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M. Binder, A. Coad. An Examination of the Dynamics of Well-Being and Life Events using Vector Autoregressions. *Journal of Economic Behavior and Organization*, 2010, 76 (2), pp.352. 10.1016/j.jebo.2010.06.006 . hal-00870186

HAL Id: hal-00870186

<https://hal.science/hal-00870186>

Submitted on 6 Oct 2013

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Accepted Manuscript

Title: An Examination of the Dynamics of Well-Being and Life Events using Vector Autoregressions

Authors: M. Binder, A. Coad

PII: S0167-2681(10)00107-1
DOI: doi:10.1016/j.jebo.2010.06.006
Reference: JEBO 2554



To appear in: *Journal of Economic Behavior & Organization*

Received date: 20-4-2009
Revised date: 19-6-2010
Accepted date: 21-6-2010

Please cite this article as: Binder, M., Coad, A., An Examination of the Dynamics of Well-Being and Life Events using Vector Autoregressions, *Journal of Economic Behavior and Organization* (2010), doi:10.1016/j.jebo.2010.06.006

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An Examination of the Dynamics of Well-Being and Life Events using Vector Autoregressions[☆]

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Abstract

We use a panel vector autoregressions model to examine the coevolution of changes in mental well-being and changes in income, health, marital status and 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 well-being are associated with subsequent increases in income, marriage, employment, and health variables, while increases in these life-domain variables (except health) tend to be followed by decreases in well-being in subsequent periods, suggesting adaptation dynamics in all domains. In addition to the robust observation that well-being is associated with subsequent longer-term improvements in health status, we observe that health improvements themselves have a long-lasting positive contribution to employment status. Employment status, in turn, has lasting positive effects on income growth. Although well-being per se may be a short-lived phenomenon, our results suggest that it may have longer-term effects through these particular channels. These find-

[☆]The authors are grateful for having been granted access to the BHPS data set, which was made available through the ESRC Data Archive. The data were originally collected by the ESRC Research Centre on Micro-Social Change at the University of Essex (now incorporated within the Institute for Social and Economic Research). Neither the original collectors of the data nor the Archive bears any responsibility for the analyses or interpretations presented here. We thank the participants of a seminar at the Max Planck Institute as well as two anonymous referees for helpful comments and suggestions. We also want to thank Stefanie Picard, Marcus Linhardt and Sebastian Geissler for valuable research assistance. All errors are ours.

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Preprint submitted to Journal of Economic Behavior & Organization

June 19, 2010

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Keywords: Mental well-being, Happiness dynamics, Vector autoregressions, Subjective well-being, BHPS

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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. Psychological research has extended this reasoning to encompass various subjective well-being concepts as the ultimate measuring rod for individual well-being, empirically captured by diverse mental well-being, happiness or life satisfaction measures (Ryff and Keyes,

1995; Easterlin, 2002; Frey and Stutzer, 2002a; Diener and Seligman, 2004).¹ Unfortunately, an individual's mental well-being or 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 in only one direction (for an overview see Easterlin, 2003). Consider the findings that 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? For example, Graham et al. (2004) found that happier individuals tend to be healthier and earn higher incomes in later time periods. 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 well-being 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 well-being. 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 Wolfers, 2008), as well as a decrease in happiness following marriage (Stutzer and Frey, 2006; Lucas

¹One 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.

and Clark, 2006).²

These stylized facts highlight two important insights: first, in exploring the determinants of subjective well-being, 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 research on subjective well-being mainly focuses on the effect of one variable on well-being, for instance how marriage affects well-being, 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 well-being, including the possibility of adaptation. The years before and after an event are important.

Panel studies do exist in research on subjective well-being, 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. There also exist some studies which apply lead and lag associations in order to better describe the dynamic adjustment process of well-being in response to major life events (Clark et al., 2008; Frijters et al., 2008). These are helpful in assessing the impact of various determinants on one variable (e.g., impact of health and income on happiness). However, a different methodology is called for if one wants to examine the complex coevolution of these interdependent variables over time, i.e. if one wants to endogenize more than one variable. This paper combines these two elements — time lags and panel data techniques — using vector autoregressions, a technique that has only very recently been applied to happiness research (Becchetti et al., 2008). Going beyond the paper of Becchetti et al. (2008), which analyzes the interplay between two variables only — happiness and social relations — a contribution of our paper lies in its broader focus on human life experiences as complex evolving processes. We consider a number of variables such as (mental) well-being, income, marriage status, employment status and health all to be interdependent and mutually endogenous. We thus look at the coevolution of a relatively large number

²Similar 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, see 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).

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.³ For that reason, we have also chosen to rely on a notion of mental well-being that is related to standard notions of happiness but somewhat broader and more encompassing (see Ryff, 1989; Ryff and Keyes, 1995; Gardner and Oswald, 2007). Also, while we are guided by theory in selecting these determinants of well-being, 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. Finally, our paper also adds to the literature in the use of the British Household Panel Survey data set (BHPS), which offers a detailed and comprehensive panel format for a large number of observations and allows us to cover a quite extensive time horizon from 1991 to 2005.

The paper is structured as follows. Section 2 presents previous findings on the coevolution of the most important determinants of subjective well-being 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, the British Household Panel Survey (BHPS), which offers a rich variety of variables for potential inclusion in our analysis. Section 4 presents our main results and robustness analysis, as well as a discussion. Section 5 concludes.

2. Methodology

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. Note also that we focus

³On this see also Binder (2010).

in our analysis on a broader notion of mental well-being that is somewhat more encompassing than the more narrow concepts such as happiness or life satisfaction. While the latter often are more focussed on the cognitive aspects of well-being, a concept of mental (or psychological) well-being also refers to the affective components.

Existing research on subjective well-being 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; Bruni and Stanca, 2008), 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, for example, one could think of adding other social relations besides marriage (Bruni and Stanca, 2008), as these might also be intervening factors that influence the other dependent variables (e.g., individuals with higher levels of well-being might have more friends and therefore be more successful with employment or healthier). We do not want to argue that only the variables we examine are relevant for well-being, but the ones mentioned so far seem to constitute the most important determinants (for extensive surveys see, 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 an individual's well-being 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 subjective well-being literature puts subjective well-being/happiness as the dependent variable and tries to explain it in terms of changes in other variables as is depicted in equation (1):

$$\text{well-being} = f(\text{marriage, health, income, employment status}). \quad (1)$$

A drawback of equation (1) is that it crucially neglects that subjective well-being (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 (Graham et al., 2004; Lyubomirsky

et al., 2005). While our main focus is on analyzing the coevolution of well-being and its determinants over time, we also want to shed light on the interplay between these other 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 well-being is measured. Taking into account the mutual interdependencies between the variables thus requires to also analyze how, for example, marriage depends on well-being, 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):

$$\text{Marriage} = g(\text{well-being, health, income, employment status}). \quad (2)$$

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:

$$\text{Income} = h(\text{marriage}) = h(g(\text{well-being, health, income, employment status})). \quad (3)$$

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):

$$\text{Health} = k(\text{marriage}) = k(g(\text{well-being, health, income, employment status})). \quad (4)$$

And so on. In fact all these variables are interrelated and mutually determined. Basically, when examining any of the relationships between the variables subjective well-being, 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,

see, e.g., Smock and Manning, 1997; Antonovics and Town, 2004). The same applies to the interplay between well-being 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 all of our five main variables, as Table 1 shows.⁴

In this context of complex interactions and mutually endogenous variables, we argue that the best approach to take is a reduced-form panel VAR. While a vector autoregression approach has been also employed by Becchetti et al. (2008) to analyze the interplay between happiness and social relations, we enlarge on their approach by focusing on the comovement of more than two variables. Following on from the preceding discussion and the literature review presented in Table 1, we have identified a system of five interdependent variables (to wit, mental well-being, income, marriage status, employment status and health), and in order to better describe the coevolution of these variables we will apply a vector autoregression model.

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).⁵ 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 (see 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

⁴This 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.

⁵See also Stutzer and Frey (2006, p. 329) who state the need for more analyses of panel data in happiness research.

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

Source	WB	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
Stack and Eshleman (1998)	D		X			World Values Studies Group	1981/1983	17 Western, industrialized nations; control: cohab., ce
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; FE
Easterlin (2003)	D				X	GSS (US)	1972-2000	Cohort analysis;
Marks and Fleming (1999)	X	D				Australian Youth in Transition Panel	1980-1995	Four cohorts
Antonovics and Town (2004)	X	D	X			TSS (US)		Differences between twins; FE
Gray (1997)	D	D	X			National Survey of Youth, US	1966-1980	Only males; FE
Blackburn and Korenman (1994)	D	D	X			March Current Population Survey (CPS), US	1967-1988	Only males; FE
Stutzer and Frey (2006)	X		D					See above
Marks and Fleming (1999)	X		D					
Cutright (1970)	X	X	D			US Census Data	1959/60	Males!
Snock and Manning (1997)	X	X	D			NSFH and NSPH2	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	
Verkeley 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		Germany, GSOEP, cohort	1984-1990	
Graham et al. (2004)	X					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
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

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. Well-being for individual i at time t can be broken down into a time-invariant fixed effect μ_i and a transitory component ϵ_{it} :

$$\text{Well-being}_{it} = \mu_i + \epsilon_{it}. \quad (5)$$

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 subjective well-being 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).

$$\begin{aligned} \Delta \text{Well-being}_{it} &= \text{Well-being}_{it} - \text{Well-being}_{i,t-1} \\ &= (\mu_i + \epsilon_{it}) - (\mu_i + \epsilon_{i,t-1}) = \epsilon_{it} - \epsilon_{i,t-1} = \Delta \epsilon_{it}. \end{aligned} \quad (6)$$

While well-being levels are affected by both the fixed effect μ_i and the transitory component ϵ_{it} (equation (5)), changes in well-being 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 at-

tention. Theoretical work has also shown interest in the time lags between life events and subjective well-being (Frijters et al., 2008; Clark et al., 2008). 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. Besides adaptation effects, decreasing happiness levels could of course be attributed to anticipation effects, where individuals become happier because they anticipate positive life events. As a result, both short-term and longer-term effects need to be investigated. It is important to note that the approaches mentioned in this subsection are restricted to the analysis of one dependent variable (such as well-being) without the possibility of endogenizing more variables in the same integrative framework, as would be allowed with the VAR methodology suggested in the present paper. 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 well-being.

2.4. The model

Our regression equation is the following:

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

where W is a vector containing our five main endogenous variables ($t - s$ referring to the number of lags examined): mental well-being, 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 5×5 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.

Put differently, each of the 5 main variables has a turn at being the dependent variable, with lags of all 5 main variables among the independent variables. Each variable is seen as a function of lagged values of itself and each other variable. For example, the first row of the VAR results table takes

growth of happiness as the dependent variable, and lagged values of growth of happiness, income, marriage status, employment status and health status as explanatory variables (along with the unreported control variables). The second row of the table takes growth of income as the dependent variable, which is explained by lagged variables and control variables, and so on.

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, see Taylor et al., 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 various 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 mental well-being (as a quite broad subjective well-being measure) and certain other variables over time. These variables include income, health, marriage status and employment 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 well-being, 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.⁶ This concept of mental well-being is relatively similar to the better known happiness measures. It is, however, more encompassing as it also relates to mental health. It is an index from the 'General Health Questionnaire' of the BHPS, composed of the answers to 12 questions that assess happiness, mental distress (such as existence of depression or anguish), 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 see, e.g., Gardner and Oswald, 2007; Shields and Wheatley Price, 2005; Clark and Oswald, 2002; Ryff and Keyes, 1995).

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

⁶The BHPS also asks for individuals' life satisfaction scores. We have decided against using these for multiple reasons. First, the question was only introduced halfway into the sampling period, resulting in considerably lower observations. Second, there seem to be order effects in the way the question was elicited in the survey, casting doubt on the validity of the answers. This point is also confirmed by estimating a ordered probit panel vector autoregression with the life satisfaction instrument that gives internally inconsistent results, as opposed to the very robust results obtained with the mental well-being variable.

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

	Mean	Std.Dev.	10%	25%	Median	75%	90%	Min.	Max.	Obs.
Δ WB	-0.0803	5.2835	-6	-2	0	2	6	-36	36	110,692
Δ Inc	0.0344	0.5706	-0.4034	-0.0878	0.0457	0.1807	0.4525	-8.7734	7.7911	110,692
Δ Marr	0.0055	0.1699	0	0	0	0	0	-1	1	110,692
Δ Empl	0.0039	0.2969	0	0	0	0	0	-1	1	110,692
Δ Hlth	-0.0209	0.8128	-1	0	0	0	1	-4	4	110,692
Age	44.7999	18.7434	21	29	42	59	72	15	99	151,702
Gender	1.5629	0.4960	1	1	2	2	2	1	2	151,702
Education	2.9297	1.7299	1	1	3	4	6	1	7	151,702

in well-being.

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).⁷ 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 (see Johnston et al., 2009). 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 individual well-being 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).

⁷As 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.

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 self-employed individuals because they are a notoriously heterogeneous group, containing both star performers and ‘social rejects’ (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.⁸

In Table 3, we report pairwise correlations between our indicators for the changes in the main and control variables. The correlations of most of our indicators are highly statistically significant.⁹ The correlations in differences are rather small in effect, the highest correlation being between change in health and change in well-being ($r = 0.1580$), probably due to the incorporation of some health aspects in the concept of mental well-being.¹⁰ It is noteworthy that all (significant) correlations between our main variables (changes in mental well-being, health, income, marriage, and employment status) are positively associated. This is different with the control variables,

⁸For more information see Taylor et al. (2007), App. 2, pp. 18-9.

⁹Although a notable exception is gender which is only correlated with change in marriage and age.

¹⁰The 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.

Table 3: Contemporaneous correlations between the main variables and the control variables

	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth	Age	Gender	Education
Δ WB	1.000							
p-value								
obs.	110,692							
Δ Inc	0.0083	1.000						
p-value	0.0060							
obs.	110,692	110,692						
Δ Marr	0.0298	0.0567	1.000					
p-value	0.0000	0.0000						
obs.	110,692	110,692	110,692					
Δ Empl	0.0561	0.0290	0.0030	1.000				
p-value	0.0000	0.0000	0.3216					
obs.	110,692	110,692	110,692	110,692				
Δ Hlth	0.1580	0.0042	0.0090	0.0270	1.000			
p-value	0.0000	0.1645	0.0027	0.0000				
obs.	110,692	110,692	110,692	110,692	110,692			
Age	0.0002	-0.0178	-0.0800	-0.0747	-0.0111	1.000		
p-value	0.9437	0.0000	0.0000	0.0000	0.0002			
obs.	110,692	110,692	110,692	110,692	110,692	151,702		
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	0.0000		
obs.	110,692	110,692	110,692	110,692	110,692	151,702	151,702	
Education	0.0024	0.0172	0.0439	0.0310	0.0074	-0.3535	-0.0804	1.000
p-value	0.4167	0.0000	0.0000	0.0000	0.0139	0.0000	0.0000	
obs.	110,692	110,692	110,692	110,692	110,692	151,702	151,702	151,702

where age is negatively correlated with most of the main variables (except for change in well-being, where the correlation is not significant), while education is positively correlated with the main variables (again, except for change in well-being, where the correlation is not significant).

Note that the correlations in Table 3 are in differences. Pairwise correlations of *levels* of mental well-being and the other indicators are similar to what has been reported in the literature.¹¹ As an additional investigation of potential multicollinearity, we inspected the VIF diagnostics for the following VAR(2) model, which were all satisfactory. This lends further support to the validity of our regression methodology.

¹¹There is positive correlation between *levels* of mental well-being 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 well-being and gender ($r = -0.1266$) and age ($r = -0.0491$, both also highly significant). The contemporary association between marriage and well-being 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 mental well-being and employment is quite high, although here, similarly, this category does not include self-employed individuals.

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 well-being.

4. Results and discussion

4.1. Aggregate analysis

The main findings of our vector autoregressions are summed up in Table 4. 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 (besides we use OLS for the income variables in the models). 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).¹² 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; note that we only report the probit models in the paper because of this similarity).

While we report the three-lag specification in the appendix (Table .6), 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 subjective well-being (as presented above). Due to the exploratory nature of our study,

¹²It 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).

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, well-being 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 sources of well-being so that further increases are less likely. Individuals are not likely 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 previous levels. Put differently, individuals are likely to revert to their previous levels of well-being 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.¹³

We find some interesting associations between the changes in variables in our data. One finding is that recent increases in well-being 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.¹⁴ The positive effect of well-being 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 (see also Graham et al., 2004). Social relations might be intervening factors for this relationship, such that happier individuals are more successful with other individuals which in turn would have a bearing on the other life-domains.

Interestingly, support for the reverse relationship is less strong, and the

¹³See, e.g., Coad (2010).

¹⁴The positive association between increases in well-being and increases in income disappears when using a different income measure, however. On this, see the next subsection.

temporal structure shows that positive changes in one of all life domains — except health, for which the coefficient is not statistically significant — in a previous period are associated with decreasing well-being in the present period. Although the contemporaneous correlations in Table 3 show that well-being is positively and statistically significantly correlated with contemporaneous values of all of these variables, the introduction of a lag between changes in the main variables and subsequent changes in well-being actually results in negative associations in most cases. The effect of getting married in the previous period, for example, has a highly significant negative association with a subsequent decrease in well-being, and we will see that the effect is very robust across model specifications. Having married in one of the two last periods makes it thus very unlikely that an individual's well-being will increase further. (The flipside of this result is, of course, that a transition out of marriage will be associated with a contemporaneous decrease in well-being, but an increase in well-being in the subsequent period.) 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 well-being, pointing to an explanation in terms of hedonic adaptation or rising aspiration levels (Frederick and Loewenstein, 1999).¹⁵

A competing explanation might be that individuals experience increases in well-being from the expectation of future life events so that the event itself does not have a large effect on already risen levels of well-being. 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, one has to keep in mind that not all important life events are really apt to be anticipated in advance. While one probably can anticipate the advent of marriage outside of Las Vegas quite well, this might not be the case for promotions, or increases in pay or changes in health condition. Nevertheless, disentangling adaptation

¹⁵ R^2 s 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.

Table 4: 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 mental well-being and income are the dependent variables are estimated via OLS (the reported results are OLS coefficients and t -statistics).

	t-1						t-2						Obs.	(Pseudo)- R^2
	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth		Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth			
Δ WB	-0.5677 -95.22	-0.1436 -3.27	-0.8040 -5.94	-0.1927 -2.45	0.0576 1.91		-0.2720 -47.57	-0.1338 -3.30	-0.8155 -6.11	-0.1127 -1.49	-0.0198 -0.67	57,421	0.2581	
Δ Inc	0.0011 2.22	-0.4193 -40.30	0.0132 1.05	0.2100 20.97	0.0054 1.93		0.0012 2.44	-0.1867 -22.08	-0.0092 -0.81	0.1174 13.16	0.0032 1.14	57,421	0.1706	
Δ Marr	0.0142 5.88	0.1045 5.22	-1.1368 -24.91	-0.0310 -0.86	-0.0142 -0.95		0.0142 5.98	0.0422 2.35	-0.6701 -11.86	-0.0857 -2.24	-0.0319 -2.21	57,421	0.0601	
Δ Empl	0.0053 3.10	0.0232 1.43	-0.2362 -4.92	-1.6979 -76.25	0.0400 3.75		0.0059 3.50	-0.0079 -0.48	-0.1594 -3.23	-0.8243 -32.73	0.0410 3.84	57,421	0.1525	
Δ Hlth	0.0115 10.31	-0.0080 -0.80	-0.0382 -1.27	-0.0187 -1.06	-0.8463 -101.68		0.0077 6.94	-0.0153 -1.65	-0.0513 -1.83	-0.0438 -2.52	-0.4052 -54.42	57,421	0.1144	

from anticipation does prove to be a fruitful issue for further research.

Moreover, while we cannot find an effect of increases in health on subsequent well-being levels,¹⁶ there is a negative association between becoming employed and subsequent well-being. If one became recently employed in the previous period, well-being is not likely to increase (presumably because one was already at one's peak of well-being in the previous period).

Overall there seems to be more support in favor of temporal associations between mental well-being and the other variables, where an increase in mental well-being 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 well-being 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 mental well-being.

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 surprisingly disappears in the male subsample, see below; see Smock and Manning, 1997).

Somewhat more surprising is the negative association between having gotten married and the subsequent decrease in employment status (in $t - 1$ robust over most 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.

¹⁶Of 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.

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').¹⁷ We have repeated the analysis using log income per person, and while the results for the mental well-being, marriage, employment, and health variables did not change in a substantial way (we report the two-lag ordered probit in Table 5), we could no longer find a significant effect of adjusted income on mental well-being, 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 well-being 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 contradicted by our results.¹⁸ A different explanation for the absence of any significant relationship might also be that households have different aspiration levels or different reference groups so that the deleterious influence of effects such as keeping up with the Joneses do not play as important a role for families as for single individuals (on the role of aspirations for happiness see also Stutzer, 2004).

In addition to this, we also find a loss of association between changes in adjusted income and marriage probability. Moreover, a change in marriage status is now associated with a subsequent decrease in per person income (significant effect).¹⁹ The latter effect is worth mentioning when considering

¹⁷Mean change in log income per person of a household is according to our calculation 0.0459 GBP (s.d. 0.5391 GBP).

¹⁸Since our adjustment for household size might be considered too simple, further research seems to be warranted here.

¹⁹Both effects pertain to both time lags.

Table 5: 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 mental well-being 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					Obs.	(Pseudo)-R ²
	Δ WB	Δ Inc*	Δ Marr	Δ Empl	Δ Hlth	Δ WB	Δ Inc*	Δ Marr	Δ Empl	Δ Hlth		
Δ WB	-0.5677	-0.0743	-0.8393	-0.2011	0.0571	-0.2722	-0.0683	-0.8395	-0.1276	-0.0204	57,421	0.2579
Δ Inc*	-95.20	-1.63	-6.21	-2.55	1.89	-47.59	-1.62	-6.29	-1.68	-0.69	57,421	0.1654
	0.0002	-0.4112	-0.0855	0.2344	0.0048	0.0007	-0.1762	-0.0703	0.1373	0.0029		
	0.54	-40.22	-6.69	24.65	1.81	1.53	-22.39	-6.23	15.89	1.09		
Δ Marr	0.0143	0.0444	-1.1146	-0.0242	-0.0140	0.0143	0.0212	-0.6642	-0.0744	-0.0318	57,421	0.0587
	5.91	2.02	-24.57	-0.67	-0.94	6.03	1.07	-11.77	-1.93	-2.20		
Δ Empl	0.0053	0.0139	-0.2313	-1.6974	0.0401	0.0060	-0.0198	-0.1604	-0.8219	0.0412	57,421	0.1525
	3.11	0.81	-4.83	-76.03	3.75	3.51	-1.15	-3.25	-32.46	3.86		
Δ Hlth	0.0115	-0.0040	-0.0405	-0.0193	-0.8463	0.0077	-0.0119	-0.0541	-0.0445	-0.4052	57,421	0.1143
	10.31	-0.39	-1.35	-1.09	-101.68	6.93	-1.21	-1.92	-2.55	-54.42		

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, on average).

A second test to check the robustness of our results is the splitting of the sample by gender. To begin with, we present separate tables of contemporaneous correlations for the male and female subsamples, and obtain a number of interesting insights (see Tables .7 and .8). While income growth is significantly positively correlated with growth of well-being in the sample of females, there is no significant association for males. Furthermore, change in marriage status is correlated with change in health for females, but not for males. Employment status appears to be of more importance for males, because the positive correlations of changes in employment status with changes in both well-being and income have a much larger magnitude in the subsample of males.

Continuing our exercise in disaggregation by gender, we present the vector autoregression results in two tables in the appendix (see Tables .10 and .11). The robustness of the findings and the consistency with the aggregate results presented above is striking. However, we find three diverging results of our subsample analysis that are noteworthy. First, for the female subsample, we can no longer establish a significant effect from employment on well-being. This finding might be explained with reference to lower levels of competitiveness as regards females: it seems that female individuals of the sample might have different priorities in life such that any changes in their employment status do not influence them as much (in terms of well-being) as is the case with males. This finding complements the analysis of Lucas et al. (2004) who found that when males go into unemployment, their levels of happiness are decreased permanently, an effect which they did not find for females.

Second, we find that for the female subsample, increases in income are positively associated with subsequent marriage, somewhat surprisingly suggesting that income is important in determining the mating value of females (this does contradict findings by Smock and Manning, 1997, who still attribute significance of income for males, but not for females). One might stipulate that a pay raise constitutes a triggering event that might stimulate a marriage proposal, as the female now feels she has reached important ca-

reer goals and wants to focus on family. While the negative association of marriage and subsequent employment status for females might support this interpretation, this finding clearly warrants more attention in future: being on a (local) career maximum (in terms of employment), might prompt marriage and thus, subsequently the individual can only experience a decrease in employment relation. The binary nature of our employment variable seems to obscure a definite explanation and leaves opportunity for further research.

As a third 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 .9 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 mental well-being has a stronger effect on the increase in incomes of this subsample. In this respect, increased mental well-being 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). An explanation proposed by Graham et al. (2004) is that higher happiness benefits individuals especially in lower income percentiles because, for example for workers in the service sector, “in the absence of income, a good attitude can make a difference to one’s future earnings” (p. 334). It is interesting to note, however, that in the restricted model, we no longer find a negative association between having gotten employed in the previous period and well-being in the present period, such that we cannot comment on the reverse relationship of the hypothesis we advanced above.

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.

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 (mental) well-being 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 variables such as health, marriage, well-being, 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 well-being, 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 (mental) well-being and other life domain variables, where we have found that if well-being 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 well-being so that further increases are less likely. Another robust finding is that recent increases in mental well-being 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 well-being in the present period. The effect of getting married in the previous period has a negative association with a subsequent decrease in well-being, with the effect being both highly significant and robust. Increases in (log) income are also associated with subsequent decreases in well-being, 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.

Our results therefore show that well-being has a positive influence on subsequent values of all of our main variables of interest. Our findings also suggest the interesting hypothesis that, although well-being seems to be a temporary phenomenon (because of habituation effects), it may have a durable character given that it acts through channels such as marriage status, health, and income levels, which themselves lead to higher levels of well-being in the future. For example, our results suggest, in a robust way, that well-being is associated with subsequent longer-term improvements in

marriage and health status, and that health improvements themselves have a long-lasting positive contribution to employment status. Employment status, in turn, has lasting positive effects on income growth. Although well-being per se may be a short-lived phenomenon, our results show that it can have longer-term effects through these particular channels. Our VAR model is therefore able to identify these effects whereas a narrow focus on the determinants and consequences of changes in well-being would not be able to detect these effects.

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 and mental well-being 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.

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Appendix

Accepted Manuscript

Table 6: Regression results of a three-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 mental well-being and income are the dependent variables are estimated via OLS though (OLS coefficients and t -stats reported).

	t-1					t-2					
	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth	
Δ WB	-0.6250	-0.1227	-0.6005	-0.1412	0.1242	-0.3881	-0.1310	-0.6615	-0.0540	0.0252	
	-84.07	-2.13	-3.71	-1.44	3.28	-48.85	-2.33	-3.94	-0.56	0.62	
Δ Inc	0.0011	-0.4453	0.0303	0.2219	0.0054	0.0015	-0.2387	0.0076	0.1493	0.0031	
	1.75	-35.19	1.85	18.35	1.55	2.34	-20.88	0.55	12.91	0.83	
Δ Marr	0.0176	0.1028	-1.2078	0.0050	-0.0165	0.0165	0.0376	-0.7821	-0.0982	-0.0283	
	5.73	3.81	-21.64	0.11	-0.88	4.85	1.54	-11.26	-1.96	-1.40	
Δ Empl	0.0058	0.0395	-0.3276	-1.8051	0.0413	0.0079	0.0193	-0.1706	-1.0323	0.0516	
	2.63	1.87	-5.49	-63.20	2.96	3.23	0.84	-2.68	-30.89	3.37	
Δ Hlth	0.0123	-0.0129	-0.0282	-0.0095	-0.9461	0.0093	-0.0098	-0.0460	-0.0381	-0.5756	
	8.71	-1.00	-0.76	-0.42	-86.30	5.92	-0.76	-1.28	-1.66	-52.78	
	t-3					obs	(pseudo)- R^2				
Δ WB	-0.2010	-0.0345	-0.7529	-0.0849	-0.1110	38,551	0.2859				
	-29.15	-0.70	-4.91	-0.94	-3.03						
Δ Inc	0.0006	-0.1079	-0.0044	0.0733	-0.0029	38,551	0.1845				
	1.02	-10.73	-0.34	7.16	-0.86						
Δ Marr	0.0051	0.0191	-0.5184	0.1040	-0.0013	38,551	0.0696				
	1.71	0.75	-6.78	2.44	-0.07						
Δ Empl	0.0072	-0.0274	-0.2148	-0.5773	0.0111	38,551	0.1600				
	3.24	-1.29	-3.80	-17.20	0.81						
Δ Hlth	0.0055	-0.0027	-0.0178	-0.0462	-0.2955	38,551	0.1284				
	3.84	-0.23	-0.49	-2.15	-32.45						

Table .7: Contemporaneous correlations for the male subsample

	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth
Δ WB	1				
p-value					
obs.	47,760				
Δ Inc	-0.0054	1			
p-value	0.2409				
obs.	47,760	47,760			
Δ Marr	0.0228	0.0354	1		
p-value	0.0000	0.0000			
obs.	47,760	47,760	47,760		
Δ Empl	0.0816	0.0402	0.0021	1	
p-value	0.0000	0.0000	0.6513		
obs.	47,760	47,760	47,760	47,760	
Δ Hlth	0.1391	0.0104	0.0040	0.0259	1
p-value	0.0000	0.0233	0.3802	0.0000	
obs.	47,760	47,760	47,760	47,760	47,760

Table .8: Contemporaneous correlations for the female subsample

	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth
Δ WB	1				
p-value					
obs.	62,932				
Δ Inc	0.0161	1			
p-value	0.0001				
obs.	62,932	62,932			
Δ Marr	0.0341	0.0699	1		
p-value	0.0000	0.0000			
obs.	62,932	62,932	62,932		
Δ Empl	0.0415	0.0226	0.0035	1	
p-value	0.0000	0.0000	0.3789		
obs.	62,932	62,932	62,932	62,932	
Δ Hlth	0.1701	0.0003	0.0124	0.0278	1
p-value	0.0000	0.9395	0.0018	0.0000	
obs.	62,932	62,932	62,932	62,932	62,932

Table .9: Analysis restricted to age group 30-60 years. 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 mental well-being and income are the dependent variables are estimated via OLS through (OLS coefficients and t -stats reported).

	t-1						t-2						obs	(pseudo)- R^2
	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth		Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth			
Δ WB	-0.5585 -71.68	-0.2385 -3.39	-0.6517 -3.49	-0.1994 -1.78	-0.0026 -0.06		-0.2667 -36.17	-0.2460 -3.88	-0.7689 -4.44	-0.1583 -1.47	-0.0357 -0.87	32,545	0.2551	
Δ Inc	0.0024 4.46	-0.3953 -30.01	0.0123 0.81	0.1980 15.54	0.0023 0.67		0.0018 3.25	-0.1848 -18.32	-0.0153 -1.16	0.1120 9.46	0.0001 0.04	32,545	0.1532	
Δ Marr	0.0152 5.08	0.1339 4.08	-1.1212 -19.91	-0.0105 -0.21	-0.0215 -1.08		0.0164 5.66	0.0492 1.69	-0.5145 -7.10	-0.0782 -1.51	-0.0602 -3.19	32,545	0.0478	
Δ Empl	0.0102 4.74	-0.0107 -0.42	-0.1554 -2.53	-1.7951 -58.42	0.0445 3.09		0.0095 4.40	-0.0332 -1.30	-0.1075 -1.69	-0.8636 -25.58	0.0678 4.74	32,545	0.1638	
Δ Hlth	0.0121 8.68	-0.0337 -2.18	-0.0129 -0.33	-0.0428 -1.72	-0.8500 -75.33		0.0073 5.22	-0.0234 -1.62	-0.0521 -1.42	-0.0699 -2.91	-0.4101 -40.78	32,545	0.1149	

Table .10: Analysis restricted to males. 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 mental well-being and income are the dependent variables are estimated via OLS though (OLS coefficients and t -stats reported).

	t-1						t-2						obs	(pseudo)- R^2
	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth		Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth			
Δ WB	-0.5617	-0.0312	-0.8183	-0.2895	0.0507		-0.2743	-0.1559	-0.7540	-0.1524	0.0133		24,337	0.2543
	-58.81	-0.44	-4.08	-2.31	1.16		-29.88	-2.26	-3.98	-1.28	0.31			
Δ Inc	0.0018	-0.4324	0.0257	0.2645	0.0034		0.0018	-0.1781	0.0132	0.1083	-0.0011		24,337	0.1802
	2.25	-22.32	1.45	14.85	0.80		2.52	-11.28	0.92	6.94	-0.27			
Δ Marr	0.0148	0.0535	-1.1663	-0.0737	-0.0203		0.0162	0.0219	-0.6878	-0.1694	-0.0084		24,337	0.0613
	3.54	1.70	-15.32	-1.29	-0.86		4.10	0.72	-7.33	-2.70	-0.36			
Δ Empl	0.0019	0.0761	-0.0435	-1.8592	0.0668		0.0009	0.0063	-0.2130	-0.8942	0.0694		24,337	0.1694
	0.60	2.59	-0.55	-47.42	3.57		0.29	0.20	-2.49	-19.42	3.71			
Δ Hlth	0.0131	0.0113	-0.0342	-0.0243	-0.8632		0.0084	-0.0046	-0.0036	-0.0618	-0.4156		24,337	0.1141
	7.05	0.67	-0.72	-0.81	-65.17		4.64	-0.28	-0.08	-2.06	-35.55			

Table .11: Analysis restricted to females. 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 mental well-being and income are the dependent variables are estimated via OLS though (OLS coefficients and t-stats reported).

	t-1						t-2						obs	(pseudo)- R^2
	Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth		Δ WB	Δ Inc	Δ Marr	Δ Empl	Δ Hlth			
Δ WB	-0.5707 -74.97	-0.2054 -3.67	-0.7901 -4.40	-0.1490 -1.48	0.0613 1.49		-0.2707 -37.09	-0.1221 -2.42	-0.8572 -4.72	-0.0944 -0.97	-0.0411 -1.02	33,084	0.2604	
Δ Inc	0.0005 0.88	-0.4119 -34.05	0.0057 0.33	0.1810 14.99	0.0073 1.93		0.0009 1.34	-0.1911 -19.34	-0.0232 -1.46	0.1217 11.14	0.0060 1.58	33,084	0.1665	
Δ Marr	0.0138 4.70	0.1268 5.11	-1.1175 -19.64	-0.0106 -0.24	-0.0107 -0.56		0.0133 4.57	0.0511 2.33	-0.6566 -9.29	-0.0452 -0.97	-0.0448 -2.47	33,084	0.0605	
Δ Empl	0.0069 3.43	-0.0009 -0.05	-0.2932 -5.10	-1.6106 -59.32	0.0257 1.98		0.0081 4.04	-0.0135 -0.71	-0.1277 -2.13	-0.7848 -26.31	0.0260 2.01	33,084	0.1446	
Δ Hlth	0.0106 7.64	-0.0180 -1.46	-0.0395 -1.03	-0.0174 -0.80	-0.8347 -77.97		0.0073 5.23	-0.0200 -1.77	-0.0796 -2.23	-0.0360 -1.69	-0.3983 -41.28	33,084	0.1146	