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AN EXAMINATION OF THE DYNAMICS OF HAPPINESS USING VECTOR AUTOREGRESSIONS

Abstract

We use a panel vector autoregressions model to examine the coevolution of changes in happiness and changes in income, health, marital status as well as employment status for the British Household Panel Survey (BHPS) data set. This technique allows us to simultaneously analyze the impact of the aforementioned factors on each other. We find that increases in happiness are associated with subsequent increases in income, marriage, employment, and health variables, while increases in the these life-domain variables (except health) tend to be followed by decreases in happiness in subsequent periods, suggesting adaptation dynamics in all domains. These findings are quite robust to different model specifications.

Keywords: Happiness dynamics, vector autoregressions, subjective well-being, BHPS
JEL-classification: I31, D63, C33

1 Introduction

In welfare economics, individual well-being is traditionally conceptualized by the satisfaction of an individual's preferences, and the usual proxy to measure this satisfaction has been income. Happiness research has extended this reasoning to encompass happiness (or, synonymously, subjective well-being) as the ultimate measuring rod for individual well-being, empirically captured by diverse happiness or life-satisfaction measures (Easterlin, 2002; Frey and Stutzer, 2002a; Diener and Seligman, 2004).[1] Unfortunately, an individual's happiness depends on a complex vector of factors, ranging from individual determinants (e.g., self-esteem, optimism) to socio-demographic (such as gender, age, education, or marital status), economic (such as income, status, or unemployment), situational (such as health, social relationships), and even institutional factors (Frey and Stutzer, 2002a, pp.10-1).

Moreover, in many of the relationships, causality cannot be attributed unambiguously into only one direction (for an overview cf. Easterlin, 2003). For example, healthy individuals tend to be happier; but is that because happy individuals fall ill less often, or is it because healthy individuals have less reason to worry and thus are happier? To make things even more complex, intervening variables often play a role as well. Income and health positively correlate with education; but can one find a direct relationship between happiness and education?

And lastly, from a dynamic point of view, there is the additional problem of adaptation. Increases in income, better health, a fulfilling job or a marriage tend to increase happiness. But it is debated whether such influences are ephemeral or have a lasting impact on subjective well-being. For example, conventional wisdom in the happiness literature holds that increases in income only temporarily increase happiness, while marriage has a lasting influence (Frey and Stutzer, 2002b; Easterlin, 2003). But recent findings give reason to qualify these results, as stronger, lasting effects of income on subjective well-being have been found (Stevenson and

[1] One might be critical of the validity of such constructs and ask whether these surveys really elicit anything useful at all. However, an impressive psychological literature exists showing that there is a strong correlation between such well-being constructs and emotional expressions like smiling (Fernandez-Dols and Ruiz-Belda, 1995) and brain activity (Shizgal, 1999). Moreover, individuals tend to discontinue unsatisfactory behaviors (Kahneman et al., 1993; Shiv and Huber, 2000), thus also relating low satisfaction scores to choice behavior. Lastly, studies found that individuals are to a certain extent able to (ordinally) compare and assess other individuals' levels of satisfaction or happiness (Sandvik et al., 1993; Diener and Lucas, 1999). We thus feel justified in attributing a certain validity to measures of subjective well-being and thus abstract from this fundamental criticism in the remainder of the paper.

Wolfers, 2008), as well as a decrease in happiness following marriage (Stutzer and Frey, 2006; Lucas and Clark, 2006).[2]

These stylized facts highlight two important insights: First, in exploring the determinants of happiness, one has to deal with a complex interplay of causal relationships, which are still not fully understood. Second, the dynamic interplay of these factors has to be analyzed. While existing happiness research mainly focuses on the effect of one variable on happiness, for instance how marriage affects happiness, it neglects the complex interaction between these and other variables, especially their intertemporal development. We need to consider several different time lags to appreciate the richer structure of the dynamics of individual happiness, including the possibility of adaptation. The years before and after an event are important.

Panel studies do exist in happiness research, and they play an increasingly important role — they allow us to remove individual-specific effects, thus providing more reliable identification of individual responses to changes in lifestyle and living conditions. This paper combines these two elements —time lags and panel data techniques — using vector autoregressions, a technique that has not been applied previously to happiness research.

A related contribution of this paper lies in its focus on human life experiences as complex evolving processes. We consider variables such as health, marriage, happiness, income all to be interdependent and mutually endogenous. We look at the coevolution of a relatively large number of variables, allowing each to be associated with each other over a number of time lags. In this way, we take a more global view on the sources, processes, and dynamics of individual well-being. While we are guided by theory in selecting these determinants of happiness, the techniques we employ do not force us to assume specific causal relationships. We thus analyze how changes in these variables are *associated* with changes in the other variables.

The paper is structured as follows. Section 2 presents previous findings on the coevolution of the most important determinants of happiness to motivate the use of panel vector autoregressions. We further discuss the methodology of panel vector autoregressions and present the main advantages we see in using this technique. Section 3 introduces the data set we use, namely the

[2]Similar adaptation effects have been reported for paraplegics, whose happiness levels fall drastically directly after the accident causing their disability, but whose happiness tends to rise after a while (though not to previous levels, cf. Brickman et al., 1978). By contrast, adaptation to chronic pain is less pronounced. These examples show that adaptation is domain-specific (Frederick and Loewenstein, 1999).

British Household Panel Survey (BHPS), which offers a rich variety of variables for potential inclusion in our analysis. Section 4 presents our results and a discussion. Section 5 concludes.

2 Methodology of empirical happiness research

2.1 Coevolution of the main variables

In this section, we conduct a verbal discussion of some features that are relevant to empirical work on subjective well-being. To begin with, we argue that all of our main variables are in fact interrelated and mutually endogenous, and we aim to take a more complete, comprehensive view of the phenomenon in question by considering interactions between all of these main variables. We aim to better describe the procedures and dynamics of individual well-being and the channels through which life events affect well-being. We do not focus exclusively on well-being, though, since we also will have other variables as dependent variables. Nevertheless, well-being is of course a major variable in our analysis.

Existing happiness research mainly tends to focus on the effect of one variable (e.g., marriage) on happiness. It seems to be well understood that happiness is associated with fulfilling social relations (e.g. Myers, 1999), with marriage being the most important. Similarly, happiness is associated with being in good health (Easterlin, 2003), being in employment (or at least not being unemployed, see Clark and Oswald, 1994); and to a certain degree happiness also seems to depend on financial security (Oswald, 1997; Frey and Stutzer, 2002b; Stevenson and Wolfers, 2008). Of course, many other influences have been found to play a role as well, but the ones mentioned so far seem to constitute the most important ones (for extensive surveys cf., e.g., Argyle, 1999; Diener et al., 1999).

It is our opinion that it is not realistic to view one variable as the exogenous stimulus and the other as the outcome. While happiness is the outcome for some variables, it is also a determinant of other variables. It would be better to view different variables as inextricably linked together and coevolving over time. An appropriate statistical technique for such a system would be a reduced-form vector autoregression. We have to note that, more often than not, the happiness literature puts happiness as the dependent variable and tries to explain happiness in terms of

changes in other variables as is depicted in equation (1):

$$Happiness = f(marriage, health, income, employment\ status). \quad (1)$$

A drawback of equation (1) is that it crucially neglects that happiness (broadly understood) is itself an important determinant of how healthy we are, how successful we are at work or in social relations, and probably even how large our income is (Lyubomirsky et al., 2005). While our main focus is on analyzing the coevolution of happiness and its determinants over time, we also want to shed light on the interplay between these others factors. These mutual interdependencies cannot be captured in the standard regression framework, where, for example, the influence of variables such as marriage or health on happiness is measured. Taking into account the mutual interdependencies between the variables thus requires to also analyze how, for example, marriage depends on happiness, health, or income. The need for such a more complete view has also been expressed in the recent happiness literature; for example Lucas and Clark (2006) state that "marital events are not completely exogenous" (p.407) — happiness depends on marriage, but marriage depends on happiness (as well as other variables such as health and income), giving us equation (2):

$$Marriage = g(happiness, health, income, employment\ status). \quad (2)$$

But similarly, there is also long-standing evidence that marriage leads to greater income and better health (e.g., Gray, 1997; Gardner and Oswald, 2004), one hypothesis being that this results from specialization effects of the partners in a marriage. Taking this relationship into account and inserting equation (2), we obtain:

$$Income = h(Marriage) = h(g(happiness, health, income, employment\ status)). \quad (3)$$

Furthermore, marriage seems to be beneficial to both partners' health. It has been found that "married people have better physical and psychological health . . . and that they live longer"

(Stutzer and Frey, 2006, p.328), giving us equation (4):

$$Health = k(Marriage) = k(g(happiness, health, income, employment\ status)). \quad (4)$$

And so on. In fact all these variables are interrelated and mutually determined. Basically, when examining any of the relationships between the variables happiness, income, health, marriage status, and employment status, there are competing hypotheses as to which direction the causal arrow points and explanatory hypotheses exist that could explain both directions. Coming back to our earlier example regarding the relationship between marriage and income, it has not only been conjectured that marriage leads to increased income due to specialization after marriage (effects of marriage on income) but also —assuming a reverse causality— that there is a selection of wealthy individuals into marriage (for effects of income on marriage, cf., e.g., Smock and Manning, 1997; Antonovics and Town, 2004). The same applies to the interplay between happiness and health, in reference to which Easterlin (2003) notes that it is not sure "which way the causal arrow runs: from health to life satisfaction or from life satisfaction to health" (p. 11177). Similarly, in labor economics, findings corroborate that unemployed individuals are less healthy (unemployment causes stress and leads to deteriorated health), on the one hand, but other studies suggest that there is a selection effect of the less healthy into unemployment (e.g., Arrow, 1996; Gardner and Oswald, 2004). Such competing hypotheses can be found for virtually all of our variables (see table 1).[3]

In this context of complex interactions and mutually endogenous variables, we argue that the best approach to take is a reduced-form panel VAR. This regression model allows us to investigate the coevolution of a number of main variables without imposing any restrictions on the causal relationships between the variables. Instead of trying to firmly establish any direction of causality, we present interesting correlations that provide a description of comovements between a number of key variables related to subjective well-being. Our results should thus be seen as an attempt to summarize the lead and lag associations over time between the main variables.

[3]This table is not intended to be complete, we merely seek to point out that indeed all variables have been empirically analyzed in all directions, giving rise to diametrically opposed theoretical explanations regarding causality.

2.2 Time-invariant individual effects

Research into subjective well-being began with cross-sectional analyses, but scholars are becoming increasingly aware of the drawbacks of making inferences from cross-sectional data (Lucas and Clark, 2006).[4] As happiness research progresses, scholars need to become more wary of statistical pitfalls that may produce misleading results.

One of the main statistical problems facing this body of research stems from the existence of time-invariant individual-specific components (also known as 'fixed effects') in well-being variables (cf. Ferrer-i Carbonell and Frijters, 2004). For example, while cross-sectional analyses tend to associate marriage with happiness, some researchers have suggested that this could be due to happier individuals self-selecting themselves into marriage. As such, marriage might be correlated with happiness in a cross-section because of this self-selection mechanism, even if marriage *per se* has no effect on happiness.

Fixed effects are an important feature in our specific context. Most of the variance in well-being is between individuals at a specific cross-section in time, rather than within individuals over time. As a result, a longitudinal approach is to be preferred to a cross-sectional one, and individual-specific fixed effects need to be allowed for. In this paper, we control for fixed effects by taking first differences of the main variables, in the following way. Happiness for individual i at time t can be broken down into a time-invariant fixed effect μ_i and a transitory component ϵ_{it}:

$$Happiness_{it} = \mu_i + \epsilon_{it}. \tag{5}$$

By taking first differences, we can remove the influence of the time-invariant effect μ_i and thus remove any misleading influence that μ_i might have on the regression results. This is not unimportant since happiness does not only have state-like but also trait-like properties (Diener et al., 1999, pp.279-80), thus being dependent not only on situational influences but also on personality and genes (Lykken and Tellegen, 1996).

[4] See also Stutzer and Frey (2006, p.329) who state the need for more analyses of panel data in happiness research.

Source	Happ.	Inc.	Marr.	Empl.	Health	Data	Period	Notes
Stevenson and Wolfers (2008)	D	X				GSS (US) et al.	1972-2006	Analyzing several data sets
Oswald (1997)	D	X				GSS (US), Eurobarometer Survey (Europe)	1972-1990	
Lucas and Clark (2006)	D		X			GSOEP (Germany)		Multilevel analysis; FE; control for cohabitation
Stutzer and Frey (2006)	D		X			GSOEP (Germany)	1984-2000	Conditional logistic estimates; FE; control for family size
Stack and Eshleman (1998)	D		X			World Values Studies Group	1981/1983	17 Western, industrialized nations; control: cohab., ease of divorce
Di Tella et al. (2001)	D			X		Euro Barometer / US GSS	1975-1991	Macro focus; lower inflation also increases happiness
Clark and Oswald (1994)	D			X		BHPS (UK)	1991	Focus on regional variation: control for UK regions
Oswald and Powdthavee (2008)	D				X	BHPS (UK)	1997-2004	Using lags; fixed effects
Easterlin (2003)	D				X	GSS (US)	1972-2000	Cohort analysis; no complete adaptation
Marks and Fleming (1999)	X	D				Australian Youth in Transition Panel	1980-1995	Four cohorts
Antonovics and Town (2004)		D	X			TSS (US)		Differences between twins; fixed effects
Gray (1997)		D	X			National Survey of Youth, US	1966-1980	Only: males; fixed effects
Blackburn and Korenman (1994)		D	X			March Current Population Survey (CPS), US	1967-1988	Only: males; fixed effects
Stutzer and Frey (2006)	X		D					
Marks and Fleming (1999)	X		D					See above
Cutright (1970)		X	D			US Census Data	1959/60	Males!
Smock and Manning (1997)		X	D			NSFH1 and NSFH2	1987/88, 1992-94	For already cohabiting couples
Kalmijn and Luijkx (2005)			D	X		Netherlands, cohort	1930-1970	Focus on males, multinomial logit model
Hu and Goldman (1990)			D		X	16 countries	differs	
Verkley and Stolk (1989)	X			D		Netherlands, longitudinal study	1983-1984	
Marks and Fleming (1999)	X			D				See above
Kalmijn and Luijkx (2005)			X	D		Netherlands, cohort	1930-1970	Focus on males, multinomial logit model
Arrow (1996)				D	X	Germany, GSOEP, cohort	1984-1990	
Graham et al. (2004)	X				D	Russia Longitudinal Monitoring Survey (RLMS)	1995/2000	
Smith (1999)		X			D	National Center for Health Statistics Data	1984	Largely based on Whitehall Studies evidence
Gardner and Oswald (2004)		X			D	BHPS	1991-2001	Aged over 40; controlling for subj. health assessments
Umberson (1987)			X		D	US	1974-75	Negative health behaviors
Gardner and Oswald (2004)			X		D	BHPS	1991-2001	Aged over 40; controlling for subj. health assessments
Joung et al. (1997)			X		D	Netherlands, GLOBE	1991	Married indiv. show more healthy behaviors; control for cohabitation
Gardner and Oswald (2004)				X	D	BHPS	1991-2001	Aged over 40; controlling for subjective health assessments
Wadsworth et al. (1999)				X	D	National Child Develop. Study (NCDS)	1974-1985	Ages 16-33, males

Table 1: A review of the literature relating to our five main variables. Legend: D = dependent variable, X = major explanatory variable, FE = fixed effects.

$$\Delta Happiness_{it} = Happiness_{it} - Happiness_{i,t-1}$$
$$= (\mu_i + \epsilon_{it}) - (\mu_i + \epsilon_{i,t-1}) = \epsilon_{it} - \epsilon_{i,t-1} = \Delta\epsilon_{it}. \quad (6)$$

While happiness levels are affected by both the fixed effect μ_i and the transitory component ϵ_{it} (equation (5)), changes in happiness can be expressed purely in terms of changes in the transitory component (i.e., $\Delta\epsilon_{it}$; see equation (6)).

Removing the fixed effect in this way can be problematic if there is measurement error in the variables, because taking differences may amplify the noise to signal ratio in the data set. As a result, there may be a small downward bias in the magnitudes of our coefficient estimates. Nonetheless, in our data set we have a large number of observations which should help in the identification of the coefficient estimates. In addition, in section 4.2 we investigate the robustness of our results in a number of directions.

2.3 Time lags

As researchers have moved from cross-sectional to longitudinal data sets, the study of the time lags between key variables has received increasing attention. Theoretical work has also shown interest in the time lags between life events and subjective well-being. Scholars who subscribe to the adaptationist view of well-being suggest that (at least some) changes in well-being are transitory and that individuals revert to long-run levels after a certain time lag. In this vein, Stutzer and Frey (2006) investigate how the effects of marriage on happiness vary over time, and observe that individuals report increasing average satisfaction scores before marriage and decreasing ones after marriage. As a result, both short-term and longer-term effects need to investigated. Our analysis includes a number of time lags both before and after life events in order to appreciate the richer structure of the dynamics of individual life satisfaction.

2.4 The model

Our regression equation is the following:

$$W_{i,t} = a + \sum_{\tau=t-s}^{t-1} b_{i,\tau} W_{i,\tau} + c \cdot X_{i,t-1} + \varepsilon_{i,t}, \tag{7}$$

where W is a vector containing our five main endogenous variables ($t - s$ referring to the number of lags examined): happiness, income, marital status, employment status, and health status. X corresponds to a vector of control variables that are supposedly exogenous (i.e., age, gender, year dummies, and academic qualification). b is a matrix of dimension 5 $\times$ 5 and contains our main coefficients of interest. The coefficients in c, relating to the control variables, are included in all regressions, but for the sake of space they are not reported in our results tables. ε corresponds to the usual residual error term.

3 Data set and summary statistics

3.1 Data set

The British Household Panel Survey (BHPS) is a longitudinal survey of private households in Great Britain, undertaken by the ESRC UK Longitudinal Studies Centre with the Institute for Social and Economic Research at the University of Essex, UK (BHPS, 2007). Its aim is to track social and economic change in a representative sample of the British population (for the following and more information on the data set, cf. Taylor, 2007, sections A2 & A4). The BHPS started in 1991 as a nationally representative sample of 5,000 households, where adults (aged sixteen and over) were interviewed and tracked over the years. The sample comprises about 15,000 individual interviews.

The first wave was created with a two-stage clustered probability design and systematic sampling. Sample units were selected with the small users Postcode Address File (PAF). Two hundred and fifty postcode sectors were first selected as Primary Sampling Units (PSU). These were stratified by region and socio-demographic variables derived from the 1981 census. In stage two of the process, addresses were selected in a similar fashion.

The aim of all further waves was to track the individuals of the first wave over time. A new wave of interviews has been added annually. The BHPS data contains information on var-

ious domains of the respondents' lives, ranging from income to jobs, household consumption, education, health, but also social and political values.

3.2 Indicator selection and descriptive statistics

For our approach, we want to analyze the interplay between an individual's happiness and certain other variables over time. These variables include income, health, marriage status as well as job status. As control variables, we have chosen an individual's highest education as well as age and gender. With these variables we use the most prevalent factors that are argued to have an influence on individual subjective well-being (see, e.g., Argyle, 1999; Easterlin, 2003). We will discuss each of them and the proxies we use to measure them in turn. Table 2 gives an overview of the descriptive statistics. As we are using unbalanced panel data from 1991 to 2005, we have a total of $151,702$ observations after cleaning the panel (discarding individuals who have not reported the indicators we use, see below) from 14 waves (We also had to drop one year because the coding of one of the variables was changed, see below). Taking the changes in variables, we are left with $110,692$ observations, yielding $57,421$ observations for use in the regressions with the models of lag length 2. Due to the nature of the data set, first differences are between years so that the lag structure is on an annual basis.

To assess happiness, we have decided on using the well-known GHQ-12 measure which tracks the individual's assessment of mental well-being as a proxy of subjective well-being. It is an index from the 'General Health Questionnaire' of the BHPS, composed of the answers to 12 questions that assess happiness, mental distress, and well-being. This subjective assessment is measured on a Likert scale from 0 to 36, which we have recoded to values of one (lowest well-being) to 37 (highest scores in mental well-being). This proxy is widely used in the psychological literature (for more details on this indicator cf., e.g., Gardner and Oswald, 2001; Clark and Oswald, 2002).

	Mean	Std.Dev.	10%	25%	Median	75%	90%	Min.	Max.	Obs.
ΔHappiness	-0.08034	5.283502	-6	-2	0	2	6	-36	36	110692
ΔLog(income)	0.0343733	0.5705884	-0.403388	-0.0877953	0.0457134	0.1807351	0.4525118	-8.773426	7.791135	110692
ΔMarriage	0.0054927	0.1699386	0	0	0	0	0	-1	1	110692
ΔEmployment	0.0038847	0.2969146	0	0	0	0	0	-1	1	110692
ΔHealth	-0.0209229	0.8127567	-1	0	0	0	1	-4	4	110692
Age	44.79988	18.74335	21	29	42	59	72	15	99	151702
Gender	1.562913	0.4960278	1	1	2	2	2	1	2	151702
Education	2.929737	1.729894	1	1	3	4	6	1	7	151702

Table 2: Summary statistics of the main variables and control variables

Turning to our measure of income, we have decided to use mean gross income (in British Pound Sterling). In accordance with recent consensus in the literature, we use the *logarithm* of the income measure as a regressor in our analysis (Stevenson and Wolfers, 2008; Easterlin, 2001, p.468), assuming that the same change in the proportion of income leads to the same change in happiness.

To measure an individual's health, we have chosen to use an individual's subjective assessment of health (during the last 12 months). This is ordinally scaled on a five point Likert scale, ranging from 'excellent' (five) to 'very poor' (one).[5] Subjective assessments of health seem to predict objective health quite well in some cases (e.g., regarding morbidity).

Whether objective health is sufficiently well captured by subjective health assessments is still debated (cf. Johnston et al., 2007). Nevertheless, although a more detailed indicator set would certainly be welcome, we think that for our expositional measurement exercise, this single indicator will do. Note further that in the 1999 wave, a different coding of this indicator has been used. Since comparability between the different scalings is nontrivial, we have chosen to discard the observations of this wave to have a more consistent panel at our disposal.

As indicators for important life events influencing happiness we have chosen to include dummies for being married and being employed. We have tried to code these indicators as conservatively as possible. For marriage we have chosen the dummy to be '1' if married (53.42%) and zero otherwise, including being separated (2.04%), divorced (7.66%), or widowed (8.12%) as well as those individuals who have not yet married. As individuals start out as never married but can never occupy that category again after once leaving it, it would not be possible to otherwise rank changes in marriage status (we implicitly consider that status to be somewhat similar to being separated).

For our employment dummy, we have chosen to code 'being employed' (54.46%) as '1' and all other conditions such as being unemployed (4.24%), retired (20.84%), on long-term sick leave (4.17%, etc.) as zero. We have dropped individuals who are self-employed because they are a notoriously heterogeneous group containing both star performers and social rejects

[5] As in the case of well-being, we have reversed the numerical order of the Likert scale to consistently use higher values for higher 'achievement' in these domains. The original coding in the BHPS codes a value of one to be excellent health and five to be very poor health.

	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth
ΔHappiness	1.000				
p-value					
obs.	110692				
ΔLog(income)	0.0083	1.000			
p-value	0.0060				
obs.	110692	110692			
ΔMarriage	0.0298	0.0567	1.000		
p-value	0	0			
obs.	110692	110692	110692		
ΔEmployment	0.0561	0.0290	0.0030	1.000	
p-value	0	0	0.3216		
obs.	110692	110692	110692	110692	
ΔHealth	0.1580	0.0042	0.0090	0.0270	1.000
p-value	0	0.1645	0.0027	0	
obs.	110692	110692	110692	110692	110692

Table 3: Correlations

(Santarelli and Vivarelli, 2007). This again we consider as conservative since it would have been comparatively more difficult to put these events in a rank ordering of betterness. Is being self-employed a positive change from being employed or not? This might be the case for some, but others go into self-employment to escape unemployment.

The last category of variables concerns the control variables. We have decided to use gender, age as well as an individual's highest education as a selection of some of the most important individual factors influencing our analysis. These factors and their descriptive statistics are also summed up in table 2. Of our sample, 56.29% were female. The mean age is 44.80 years (s.d. 18.74) with maximum age at 99 years and minimum age at 15 (younger individuals were not interviewed in the BHPS). We control for an individual's highest level of education. Again, this is measured ordinally, ranging from one ('none of these') to seven ('higher degree'), giving intermediate values to the middle education levels.[6]

In table 3, we report pairwise correlations between our indicators for the changes in the main variables (a full correlation table including control variables is presented in the appendix, see table 6). The correlations of most of our indicators are highly statistically significant.[7] The correlations in differences are rather small in effect, the highest correlation being between

[6]For more information cf. Taylor (2007), App.2, pp.18-9.

[7]Although a notable exception is gender which is only correlated with change in marriage and age.

change in health and change in happiness ($r = 0.1580$).[8] It is noteworthy that all (significant) correlations between our main variables (changes in happiness, health, income, marriage, and employment status) are positively associated. This is different with the control variables, where age is negatively correlated with most of the main variables (except for change in happiness, where the correlation is not significant), while education is positively correlated with the main variables (again, except for change in happiness, where the correlation is not significant).

Note that the correlations in table 3 are in differences. Pairwise correlations of *levels* of happiness and the other indicators are similar to what has been reported in the literature (we present them in the appendix in full, see tables 6 and 7).[9] As an additional investigation of potential multicollinearity, we inspected the VIF diagnostics for the following VAR(2) OLS model, which were all satisfactory. This lends further support to the validity of our regression methodology.

Nevertheless, due to the simplistic nature of this correlation analysis, one should probably not put too much emphasis on these correlations. Moreover, one could include even more personal characteristics and other variables into our approach. To illustrate the core idea, however, we deem these variables to be sufficient and capturing some of the most important determining factors of an individual's happiness.

[8]The other comparatively high correlation in that table is between education and age ($r = -0.3535$), two of our control variables of which we report only levels, not differences. An explanation why age is negatively associated with education could be that the sample contains a large proportion of older individuals who do not hold as many high academic degrees as might be usual today.

[9]There is positive correlation between *levels* of happiness and income ($r = 0.0867$), health ($r = 0.3772$), marriage ($r = 0.0157$), being employed ($r = 0.1086$) and being better educated ($r = 0.0702$, all highly significant). Correlations of measures of well-being and income are generally low in intra-country cross-sections (Bechtel, 2007). Negative correlations exist between happiness and gender ($r = -0.1266$) and age ($r = -0.0491$, both also highly significant). The contemporary association between marriage and happiness here is rather small, probably due to the fact how we have coded the marriage dummy (where the dummy is one when married but zero when not (yet) married or separated, divorced or widowed). Another interesting fact is that the correlation between happiness and employment is quite high, although here, similarly, this category does not include self-employed individuals.

4 Results and discussion

4.1 Aggregate analysis

The main findings of our vector autoregressions are summed up in tables 4 and 5. To begin with, we can state that the findings are very similar between the different estimators (OLS vs. ordered probit). Although economists tend to prefer ordinally scaled happiness constructs, we have decided on (implicitly) interpreting our well-being measure as cardinal in using an OLS regression in the panel VAR. This is justified for two reasons. First, such an interpretation is common in the psychological literature on well-being, and it has been shown that there are no substantial differences between both approaches in terms of the results they generate (Ferrer-i Carbonell and Frijters, 2004).[10] Second, as our measure of well-being has 37 outcomes, the supposition of a cardinal underlying latent variable does not really seem problematic.

The similarity between OLS and ordered probit estimators largely extends to all models, i.e., it seems to extend to the different lag specifications (two vs. three lags) and also to different model specifications which we did to test for robustness (with some qualifications to be reported in the next subsection). While we report the three-lag specification in the appendix (table 8), we focus in our interpretation of the results on the two-lag specification. Moreover, we largely limit our analysis to the signs of the significant variables and relate them to findings that already exist in the literature on happiness (as presented above). Due to the exploratory nature of our study, focusing on the signs instead of the absolute coefficient magnitudes seems to be the conservative choice.

Throughout our data, we observe negative autocorrelation for each of our variables. This is exhibited on the diagonals of the tables. If, for example, happiness increased the previous period, it is less likely to increase this period. This can be interpreted as evidence for adaptation effects, where individuals adjust to their new levels of happiness so that further increases are less likely. Individuals are not prone to take off and launch into a long spell of increasing happiness; instead increases in happiness seem to be followed by a plateau or even a return to

[10] It seems that individuals convert ordinal response labels into similar numerical values such that these cardinal values equally divide up the response space (Praag, 1991; Clark et al., 2008). As opposed to this, the differences in results between model specifications that account for fixed effects and those which do not are substantial (Ferrer-i Carbonell and Frijters, 2004).

previous levels. Put differently, individuals are likely to revert to their previous happiness levels after positive life events.

Concerning the other variables, analogous explanations hold, although we remark that the interpretation of negative autocorrelation for both the marriage and employment status variables, in particular, is self-evident. A negative temporal association between increases in income and changes in well-being has also been found for the BHPS by Burchardt (2005) who has also interpreted this as a sign of adaptation to increases in income. Finally, it is of interest that negative autocorrelations between individual variables expressed in differences have also been found in a number of applications of panel vector autoregressions (see, e.g., Coad, 2007).

We find some interesting associations between the changes in variables in our data. One finding is that recent increases in happiness are positively associated with subsequent increases in (log) income, marriage probability, employment status, and health. These effects we have found to be significant regardless of model specification and clearly visible at the second lag also.[11] The positive effect of happiness on all of these examined life domains reinforces the points made by Lyubomirsky et al. (2005) that happy individuals tend to be more successful in terms of health, social relations, and job success and income.

Interestingly, support for the reverse relationship is less strong, and the temporal structure shows that positive changes in one of all life domains —except health— in a previous period are associated with decreasing happiness in the present period. The effect of getting married has even an astonishingly large magnitude regarding the association with a subsequent decrease in happiness, and the effect is significant regardless of model specification. Having married in one of the two last periods makes it thus very unlikely that an individual's happiness will increase further. This is in line with results from Stutzer and Frey (2006) who found happiness rises before marriage and that after marriage happiness returns to levels of happiness before marrying (p.333). But also increases in (log) income are associated with subsequent decreases in happiness, pointing to an explanation in terms of hedonic adaptation or rising aspiration levels (Frederick and Loewenstein, 1999).[12]

[11] The positive association between increases in happiness and increases in income disappears when using a different income measure, however. On this, see the next subsection.

[12] R^2s regarding our marriage proxy are the lowest in the panel VAR, probably due to the fact how the marriage variable is coded and that marriage is probably better explained by factors not included here.

	t-1					t-2						
	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	Obs.	R^2
ΔHappiness	**-0.5677118**	**-0.1436107**	**-0.8040307**	**-0.1927152**	0.0576331	**-0.2720234**	**-0.1338197**	**-0.8154878**	-0.1126923	-0.0197781	57421	0.2581
	-95.22	-3.27	-5.94	-2.45	1.91	-47.57	-3.30	-6.11	-1.49	-0.67		
ΔLog(income)	**0.0010793**	**-0.4193244**	0.0131742	**0.2100182**	0.0054363	**0.0011722**	**-0.1866675**	-0.0091752	**0.117366**	0.0032303	57421	0.1706
	2.22	-40.30	1.05	20.97	1.93	2.44	-22.08	-0.81	13.16	1.14		
ΔMarriage	**0.00098**	**0.0077305**	**-0.1024215**	-0.0027865	-0.0010573	**0.0009981**	**0.0028162**	**-0.0508407**	**-0.0065423**	**-0.0021329**	57421	0.0192
	5.48	5.16	-14.45	-1.14	-1.03	5.68	2.13	-8.80	-2.46	-2.15		
ΔEmployment	**0.0008108**	0.0051931	**-0.0339715**	**-0.3535288**	**0.0061457**	**0.0009096**	0.000243	**-0.0194856**	**-0.1498174**	**0.0064515**	57421	0.1221
	2.94	1.84	-4.49	-51.28	3.70	3.35	0.08	-2.47	-26.39	3.91		
ΔHealth	**0.0072613**	-0.0043688	-0.0252117	-0.0108389	**-0.5374938**	**0.0049267**	-0.009406	-0.0268978	**-0.0275184**	**-0.2575803**	57421	0.2348
	10.07	-0.69	-1.32	-0.97	-109.45	6.92	-1.61	-1.51	-2.50	-54.24		

Table 4: Regression results (coefficient estimates and t-statistics) of a two-lag vector autoregression estimated via OLS. Results significant at the 5% level appear in bold ink.

	t-1					t-2						
	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	Obs.	$Pseudo - R^2$
ΔHappiness	**-0.5677118**	**-0.1436107**	**-0.8040307**	**-0.1927152**	0.0576331	**-0.2720234**	**-0.1338197**	**-0.8154878**	-0.1126923	-0.0197781	57421	0.2581
	-95.22	-3.27	-5.94	-2.45	1.91	-47.57	-3.30	-6.11	-1.49	-0.67		
ΔLog(income)	**0.0010793**	**-0.4193244**	0.0131742	**0.2100182**	0.0054363	**0.0011722**	**-0.1866675**	-0.0091752	**0.117366**	0.0032303	57421	0.1706
	2.22	-40.30	1.05	20.97	1.93	2.44	-22.08	-0.81	13.16	1.14		
ΔMarriage	**0.0142192**	**0.1045117**	**-1.136819**	-0.0310033	-0.0141947	**0.014162**	**0.0422251**	**-0.6700688**	**-0.0857023**	**-0.0319213**	57421	0.0601
	5.88	5.22	-24.91	-0.86	-0.95	5.98	2.35	-11.86	-2.24	-2.21		
ΔEmployment	**0.0052927**	0.0232241	**-0.2362252**	**-1.697886**	**0.040025**	**0.0059394**	-0.0079175	**-0.1593688**	**-0.8243357**	**0.040986**	57421	0.1525
	3.10	1.43	-4.92	-76.25	3.75	3.50	-0.48	-3.23	-32.73	3.84		
ΔHealth	**0.0114995**	-0.0079943	-0.0382401	-0.0186856	**-0.8462894**	**0.0077008**	-0.0152756	-0.0513058	**-0.043844**	**-0.4051921**	57421	0.1144
	10.31	-0.80	-1.27	-1.06	-101.68	6.94	-1.65	-1.83	-2.52	-54.42		

Table 5: Regression results of a two-lag vector autoregression estimated via ordered probit estimator (reported are ordered probit coefficients and z-statistics). Results significant at the 5% level appear in bold ink. The equations where happiness and income are the dependent variables are estimated via OLS though (OLS coefficients and t-stats reported as in previous table).

A competing explanation might be that individuals experience increases in happiness from the expectation of future life events so that the event itself does not have a large effect on already risen levels of happiness. While this cannot be ruled out completely from an empirical point of view, the temporal lag interval of one year casts some doubt on this explanation. Individuals do not seem to be very accurate judges of their future well-being, especially regarding future events that are still temporally distant (Wilson and Gilbert, 2003, 2005; Gilbert and Ebert, 2002).

Moreover, while we cannot find an effect of increases in health on subsequent happiness levels,[13] there is a negative association between becoming employed and subsequent happiness. If one became recently employed in the previous period, happiness is not likely to increase (presumably because one was already at one's peak of happiness in the previous period).

Overall there seems to be more support in favor of temporal associations between happiness and the other variables, where an increase in happiness precedes an increase in the other variables. This direction has been somewhat neglected in recent happiness research, because previous work has focused on the determinants of happiness rather than the effects of happiness on other variables. Our analysis suggests that these relationships should be more carefully researched in the future. Seeing that positive changes in important life domains in a previous period are negatively associated with changes in happiness in the present period highlights the need for more detailed intertemporal analysis of adaptation effects and the temporal structure that is associated with important life domains and their effects on happiness.

In terms of interactions between the other coevolving variables, we can report the following: Perhaps the least surprising aspect is that if one became recently employed (in one of the previous two periods) then income is expected to increase. Similarly unsurprising is the persistent positive association between improvement in health status in one of the two previous periods and the subsequent improvement in employment status. Also noteworthy is that an increase in income is associated with a subsequent increase in the probability of marriage regardless of model specification (the effect of which is significant after controlling for gender, cf. Smock and Manning, 1997).

Somewhat more surprising is the negative association between having gotten married and

[13] Of course, the absence of evidence should not be confused with evidence of the absence of an effect. Not finding a significant effect cannot be interpreted as evidence that there is no such relationship.

the subsequent decrease in employment status (in $t-1$ robust over all specifications). This could be interpreted as evidence in favor of a specialization after marriage, where a partner quits the job in favor of household activities.

4.2 Robustness analysis

In order to further explore the robustness of our results, we have conducted a series of robustness tests. It could, for example, be argued that using the income variable might lead to distortions by neglecting that household members reporting only small incomes can nevertheless not be considered poor. In this category fall spouses who do not work, adolescent children living with their parents, etc. If money buys happiness (and to a certain extent it does, as the literature suggests), the income which is at these individuals' disposal is thus poorly reflected in their reported income, as it depends on the income of the entire household. We therefore adjusted the income of a household by adding up the incomes of all household members and dividing them by the number of household members ('pp_income').[14] We have repeated the analysis using log income per person, and while the results for the happiness, marriage, employment, and health variables did not change in a substantial way (we report the two-lag OLS (table 9) and ordered probit (table 10) models in the appendix), we could no longer find a significant effect of adjusted income on happiness, and vice versa. While we should be careful in interpreting this as evidence for the absence of an effect, we can at least say that on the level of individual panel data the relationship between happiness and income is not as robust as it is sometimes claimed. While Easterlin (2001, p.468) has argued that a correlation between the two variables is often found to exist in the data regardless of adjustments to income or not, this is clearly contradicted by our results.[15]

What can be found besides the effect that changes in income lose their significant association with subsequent changes in happiness is also a loss of association between changes in adjusted income and marriage probability. Moreover, a change in marriage status is now associated with

[14] Mean change in log income per person of a household is according to our calculation 0.0459 GBP (s.d. 0.5391 GBP).

[15] Since our adjustment for household size might be considered too simple, further research seems to be warranted here.

a subsequent decrease in per person income (significant effect).[16] The latter effect is worth mentioning when considering that it is often argued that there exists a marriage wage premium (i.e., married individuals earn higher wages). When adjusting income for household size, our findings support a contrary conclusion: Marriage might lead to specialization of the partners in different activities, but the adjusted income is decreased in subsequent periods (this supports the above-mentioned finding that marriage is followed by a decrease in employment status).

As a second robustness test, we have restricted our sample to the age group between 30 and 60, approximating a sample of the working populace in order to see whether the high proportion of elderly in the sample could have distorted our findings (these results are also reported in table 11 in the appendix). While findings are very similar to the main results presented in the previous subsection, it is worth pointing out that the lagged growth in happiness has a stronger effect on the increase in incomes of this subsample. In this respect, becoming happier has a higher economic relevance for the working populace as opposed to students and the elderly. This reinforces the observation that happy individuals tend to be more successful in their jobs, evidence of which has been also presented in Lyubomirsky et al. (2005). Moreover, in the restricted model, we no longer find a negative association between having gotten employed in the previous period and happiness in the present period, probably as a consequence of no longer having included a comparatively large share of retired individuals in the sample.[17]

5 Conclusion

In the present paper, we have applied a panel vector autoregressions model to the British Household Panel Survey (BHPS) data set to examine the coevolution between changes in happiness and changes in income, health as well as marital and employment status. We have used this approach to start from the data without imposing any theoretical prejudice on the structure of causal relationships between our variables. We see another contribution of this paper in that we have focused on human life experiences as complex evolving processes. We have considered

[16] Both effects pertain to both time lags.

[17] A last test we conducted was restricting household size to households of two persons; but since the results confirm our other results, we did not include them in this paper.

variables such as health, marriage, happiness, and income all to be interdependent and mutually endogenous. Our model has allowed us to look at the coevolution of a relatively large number of variables, allowing all to be associated with each other over a number of time lags. In this way, we take a more global view on the sources, processes, and dynamics of individual well-being. While we have been guided by theory in selecting these determinants of happiness, the techniques we have employed do not force us to assume specific causal relationships. We could thus analyze how changes in these variables are associated with changes in the other variables.

Most salient are our findings regarding the coevolution of happiness and other life domain variables, where we have found that if happiness increased in the previous period, it is less likely to increase in the present period. This can be interpreted as evidence for adaptation effects, where individuals adjust to their new levels of happiness so that further increases are less likely. Another robust finding is that recent increases in happiness are positively associated with subsequent increases in (log) income, marriage probability, employment status, and health. Excepting income, these effects are found to be significant regardless of model specification and lag structure. Support for the reverse relationship is less strong, and the temporal structure shows that positive changes in one of the life domains (except health) in a previous period are associated with decreasing happiness in the present period. The effect of getting married has even an astonishingly large magnitude regarding the association with a subsequent decrease in happiness. Increases in (log) income are associated with subsequent decreases in happiness, pointing to an explanation in terms of hedonic adaptation or rising aspiration levels, an effect that cannot be found, however, when adjusting income for household size.

Overall, there seems to be more support in favor of temporal associations between happiness and the other variables, where an increase in happiness precedes an increase in the other variables. Seeing that positive changes in important life domains in a previous period are negatively associated with changes in happiness in the present period highlights the need for more detailed intertemporal analysis. This would have to focus on adaptation effects and the temporal structure associated with important life domains and their effects on happiness.

In sum, our findings are quite robust to different model specifications which our robustness tests have shown. A next step could focus on including further determinants of happiness into

the model as well as applying the panel vector autoregressions technique to other panel data sets such as the German Socio-Economic Panel (GSOEP) to validate and generalize our findings.

Appendix

	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	Age	Gender	Education
ΔHappiness	1.000							
p-value								
obs.	110692							
ΔLog(income)	0.0083	1.000						
p-value	0.0060							
obs.	110692	110692						
ΔMarriage	0.0298	0.0567	1.000					
p-value	0	0						
obs.	110692	110692	110692					
ΔEmployment	0.0561	0.0290	0.0030	1.000				
p-value	0	0	0.3216					
obs.	110692	110692	110692	110692				
ΔHealth	0.1580	0.0042	0.0090	0.0270	1.000			
p-value	0	0.1645	0.0027	0				
obs.	110692	110692	110692	110692	110692			
Age	0.0002	-0.0178	-0.0800	-0.0747	-0.0111	1.000		
p-value	0.9437	0	0	0	0.0002			
obs.	110692	110692	110692	110692	110692	151702		
Gender	0.0016	-0.0029	-0.0095	-0.0021	0.0042	0.0324	1.000	
p-value	0.5925	0.3358	0.0015	0.4811	0.1633	0		
obs.	110692	110692	110692	110692	110692	151702	151702	
Education	0.0024	0.0172	0.0439	0.0310	0.0074	-0.3535	-0.0804	1.000
p-value	0.4167	0	0	0	0.0139	0	0	
obs.	110692	110692	110692	110692	110692	151702	151702	151702

Table 6: Extensive correlations

	Happiness	Log(income)	Marriage	Employment	Health	Age	Gender	Education
Happiness	1							
p-value								
obs.	151702							
Log(income)	0.0867	1						
p-value	0							
obs.	151702	151702						
marriage	0.0157	0.1972	1					
p-value	0	0						
obs.	151702	151702	151702					
Employment	0.1086	0.4256	0.1000	1				
p-value	0	0	0					
obs.	151702	151702	151702	151702				
Health	0.3772	0.1750	0.0125	0.2452	1			
p-value	0	0	0	0				
obs.	151702	151702	151702	151702	151702			
Age	-0.0491	-0.2567	0.2391	-0.3712	-0.1883	1		
p-value	0	0	0	0	0			
obs.	151702	151702	151702	151702	151702	151702		
Gender	-0.1266	-0.1228	-0.0425	-0.1098	-0.0569	0.0324	1	
p-value	0	0	0	0	0	0		
obs.	151702	151702	151702	151702	151702	151702	151702	
Education	0.0702	0.3452	-0.0295	0.3139	0.2096	-0.3535	-0.0804	1
p-value	0	0	0	0	0	0	0	
obs.	151702	151702	151702	151702	151702	151702	151702	151702

Table 7: Correlations in levels

	t-1					t-2						
	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	Obs.	R^2
ΔHappiness	**-0.6250243**	**-0.1227304**	**-0.6004861**	-0.1412399	**0.1241687**	**-0.3881218**	**-0.1309592**	**-0.6614716**	-0.0539812	0.0251664	38551	0.2859
	-84.07	-2.13	-3.71	-1.44	3.28	-48.85	-2.33	-3.94	-0.56	0.62		
ΔLog(income)	0.0010512	**-0.4453028**	0.0303049	**0.2219404**	0.005356	**0.0015187**	**-0.238682**	0.0075588	**0.1493279**	0.0030946	38551	0.1845
	1.75	-35.19	1.85	18.35	1.55	2.34	-20.88	0.55	12.91	0.83		
ΔMarriage	**0.0012545**	**0.0077087**	**-0.1112043**	-0.0001774	-0.0011826	**0.001216**	0.0025086	**-0.0597595**	**-0.0075495**	-0.0017904	38551	0.0226
	5.45	3.78	-12.33	-0.06	-0.92	4.80	1.40	-7.94	-2.16	-1.28		
ΔEmployment	**0.0008284**	**0.0075617**	**-0.0453102**	**-0.3582472**	**0.0062225**	**0.0011318**	0.0052593	-0.0190886	**-0.1768933**	**0.0078928**	38551	0.1224
	2.41	2.13	-5.00	-41.65	2.95	2.98	1.35	-1.93	-24.00	3.45		
ΔHealth	**0.0075291**	-0.0077639	-0.0190928	-0.0056806	**-0.5858708**	**0.0057836**	-0.0065084	-0.0249182	-0.0241723	**-0.3559112**	38551	0.2584
	8.46	-0.98	-0.83	-0.41	-94.63	5.88	-0.82	-1.13	-1.71	-53.37		
	t-3											
	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth							
ΔHappiness	**-0.2009728**	-0.0344834	**-0.7529351**	-0.0848675	**-0.111046**							
	-29.15	-0.70	-4.91	-0.94	-3.03							
ΔLog(income)	0.0005988	**-0.1078679**	-0.0043995	**0.0732714**	-0.0029458							
	1.02	-10.73	-0.34	7.16	-0.86							
ΔMarriage	0.0003797	0.001498	**-0.0362332**	**0.0070413**	0.0001214							
	1.75	0.79	-5.24	2.34	0.09							
ΔEmployment	**0.0009771**	-0.0035546	**-0.0307423**	**-0.0904499**	0.0017474							
	2.91	-0.96	-3.47	-14.06	0.87							
ΔHealth	**0.0032199**	-0.0028763	-0.0128772	**-0.0282406**	**-0.1812631**							
	3.61	-0.41	-0.57	-2.12	-32.06							

Table 8: Regression results of a three-lag vector autoregression estimated via OLS. Results significant at the 5% level appear in bold ink.

	t-1					t-2						
	ΔHappiness	ΔPp_income	ΔMarriage	ΔEmployment	ΔHealth	ΔHappiness	ΔPp_income	ΔMarriage	ΔEmployment	ΔHealth	Obs.	R^2
ΔHappiness	**-0.5677078**	-0.0743488	**-0.8392845**	**-0.2010874**	0.0570647	**-0.2721704**	-0.0683055	**-0.8394953**	-0.1275945	-0.020424	57421	0.2579
	-95.20	-1.63	-6.21	-2.55	1.89	-47.59	-1.62	-6.29	-1.68	-0.69		
ΔPp_income	0.0002451	**-0.4112225**	**-0.0855135**	**0.2344153**	0.0047813	0.0006902	**-0.1761855**	**-0.0702513**	**0.137317**	0.0028842	57421	0.1654
	0.54	-40.22	-6.69	24.65	1.81	1.53	-22.39	-6.23	15.89	1.09		
ΔMarriage	**0.0009843**	**0.0032636**	**-0.1007708**	-0.0022629	-0.0010251	**0.0010042**	0.0012771	**-0.0504351**	**-0.0056469**	**-0.0021096**	57421	0.0187
	5.50	2.04	-14.26	-0.93	-1.00	5.71	0.90	-8.72	-2.11	-2.12		
ΔEmployment	**0.0008131**	0.0030381	**-0.0328522**	**-0.3533526**	**0.0061641**	**0.0009136**	-0.0022257	**-0.019435**	**-0.1492693**	**0.006477**	57421	0.1221
	2.95	1.02	-4.34	-51.23	3.72	3.37	-0.75	-2.46	-26.23	3.93		
ΔHealth	**0.0072645**	-0.001936	-0.0264741	-0.0112252	**-0.5375134**	**0.0049206**	-0.0073111	-0.0285857	**-0.0279594**	**-0.2575989**	57421	0.2348
	10.07	-0.29	-1.39	-1.00	-109.46	6.91	-1.18	-1.61	-2.53	-54.25		

Table 9: Analysis for adjusted income. Regression results (coefficient estimates and t-statistics) of a two-lag vector autoregression estimated via OLS. Results significant at the 5% level appear in bold ink.

	t-1					t-2						
	ΔHappiness	ΔPp_income	Δmarriage	Δemployment	Δhealth	Δhappiness	Δpp_income	Δmarriage	Δemployment	Δhealth	obs.	$pseudo - R^2$
ΔHappiness	**-0.5677078**	-0.0743488	**-0.8392845**	**-0.2010874**	0.0570647	**-0.2721704**	-0.0683055	**-0.8394953**	-0.1275945	-0.020424	57421	0.2579
	-95.20	-1.63	-6.21	-2.55	1.89	-47.59	-1.62	-6.29	-1.68	-0.69		
ΔPp_income	0.0002451	**-0.4112225**	**-0.0855135**	**0.2344153**	0.0047813	0.0006902	**-0.1761855**	**-0.0702513**	**0.137317**	0.0028842	57421	0.1654
	0.54	-40.22	-6.69	24.65	1.81	1.53	-22.39	-6.23	15.89	1.09		
ΔMarriage	**0.0142996**	**0.0444125**	**-1.114609**	-0.024205	-0.0140099	**0.0143171**	0.021239	**-0.6641873**	-0.0743527	**-0.0317705**	57421	0.0587
	5.91	2.02	-24.57	-0.67	-0.94	6.03	1.07	-11.77	-1.93	-2.20		
ΔEmployment	**0.0052983**	0.0139076	**-0.2312979**	**-1.697449**	**0.0401029**	**0.0059546**	-0.0197953	**-0.1603953**	**-0.8218569**	**0.0411562**	57421	0.1525
	3.11	0.81	-4.83	-76.03	3.75	3.51	-1.15	-3.25	-32.46	3.86		
ΔHealth	**0.0115029**	-0.0040475	-0.0404924	-0.0192785	**-0.8463071**	**0.0076892**	-0.0119062	-0.0540804	**-0.0445373**	**-0.4052131**	57421	0.1143
	10.31	-0.39	-1.35	-1.09	-101.68	6.93	-1.21	-1.92	-2.55	-54.42		

Table 10: Analysis for adjusted income. Regression results of a two-lag vector autoregression estimated via ordered probit estimator (reported are ordered probit coefficients and z-statistics). Results significant at the 5% level appear in bold ink. The equations where happiness and income are the dependent variables are estimated via OLS though (OLS coefficients and t-stats reported as in previous table).

	t-1					t-2						
	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	ΔHappiness	ΔLog(income)	ΔMarriage	ΔEmployment	ΔHealth	Obs.	$Pseudo - R^2$
ΔHappiness	**-0.5585092**	**-0.2384635**	**-0.651688**	-0.1993567	-0.0026349	**-0.2666889**	**-0.2460104**	**-0.7689162**	-0.158334	-0.035654	32545	0.2551
	-71.68	-3.39	-3.49	-1.78	-0.06	-36.17	-3.88	-4.44	-1.47	-0.87		
ΔLog(income)	**0.0024122**	**-0.3953356**	0.0123389	**0.1980269**	0.0022636	**0.0017851**	**-0.1848393**	-0.0152524	**0.1120092**	0.0001371	32545	0.1532
	4.46	-30.01	0.81	15.54	0.67	3.25	-18.32	-1.16	9.46	0.04		
ΔMarriage	**0.0010957**	**0.0109381**	**-0.1138349**	-0.0013147	-0.0015156	**0.0012027**	0.0035366	**-0.0397841**	-0.0062879	**-0.00432**	32545	0.0175
	4.73	4.02	-11.42	-0.38	-1.09	5.47	1.66	-5.38	-1.68	-3.27		
ΔEmployment	**0.0016164**	-0.0003337	**-0.0205416**	**-0.3766813**	**0.006565**	**0.0015052**	-0.0042201	-0.011674	**-0.1599271**	**0.0100412**	32545	0.1318
	4.81	-0.08	-2.15	-39.00	2.99	4.52	-0.99	-1.15	-20.27	4.62		
ΔHealth	**0.007515**	**-0.0211393**	-0.0106915	-0.0253013	**-0.5329594**	**0.004533**	-0.013729	-0.0280234	**-0.0414631**	**-0.2579065**	32545	0.2335
	8.47	-2.21	-0.43	-1.62	-81.02	5.13	-1.51	-1.22	-2.78	-40.56		

Table 11: Analysis restricted to age group 30-60 years. Regression results (coefficient estimates and t-statistics) of a two-lag vector autoregression estimated via OLS. Results significant at the 5% level appear in bold ink.

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