark (2002)'s in the basic specification. However, the methodology presented in this paper can disentangle age from calendar time effects whereas his work cannot.

An ordered-probit is also conducted to account for the ordinal nature of the dependent variable. Qualitatively, the conclusions remain unchanged. Even though it is not clear what the happiness-age profile suggested by these data is, it is clearly not the so often found U-shaped curve.

Table 3: OLS estimates of a happiness equation, conditioning on age, birth cohort and calendar time: first 3 months only

	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**
Age	-0.0272	0.0239	0.1185	0.1144		-0.0461	0.0017	0.0328	0.0293	
	(0.0061)**	(0.0103)*	(0.0347)**	(0.0347)**		(0.0060)**	(0.0088)	(0.0267)	(0.0267)	
Age^2	0.0002	-0.0003	-0.0004	-0.0004		0.0007	0.0002	0.0001	0.0001	
	(0.0001)**	(0.0001)**	(0.0001)**	(0.0001)**		(0.0001)**	(0.0001)*	(0.0001)	(0.0001)	
Age 21					0.1323					0.1029
					(0.0574)*					(0.0530)
Age 31					1.1596					0.5249
					(0.3787)**					(0.2898)
Age 41					2.0116					0.8943
					(0.7204)**					(0.5481)
Age 51					2.7113					1.1695
					(1.0639)*					(0.8095)
Age 60					3.6383					1.7622
					(1.3723)**					(1.0431)
Cohort				0.0711	0.1032				0.0011	0.0317
				(0.0414)	(0.0417)*				(0.0322)	(0.0324)
Cohort^2/100				-0.0811	-0.2409				0.0060	-0.1482
				(0.1398)	(0.1435)				(0.1110)	(0.1144)
Cohort^3/1000				0.0462	0.0756				0.0182	0.0459
				(0.0332)	(0.0340)*				(0.0264)	(0.0272)
Cohort^4/10000				-0.0046	-0.0063				-0.0018	-0.0035
				(0.0027)	(0.0027)*				(0.0021)	(0.0022)

Continued on next page

Table 3 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
Cohort [1929, 1934[		-0.1350					0.0096			
		(0.1069)					(0.0855)			
Cohort [1939, 1944[		-0.2524					-0.1553			
		(0.1495)					(0.1148)			
Cohort [1949, 1954[		-0.2341					-0.1519			
		(0.2215)					(0.1685)			
Cohort [1959, 1964[		-0.0998					-0.0436			
		(0.2988)					(0.2252)			
Cohort [1969, 1974[		0.1583					0.1954			
		(0.3743)					(0.2816)			
Cohort [1979, 1984[		0.1847					0.3448			
		(0.4498)					(0.3398)			
Cohort 1925			0.3663					0.0603		
			(0.2918)					(0.2646)		
Cohort 1935			0.5093					-0.1808		
			(0.4535)					(0.3695)		
Cohort 1945			1.5745					0.2704		
			(0.7656)*					(0.5949)		
Cohort 1955			2.4032					0.4907		
			(1.0959)*					(0.8411)		
Cohort 1965			3.4975					0.9658		
			(1.4275)*					(1.0922)		
Cohort 1975			4.7944					1.6315		
			(1.7674)**					(1.3474)		
Cohort 1983			5.5499					1.9791		

Continued on next page

Table 3 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
			(2.1614)*					(1.7510)		
Year 1986	-4.2559	-4.4085	-3.7883	-2.0570	-3.6760	0.0000	0.0000	0.0000	-1.3090	0.0000
	(0.0289)**	(0.1122)**	(0.1967)**	(0.5861)**	(0.1812)**	(0.0000)**	(0.0000)**	(0.0000)**	(0.4475)**	(0.0000)**
Year 1991	0.0000	0.0000	0.0000	1.6386	0.0000	2.2577	2.1657	2.1026	0.7375	2.0519
	(0.0000)**	(0.0000)**	(0.0000)**	(0.4110)**	(0.0000)**	(0.0612)**	(0.0783)**	(0.1586)**	(0.3130)*	(0.1489)**
Year 1996	-0.4937	-0.7971	-0.9785	0.6802	-0.9647	2.2189	2.0921	1.8912	0.5397	1.8504
	(0.0480)**	(0.1032)**	(0.1763)**	(0.2449)**	(0.1759)**	(0.0674)**	(0.1025)**	(0.2772)**	(0.1880)**	(0.2708)**
Year 2001	-0.2939	-0.6568	-1.2859	0.3876	-1.2577	2.1535	1.9700	1.6275	0.2907	1.6064
	(0.0427)**	(0.1227)**	(0.3438)**	(0.0818)**	(0.3431)**	(0.0639)**	(0.1235)**	(0.4021)**	(0.0662)**	(0.3974)**
Constant	7.9230	7.2055	1.0943	-0.5019	3.0322	2.7051	1.8214	0.2429	1.7031	0.7935
	(0.1152)**	(0.5398)**	(2.2802)	(2.7130)	(1.6202)	(0.1571)**	(0.3829)**	(1.6054)	(2.0636)	(1.1036)
R^2	0.02	0.02	0.03	0.02	0.02	0.30	0.30	0.30	0.30	0.30
Added covariates	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Shape of Profile	U-shaped	Inverted U-shaped	Increasing	Increasing	Increasing	U-shaped	Increasing	Unrelated	Unrelated	Increasing

Significance levels : $*$: 5% $**$: 1%

Robust standard errors in parentheses.

Additional covariates are gender, *bundesland*, nationality, marital status, educational diploma, labor force status, household income and self reported satisfaction with health and number of members in the household.

Omitted categories: 21 year olds, year 1984, January of every year, cohort born between $[1924, 1929[$, cohort born in 1924 and 1-member household.

Table 4: OLS estimates of a happiness equation, conditioning on age, birth cohort and calendar time: first 4 months only

	I	II	III	IV	V	VI	VII	VIII	IX	X
Age	-0.0274	0.0190	0.1049	0.1027		-0.0437	0.0030	0.0273	0.0259	
	(0.0057)**	(0.0096)*	(0.0315)**	(0.0315)**		(0.0056)**	(0.0084)	(0.0242)	(0.0242)	
Age^2	0.0002	-0.0003	-0.0003	-0.0003		0.0006	0.0002	0.0001	0.0001	
	(0.0001)**	(0.0001)**	(0.0001)**	(0.0001)**		(0.0001)**	(0.0001)*	(0.0001)	(0.0001)	
Age 21					0.1146					0.0824
					(0.0515)*					(0.0480)
Age 31					1.0430					0.4761
					(0.3428)**					(0.2625)
Age 41					1.8366					0.8091
					(0.6527)**					(0.4966)
Age 51					2.4353					1.0125
					(0.9637)*					(0.7329)
Age 60					3.3248					1.5832
					(1.2432)**					(0.9444)
Cohort				0.0775	0.1126				0.0075	0.0422
				(0.0378)*	(0.0380)**				(0.0296)	(0.0297)
$Cohort^2/100$				-0.1277	-0.3128				-0.0431	-0.2244
				(0.1317)	(0.1352)*				(0.1065)	(0.1094)*
$Cohort^3/1000$				0.0523	0.0892				0.0271	0.0617
				(0.0314)	(0.0321)**				(0.0253)	(0.0260)*
$Cohort^4/10000$				-0.0048	-0.0073				-0.0024	-0.0046
				(0.0025)	(0.0026)**				(0.0021)	(0.0021)*

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Table 4 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
Cohort $[1929, 1934[$		-0.1068					0.0271			
		(0.0994)					(0.0814)			
Cohort $[1939, 1944[$		-0.1932					-0.1208			
		(0.1403)					(0.1095)			
Cohort $[1949, 1954[$		-0.1640					-0.1159			
		(0.2084)					(0.1605)			
Cohort $[1959, 1964[$		-0.0523					-0.0075			
		(0.2810)					(0.2145)			
Cohort $[1969, 1974[$		0.1903					0.2301			
		(0.3521)					(0.2683)			
Cohort $[1979, 1984[$		0.2102					0.3863			
		(0.4236)					(0.3239)			
Cohort 1925			0.4061					-0.0264		
			(0.2714)					(0.2565)		
Cohort 1935			0.5972					-0.1781		
			(0.4137)					(0.3443)		
Cohort 1945			1.5443					0.1780		
			(0.6961)*					(0.5449)		
Cohort 1955			2.2874					0.3530		
			(0.9939)*					(0.7655)		
Cohort 1965			3.3105					0.7831		
			(1.2935)*					(0.9916)		
Cohort 1975			4.4754					1.3732		
			(1.6015)**					(1.2225)		
Cohort 1983			5.2501					1.6737		

Continued on next page

Table 4 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
			(1.9388)**					(1.6285)		
Year 1986	-4.8970	-4.7864	-4.6987	-2.1381	-4.5724	-2.6276	-2.5219	-2.5592	-1.3849	-2.4653
	(0.2033)**	(0.2161)**	(0.2321)**	(876.3592)	(0.2185)**	(0.2356)**	(0.2379)**	(0.2514)**	(0.4058)**	(0.2482)**
Year 1991	-1.4483	-1.4206	-1.6623	0.7946	-1.6685	-0.2443	-0.2327	-0.3073	0.8040	-0.2927
	(0.2057)**	(0.2138)**	(0.2336)**	(841.0383)	(0.2315)**	(0.2407)	(0.2407)	(0.2556)	(0.2922)**	(0.2577)
Year 1996	-1.1325	-1.1486	-1.7933	0.6782	-1.7897	-0.3990	-0.4146	-0.5948	0.5174	-0.5776
	(0.2071)**	(0.2224)**	(0.3289)**	(843.3216)	(0.3275)**	(0.2323)	(0.2363)	(0.3032)*	(0.1715)**	(0.3053)
Year 2001	-0.9326	-1.0049	-2.0588	0.4208	-2.0479	-0.4709	-0.5439	-0.8365	0.2819	-0.8080
	(0.2062)**	(0.2350)**	(0.4579)**	(774.4704)	(0.4565)**	(0.2315)*	(0.2429)*	(0.3876)*	(0.0626)**	(0.3894)*
Constant	8.5716	7.6220	2.4664	-0.0147	4.1299	5.2688	4.2732	3.0887	1.9410	3.3580
	(0.2320)**	(0.5241)**	(1.9810)	(959.1800)	(1.3866)**	(0.2693)**	(0.4469)**	(1.5195)*	(1.8687)	(1.0695)**
R^2	0.02	0.02	0.03	0.02	0.03	0.29	0.30	0.30	0.30	0.30
Added covariates	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Shape of Profile	U-shaped	Inverted U-shaped	Increasing	Increasing	Increasing	U-shaped	Increasing	Unrelated	Unrelated	Increasing

Significance levels : $*$: 5% $**$: 1%

Robust standard errors in parentheses.

Additional covariates are gender, *bundesland*, nationality, marital status, educational diploma, labor force status, household income and self reported satisfaction with health and number of members in the household.

Omitted categories: 21 year olds, year 1984, January of every year, cohort born between [1924, 1929[, cohort born in 1924 and 1-member household.

Table 5: OLS estimates of a happiness equation, conditioning on age, birth cohort and calendar time: first 6 months only

	I	II	III	IV	V	VI	VII	VIII	IX	X
Age	-0.0279	0.0182	0.1062	0.1045		-0.0443	0.0039	0.0335	0.0326	
	(0.0055)**	(0.0093)	(0.0295)**	(0.0295)**		(0.0054)**	(0.0081)	(0.0225)	(0.0226)	
Age^2	0.0002	-0.0003	-0.0003	-0.0003		0.0006	0.0002	0.0001	0.0001	
	(0.0001)**	(0.0001)**	(0.0001)**	(0.0001)**		(0.0001)**	(0.0001)*	(0.0001)	(0.0001)	
Age 21					0.1198					0.0787
					(0.0483)*					(0.0453)
Age 31					1.0677					0.5398
					(0.3209)**					(0.2439)*
Age 41					1.8941					0.9388
					(0.6112)**					(0.4614)*
Age 51					2.5363					1.2050
					(0.9026)**					(0.6809)
Age 60					3.4403					1.8348
					(1.1642)**					(0.8773)*
Cohort				0.0816	0.1166				0.0124	0.0480
				(0.0358)*	(0.0361)**				(0.0279)	(0.0281)
Cohort^2/100				-0.1274	-0.3140				-0.0378	-0.2261
				(0.1284)	(0.1318)*				(0.1037)	(0.1065)*
Cohort^3/1000				0.0515	0.0889				0.0266	0.0633
				(0.0306)	(0.0313)**				(0.0247)	(0.0253)*
Cohort^4/10000				-0.0047	-0.0072				-0.0024	-0.0048
				(0.0025)	(0.0025)**				(0.0020)	(0.0021)*

Continued on next page

Table 5 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
Cohort [1929, 1934[		-0.1290					0.0132			
		(0.0955)					(0.0786)			
Cohort [1939, 1944[		-0.1989					-0.1290			
		(0.1351)					(0.1057)			
Cohort [1949, 1954[		-0.1588					-0.1072			
		(0.2011)					(0.1551)			
Cohort [1959, 1964[		-0.0463					0.0096			
		(0.2714)					(0.2073)			
Cohort [1969, 1974[		0.1986					0.2605			
		(0.3401)					(0.2593)			
Cohort [1979, 1984[		0.2254					0.4277			
		(0.4094)					(0.3132)			
Cohort 1925			0.2791					-0.0903		
			(0.2678)					(0.2556)		
Cohort 1935			0.6085					-0.1057		
			(0.3938)					(0.3290)		
Cohort 1945			1.5489					0.2908		
			(0.6553)*					(0.5121)		
Cohort 1955			2.3164					0.5261		
			(0.9323)*					(0.7150)		
Cohort 1965			3.3618					1.0176		
			(1.2123)**					(0.9246)		
Cohort 1975			4.5762					1.6832		
			(1.4999)**					(1.1383)		
Cohort 1983			5.3137					1.9401		

Continued on next page

Table 5 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
			(1.7705)**					(1.4036)		
Year 1986	-4.2975	-4.2193	-3.9308	-4.4110	-3.8323	-2.2218	-2.1498	-2.0974	-1.2599	-2.0458
	(0.0745)**	(0.0937)**	(0.1608)**	(0.2380)**	(0.1455)**	(0.1854)**	(0.1910)**	(0.2157)**	(0.3771)**	(0.2081)**
Year 1991	-0.1868	-0.1939	-0.2691	-0.8370	-0.2735	-0.2112	-0.2301	-0.2578	0.5260	-0.2575
	(0.1214)	(0.1214)	(0.1248)*	(0.3130)**	(0.1250)*	(0.2016)	(0.2017)	(0.2028)	(0.2771)	(0.2018)
Year 1996	-0.5334	-0.5849	-1.0686	-1.6264	-1.0714	-0.0006	-0.0620	-0.2202	0.5662	-0.2264
	(0.0843)**	(0.0947)**	(0.1901)**	(0.3989)**	(0.1901)**	(0.1822)	(0.1853)	(0.2216)	(0.1604)**	(0.2206)
Year 2001	-0.3335	-0.4438	-1.3486	-1.9000	-1.3458	-0.0728	-0.1980	-0.4945	0.2962	-0.4924
	(0.0819)**	(0.1145)**	(0.3259)**	(0.5222)**	(0.3259)**	(0.1812)	(0.1912)	(0.2973)	(0.0602)**	(0.2967)
Constant	7.9825	7.0600	1.6246	2.0724	3.2455	4.8804	3.8663	2.2811	1.4248	2.6767
	(0.1244)**	(0.4830)**	(1.9082)	(1.7945)	(1.3489)*	(0.2213)**	(0.4206)**	(1.4576)	(1.7361)	(1.0344)**
R^2	0.02	0.02	0.03	0.02	0.03	0.29	0.29	0.30	0.29	0.30
Added covariates	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Shape of Profile	U-shaped	Decreasing	Increasing	Increasing	Increasing	U-shaped	Increasing	Unrelated	Unrelated	Increasing

Significance levels : $*$: 5% $**$: 1%

Robust standard errors in parentheses.

Additional covariates are gender, *bundesland*, nationality, marital status, educational diploma, labor force status, household income and self reported satisfaction with health and number of members in the household.

Omitted categories: 21 year olds, year 1984, January of every year, cohort born between $[1924, 1929[$, cohort born in 1924 and 1-member household.

Table 6: Following individuals who answered all 20 questionnaires: estimation results

	I	II	III	IV	V	VI	VII	VIII	IX	X
Age	-0.0303	0.0241	0.0607	0.0630		-0.0454	0.0105	0.0264	0.0265	
	(0.0083)**	(0.0141)	(0.0397)	(0.0397)		(0.0084)**	(0.0121)	(0.0299)	(0.0298)	
Age^2	0.0003	-0.0002	-0.0002	-0.0002		0.0007	0.0002	0.0001	0.0001	
	(0.0001)**	(0.0001)	(0.0001)*	(0.0001)*		(0.0001)**	(0.0001)*	(0.0001)	(0.0001)	
Age 21					0.1064					0.1234
					(0.0702)					(0.0643)
Age 31					0.6067					0.4688
					(0.4306)					(0.3195)
Age 41					1.1245					0.8459
					(0.8195)					(0.6011)
Age 51					1.4326					1.1313
					(1.2102)					(0.8856)
Age 60					1.8910					1.5963
					(1.5606)					(1.1403)
Cohort				-0.0163	0.0103				-0.0174	0.0027
				(0.0509)	(0.0512)				(0.0385)	(0.0388)
Cohort^2/100				0.1934	0.0539				0.0902	-0.0164
				(0.2043)	(0.2076)				(0.1575)	(0.1601)
Cohort^3/1000				-0.0207	0.0070				0.0000	0.0209
				(0.0487)	(0.0494)				(0.0378)	(0.0384)
Cohort^4/10000				0.0009	-0.0009				-0.0004	-0.0018
				(0.0040)	(0.0040)				(0.0031)	(0.0031)
Cohort $[1929, 1934[$		-0.1415					-0.0662			

Continued on next page

Table 6 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
		(0.1393)					(0.1074)			
Cohort $[1939, 1944[$		-0.2190					-0.1031			
		(0.2075)					(0.1537)			
Cohort $[1949, 1954[$		-0.0974					-0.0053			
		(0.3153)					(0.2326)			
Cohort $[1959, 1964[$		0.1771					0.2741			
		(0.4331)					(0.3163)			
Cohort $[1969, 1974[$		0.4388					0.5739			
		(0.5470)					(0.3988)			
Cohort $[1979, 1984[$		0.5724					0.8076			
		(0.6589)					(0.4822)			
Cohort 1925			-0.1724					-0.0947		
			(0.4302)					(0.3508)		
Cohort 1935			-0.3185					-0.3326		
			(0.5674)					(0.4428)		
Cohort 1945			0.1115					-0.0554		
			(0.9022)					(0.6713)		
Cohort 1955			0.6681					0.3543		
			(1.2669)					(0.9325)		
Cohort 1965			1.0737					0.6090		
			(1.6391)					(1.2056)		
Cohort 1975			1.9895					1.2692		
			(2.0245)					(1.4825)		
Cohort 1983			2.9870					2.3544		
			(2.3345)					(1.7627)		

Continued on next page

Table 6 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
Year 1986	1.3237	0.8072	2.1901	0.7465	0.8120	0.7583	1.0195	1.2597	1.2195	0.2983
	(0.3656)**	(0.4612)	(0.7644)**	(0.5628)	(0.4637)	(0.3970)	(0.4276)*	(0.6294)*	(0.6198)*	(0.4733)
Year 1991	0.5504	0.0016	1.1241	-0.2206	-0.1769	0.4365	0.6497	0.7997	0.8008	-0.1421
	(0.1061)**	(0.2960)	(0.4664)*	(0.5012)	(0.3738)	(0.1046)**	(0.1467)**	(0.3460)*	(0.3466)*	(0.3202)
Year 1996	0.0328	-0.5899	0.3893	-0.9708	-0.9421	0.2224	0.3579	0.4635	0.4521	-0.4942
	(0.2135)	(0.3684)	(0.3395)	(0.6283)	(0.5487)	(0.1687)	(0.1783)*	(0.2589)	(0.2580)	(0.4314)
Year 2001	0.1613	-0.5453	0.2679	-1.1062	-1.0682	0.1961	0.2326	0.2669	0.2619	-0.6792
	(0.0709)*	(0.3376)	(0.1040)*	(0.7563)	(0.6772)	(0.0662)**	(0.0680)**	(0.0862)**	(0.0865)**	(0.5179)
Constant	7.6111	6.8378	3.9021	4.8550	5.7795	4.5080	2.8143	2.0115	1.9260	3.3036
	(0.1644)**	(0.7600)**	(3.0676)	(2.4291)*	(1.6382)**	(0.2217)**	(0.6997)**	(2.2559)	(2.2717)	(1.2199)**
R^2	0.01	0.02	0.02	0.02	0.02	0.30	0.30	0.30	0.30	0.30
Added covariates	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Shape of Profile	U-shaped	Unrelated	Increasing	Increasing	Increasing	U-shaped	Increasing	Unrelated	Unrelated	Increasing

Significance levels : $*$: 5% $**$: 1%

Robust standard errors in parentheses.

Additional covariates are gender, *bundesland*, nationality, marital status, educational diploma, labor force status, household income and self reported satisfaction with health and number of members in the household.

Omitted categories: 21 year olds, year 1984, January of every year, cohort born between $[1924, 1929[$, cohort born in 1924 and 1-member household.

Table 7: Following individuals who answered 1^{st} and last waves: estimation results

	I	II	III	IV	V	VI	VII	VIII	IX	X
Age	-0.0304	0.0245	0.0578	0.0604		-0.0451	0.0108	0.0251	0.0255	
	(0.0083)**	(0.0141)	(0.0396)	(0.0396)		(0.0084)**	(0.0120)	(0.0298)	(0.0297)	
Age^2	0.0003	-0.0002	-0.0002	-0.0002		0.0007	0.0002	0.0001	0.0001	
	(0.0001)**	(0.0001)	(0.0001)*	(0.0001)*		(0.0001)**	(0.0001)	(0.0001)	(0.0001)	
Age 21					0.1069					0.1237
					(0.0702)					(0.0642)
Age 31					0.5804					0.4544
					(0.4296)					(0.3188)
Age 41					1.0777					0.8223
					(0.8177)					(0.5996)
Age 51					1.3567					1.0904
					(1.2076)					(0.8835)
Age 60					1.7965					1.5447
					(1.5571)					(1.1375)
Cohort				-0.0214	0.0052				-0.0196	0.0006
				(0.0508)	(0.0511)				(0.0384)	(0.0387)
$\text{Cohort}^2/100$				0.2103	0.0704				0.0958	-0.0114
				(0.2039)	(0.2073)				(0.1571)	(0.1597)
$\text{Cohort}^3/1000$				-0.0248	0.0030				-0.0014	0.0196
				(0.0486)	(0.0494)				(0.0377)	(0.0383)
$\text{Cohort}^4/10000$				0.0012	-0.0006				-0.0003	-0.0017
				(0.0039)	(0.0040)				(0.0031)	(0.0031)
Cohort $[1929, 1934[$		-0.1421					-0.0672			

Continued on next page

Table 7 – continued from previous page

	I	II	III	IV	V	VI	VII	VIII	IX	X
		(0.1393)					(0.1074)			
Cohort $[1939, 1944[$		-0.2154					-0.1046			
		(0.2075)					(0.1536)			
Cohort $[1949, 1954[$		-0.0901					-0.0074			
		(0.3153)					(0.2324)			
Cohort $[1959, 1964[$		0.1862					0.2668			
		(0.4330)					(0.3160)			
Cohort $[1969, 1974[$		0.4504					0.5688			
		(0.5468)					(0.3985)			
Cohort $[1979, 1984[$		0.5939					0.8053			
		(0.6584)					(0.4815)			
Cohort 1925			-0.2052					-0.0957		
			(0.4228)					(0.3508)		
Cohort 1935			-0.3745					-0.3499		
			(0.5608)					(0.4424)		
Cohort 1945			0.0305					-0.0854		
			(0.8966)					(0.6699)		
Cohort 1955			0.5621					0.3057		
			(1.2613)					(0.9305)		
Cohort 1965			0.9392					0.5462		
			(1.6331)					(1.2029)		
Cohort 1975			1.8207					1.1859		
			(2.0166)					(1.4777)		
Cohort 1983			2.8106					2.2618		
			(2.3276)					(1.7592)		

Continued on next page

Table 7 – continued from previous page

	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**
Year 1986	1.2662	0.8053	2.0406	2.0804	0.8140	0.2430	0.5161	0.6976	0.8303	-0.0785
	(0.3669)**	(0.4613)	(0.7316)**	(0.7574)**	(0.4644)	(0.1494)	(0.2063)*	(0.4669)	(0.4942)	(0.2937)
Year 1991	0.4928	-0.0004	0.9895	1.1264	-0.1612	0.3301	0.5181	0.6381	0.7847	-0.1308
	(0.1105)**	(0.2960)	(0.4300)*	(0.4644)*	(0.3735)	(0.1069)**	(0.1435)**	(0.3185)*	(0.3457)*	(0.3201)
Year 1996	-0.0144	-0.5849	0.2725	0.3976	-0.9043	0.1191	0.2287	0.3088	0.4453	-0.4727
	(0.2155)	(0.3671)	(0.3118)	(0.3377)	(0.5469)	(0.1714)	(0.1788)	(0.2393)	(0.2566)	(0.4301)
Year 2001	0.1018	-0.5549	0.1536	0.2616	-1.0311	0.0828	0.0949	0.1118	0.2518	-0.6614
	(0.0733)	(0.3373)	(0.0827)	(0.1044)*	(0.6755)	(0.0667)	(0.0674)	(0.0718)	(0.0868)**	(0.5167)
Constant	7.6707	6.8179	4.2412	3.6891	5.8913	4.6138	2.9505	2.2785	2.0379	3.3649
	(0.1676)**	(0.7594)**	(3.0217)	(3.0798)	(1.6347)**	(0.2216)**	(0.6927)**	(2.2217)	(2.2658)	(1.2171)**
R^2	0.01	0.02	0.02	0.02	0.02	0.30	0.30	0.30	0.30	0.30
Added covariates	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Shape of Profile	U-shaped	Unrelated	Increasing	Increasing	Increasing	U-shaped	Unrelated	Unrelated	Unrelated	Increasing

Significance levels : $*$: 5% $**$: 1%

Robust standard errors in parentheses.

Additional covariates are gender, *bundesland*, nationality, marital status, educational diploma, labor force status, household income and self reported satisfaction with health and number of members in the household.

Omitted categories: 21 year olds, year 1984, January of every year, cohort born between $[1924, 1929[$, cohort born in 1924 and 1-member household.

Table 8: Accounting for individual heterogeneity, measurement error and the qualitative nature of the dependent variable: estimation results

	WG - basic specification	**WG - full model specification**	**Ordered Probit**
Age	-0.0125	-0.0450	0.0193
	(0.0224)	(0.0220)*	(0.0154)
Age^2	-0.0002	0.0002	0.0001
	(0.0001)**	(0.0001)*	(0.0000)
Cohort			-0.0076
			(0.0195)
$Cohort^2/100$			0.0268
			(0.0738)
$Cohort^3/1000$			0.0081
			(0.0175)
$Cohort^4/10000$			-0.0009
			(0.0014)
Year 1986	0.2028	-0.0954	-3.3343
	(0.3695)	(0.3749)	(0.3990)**
Year 1991	0.2177	0.0104	-0.0470
	(0.2693)	(0.2628)	(0.1709)
Year 1996	0.1967	0.1373	-0.3083
	(0.1574)	(0.1540)	(0.2144)
Year 2001	0.2252	0.1804	-0.4791
	(0.0588)**	(0.0580)**	(0.2754)*
Constant	7.7198	6.3532	
	(1.0467)**	(1.0378)**	
Shape of Profile	Decreasing	Increasing	Unrelated

Significance levels : $*$: 5% $**$: 1%

Robust standard errors in parentheses.

Additional covariates: gender, *bundesland*, nationality, marital status, educational diploma, labor force status, household income and self-reported satisfaction with health and number of members in the household.

Omitted categories: 21 year olds, year 1984, January of every year, cohort born between $[1924, 1929[$, cohort born in 1924 and 1-member household.

4 Conclusion

Because age, calendar time and birth cohort are linearly dependent, the latter is typically sacrificed in empirical work. A redefinition of age, when data are only available on an annual basis, breaks the linear dependence between the three variables. An application to the estimation of the age-happiness profile suggests that average happiness increases as individuals grow older, even though this is not a robust result. When cohorts are omitted, and hence the age coefficients are biased, a U-shaped pattern emerges. This implies that cohorts can have a substantial impact on the variable of interest and omitting them or inadequately accounting for them can render conclusions invalid.

The applications for this method are immense. Even if one questions how much is the lifecycle happiness profile the real effect of age on happiness, vis-à-vis how much it is the lack of knowledge of the underlying variables that vary with age and further make happiness change, this procedure can be used to in several applications from Economics, Medicine and Demographics.

The key element to implement this procedure is having enough variation in the month of the interview and the recording of individual birthday, preferable the day of birth which is not however available in this dataset. As long as adequate accounts of time have been made, spreading interviews throughout the year allows the econometrician to observe two individuals that are exactly the same in everything except in their number of completed years. Further, interviewing each individual in different moments of the year further allows the same individual being observed in two consecutive years with the same age or a 2-year difference in age. Moreover, recording the number of attempts made, before succeeding in contacting the interviewee, would help in identifying the group of people most likely to bias the results.

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