Happiness is a Warm Gun*

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Abstract

Based on evolutionary reasons, we propose that current happiness may depend negatively on past happiness. Our theoretical model shows how addiction may be thought as an optimum mechanism to make mankind maximize fitness. We run happiness regressions using panel data from the British Household Panel Survey (BHPS) to test the different hypotheses. The results are twofold: originally happiness may have been autoregressive, but under modern circumstances mankind might have found the key to perpetuate life satisfaction.

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* Special thanks to The Beatles for such an inspiring song.
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1. Introduction

In the very beginning, mankind strived for survival and reproduction. Today, life is infinitely more complex, but one thing has not changed: the constant pursuit of happiness.

Due to evolutive purposes, nature designed a mechanism of rewards and punishments in which individuals were prized with greater happiness[1] for improving own condition. Conversely, those who did not were punished with greater unhappiness. Since the environment constantly changes throughout time, this incentive system must be optimal under any circumstance. The evolutive solution to this optimization problem has been the introduction of adaptive targets. These act as an 'addiction device' in which individuals must increase stimulus in order to match previous level of happiness.

These mechanisms are easily observed in nature. It is well known that dopamine is the main hormone associated with pleasurable stimuli and is closely related to addictive mechanisms in the body: stimulation of dopamine today increases the desire of dopamine tomorrow. Evidence suggests that this hormone is released while eating (which is a possible cause of food addiction) and sex. Cocaine increases by five-fold the normal amount of dopamine in the system (Hernandez and Hoebel, 1988). This paper studies the way in which this addictive mechanism may be extrapolated to the more holistic concept of life satisfaction.

Great part of studies on happiness in economics is concentrated on determining whether there is adaptation to income (Di Tella *et al.*, 2007a). This can also be applied to other significant life events, such as marriage and health disabilities (Oswald and Powdthavee, 2006). However, we propose a subtle difference: rising today's consumption may worsen tomorrow's well-being not only because individuals will desire a higher level of consumption, but partly because having experienced moments of happiness today will make them more prone to feelings of unhappiness tomorrow. Income and other life events are not only adaptive because of norms and social/cultural behaviors. Part of this adaptability is related to the fact that it is hard-wired: happiness today is linked physically and chemically to happiness tomorrow.

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[1] Happiness, life satisfaction, subjective well-being are used interchangeably throughout.

This evolutionary design of happiness is similar to that of Rayo and Becker (2005). They assume that utility depends on current and past levels of consumption. We propose that this cannot be the case; therefore, current utility can only depend on yesterday's utility (i.e. the relation between past consumption and current happiness may only relate through past happiness). From this point is where conclusions differ noticeably.

Our hypothesis fully explains the observation by psychologists that happiness is neutral. This notion implies that effects of a stimulus causing happiness (or unhappiness) will tend to out balance each other. Hence, the feeling of greater happiness today is only transitory (Veenhoven, 1991). It is in this sense that we consider happiness to be a warm gun. This theory has not been truly explored by economists yet, therefore this paper will try to fill the gap.

We run happiness regressions using individual level panel data from the British Household Panel Survey to test our hypothesis. Due to the employment of dynamic autoregressive framework, the use of OLS with fixed effects does not suffice for estimation since coefficients are inconsistent. We first employ the standard solution proposed by Anderson and Hsiao (1981). Nevertheless, validity of instruments used by this approach is doubtful. Additionally, this estimation method is very sensible to chosen specification (i.e. including individual time trends).

This is why we propose an exogenous instrument for the first differenced lagged dependent variable: the number of serious accidents suffered by respondent in given year. We cannot find conclusive evidence for neutrality of happiness, although this remains a strong possibility. Fortunately, results have a very positive interpretation: originally, happiness may have been autoregressive, but under modern circumstances, mankind may have finally found the key to perpetuate life satisfaction through time.

One of the objectives is to identify the need of using AR models for happiness regressions. In addition, we test a closely related theory: whether or not individual happiness is related to that of other individuals. The results suggest that happiness may be 'contagious', which is consistent with psychological findings that individuals are 'infected' by emotions transmitted by others (Wild *et al.*, 2001, 2003).

In summary, further investigation should address the issues of biases identified as to consistently estimate the autoregressive nature of happiness. This is definitively a profound inquiry that needs to be fulfilled, both for providing a better understanding of happiness and for the subsequent modifications that it would imply to Economics.

The paper proceeds as follows: section 2 presents the theoretical model describing the dynamics of happiness. Section 3 discusses the empirical strategy employed as well as presenting the data used to test our hypothesis. Empirical findings are detailed and discussed in section 4. The final section concludes.

2. Theoretical Model

2.1 Is Happiness Autoregressive?

The quest for happiness is regarded as the main concern of every individual. Consider the definition in which happiness is the result of aspirations. The assessment of individual subjective happiness is done by comparing achievements to pursued goals. This is the result of adaptive challenges which have played a central role in evolution through the domain of positive and negative emotions (Nesse, 2004). In biological terms, the feeling of happiness is generated by various hormones under diverse circumstances. Dopamine is considered a reinforcement hormone; it is released by rewarding experiences such as food, sex and drugs. Individuals strive to generate these primary reinforcers and only manage to do so by accomplishing higher goals.

Happiness played a central role in natural evolution. In the very beginning, nature hard-wired individuals to feed themselves better in order to survive and improve odds of mating. There is hormonal evidence of this in primates, where the ability to copulate is not affected by hormones, but instead, they influence sexual motivation (Wallen, 2001). Happiness may be the result of a tug-o-war between pleasure and pain. Biologists and psychologists suggest this evolutionary path, in which stress triggers a search for pleasure and well-being (Esch and Stefano, 2005). Subjects with lower levels of stress have improved odds in courtship.

In this context, the subjective happiness reported could be the result of the quotient between pleasurable and painful experiences (Larsen, 2000). Neuroscientists have been concerned with finding how the brain processes these different stimuli, the way it functions when faced with decision making (Camerer *et al*, 2005) and giving value to the options (Sanfey *et al*, 2006; Stuphorn, 2006). They have found that different regions in the brain are responsible of giving emotional and motivational value of learned stimuli (i.e. utility of a good, in economic terms). They additionally send 'biased signals' to other regions of the brain "to guide behavior towards the most current adaptive goals" (Dalgleish, 2004). Money in itself activates similar reward areas as other primary reinforcers like food or drugs (Camerer *et al*, 2005), which would suggest that money has intrinsic value in itself and not for consumption possibilities derived from it, as usually thought in economic theory.[2]

There is a problem in the way happiness is dealt with in neuroscience. This is due to the impossibility of telling apart between two distinct effects: pleasure (rewarding stimuli) and subjective happiness. They are treated as if they were interchangeable when this is most definitely not the case. Evolution favored the need of receiving rewarding stimuli in the brain, perceived as pleasure (satisfaction) by people, as to reduce stress (Esch and Stefano, 2005). But pleasure is only an instantaneous feeling (or short lived). Treating happiness merely as a set of rewarding stimuli is an oversimplification and is, most certainly, not plausible due to its 'short liveliness'. Sensations are a flow, while happiness is a stock. Therefore, it necessarily must be the result of a more complex process: adaptive happiness (in which the rewarding stimuli play a central role).

Nature developed an incentive scheme of prizes and punishments to drive human behavior. Think of evolution itself as a central planner who chooses the utility function used by individuals to maximize. This is done in a way as to maximize its own utility: reproduction and survival of mankind. The problem is that it is impossible to reach a level of 'too much reward or punishment'. In other words, an individual can never reach satiation or be dissuaded from pursuing happiness. For evolutive purposes, a system where individuals can reach satiation is not desirable. Reaching a level of complete satiation could lead to a bad equilibrium where individual could stop satisfying basic needs; or simply could choose a suboptimal level. The same applies to inefficiently high rewards, where individual could allocate all energy to a certain cause and may forget to eat or copulate.[3] On the other extreme, complete dismay would not be desirable either, since an individual could be so unsatisfied (depressed) as to not cover basic needs for survival.

[2] But consumption expenditure may have a double effect: positive – the utility derived from acquiring new consumption good; negative – 'giving away' those hard-earned income.

[3] There is evidence of this in rats where they received electronic brain stimulation by pressing down on a lever. The pleasure caused by this electronic stimulus was so great that rats would press the lever up to 7000 times in an hour and forgo feeding and mating if allowed. (Olds and Milner, 1954)

This biological design should work under different contexts. If, for example, an individual should optimize survival and reproduction probabilities, he/she should do so in both situations of abundance or scarcity. Nature has guaranteed this consistent behavior through adaptive goals. New achievements are rewarded based past accomplishments. This is equivalent to consider attainments as addictions. The brain reward system is separated into likes and wants (Nesse and Berridge, 1997). Likes refer to the opioid system (i.e. endorphin), while wants are ruled by dopamine.[4] This mechanism ensures that individuals will strive to surpass previous levels of given stimuli. This built-in characteristic explains the constant search for improvement and innovation in human nature.

Imagine the case in which an individual discovers more resources in the environment (i.e. discovers that certain fruits are edible). The ideal scenario is one in which he/she is prized initially if consumption is increased and in later periods punished if that level is not achieved or passed. Nature "learns" that an individual has more resources available and thus provides the incentives to take advantage of them. The opposite case is one in which the individual is faced with a reduction in resources after a natural disaster. The reduction of consumption will initially punish this individual severely. If the resources were available, he/she would try to gather more fruits than before as to avoid punishment. Since resources are not available, low level of consumption will be repeated. In this scenario, nature "learns" that there are less resources available and therefore does not punish the individual.

A similar idea has been developed by Rayo and Becker (2005). They developed a framework in which happiness depends on level of output achieved by individual. Nature determined the utility function to be maximized by individuals where optimal response depends on past levels of output (through its effect on happiness). We propose that this cannot be the case since happiness does not have "memory" of past levels of output, but instead, it depends on past happiness in itself. The main implication of this is the fact that happiness is autoregressive.

[4] Dopamine plays a central role in drug addiction. There is evidence which gives drug addiction an important role in the evolution of the mammalian brain (Saah, 2005). The problem with addictions (especially drug related) is that it can be very detrimental to health. In terms of addictive happiness: the excessive pursuit of happiness may lead to nothing more than frustrations.

2.2 Model of Adaptive Happiness

To better understand the concepts of adaptive happiness consider the following dynamic model propounded by Sprott (2005) detailed in this section. The dynamics of happiness are modeled by a simple dampened harmonic oscillator typically used in physics. Suppose that the level of happiness is given by a spring attached to an immoveable anchor and a loose weight on the other end. If remained untouched, the weight will not move and happiness would remain constant at a predetermined level. Now suppose an individual tries to increase level of happiness by pulling down on the weight and letting go. The spring will snap back to original position (and may oscillate until reaching steady state). Hence, the individual's first attempt of increasing level of happiness was useless.

Let $F(t)$ be a variable under control of individual. For example, increasing level of income is equivalent to pulling on the weight in order to increase happiness. If the individual increases level of income, his/her happiness will initially increase. But after some time our individual adapts to current situation (the spring pulls the weight back to original position). The dynamics of happiness are given by:

$$\frac{d^2R}{dt^2} + \beta\frac{dR}{dt} + \omega^2 R = F(t)$$

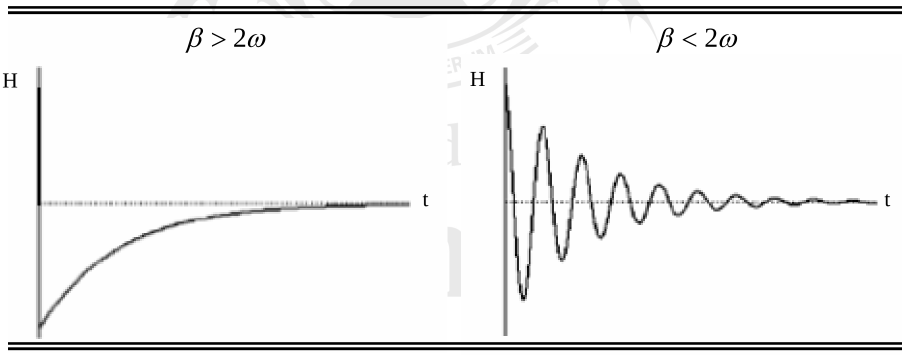
where R represents circumstances of individual (a feedback which affects level of happiness), β is the damping and ω is the natural resonant frequency of oscillation (for simplicity suppose that $\omega = 1$). The model reaches a steady state when oscillator is dampened ($\beta > 0$). If model were not damped ($\beta < 0$), it would never converge to a steady value.[5] Happiness is defined by the rate of change of R: $H = dR/dt$. The only equilibrium is when $R(t)$ is a constant, $H = 0$ and $R = F(t)$. If individual weren't to pull down on weight, level of happiness would remain constant. The case where oscillator is not damped is not desirable since happiness would never return to baseline level. This would be the case of receiving 'too much of a reward or punishment', therefore it would not form part of nature's optimal design. The rest of the section supposes that $\beta > 0$.

[5] A spring with no friction would contract and expand indefinitely.

Consider the example of a single stimulus (i.e. winning the lottery, falling in love, marriage, etc.) depicted in Figure 1.A. If $\beta > 2\omega$, it is said that the oscillator is overdamped. After the initial stimulus, nature 'punishes' individual for not repeating stimulus. Happiness converges exponentially to baseline level. This case is consistent with an idea of gradual adaptation to the stimulus.

In the second case, when $\beta < 2\omega$, the oscillator is said to be underdamped and the effect of initial stimulus decays exponentially while fluctuating around zero. In this scenario, adaptation of happiness is 'emotionally violent' compared to overdamped version. At first, stimulus increases happiness to highest point. But in the following period happiness precipitates due to nature's design of prizes and punishments. The individual is 'punished' for not repeating previous stimulus, therefore the level of happiness is greatly reduced. In the next period, nature now rewards individual for having attained previous level of stimulus (zero) with a higher level of happiness and so on.

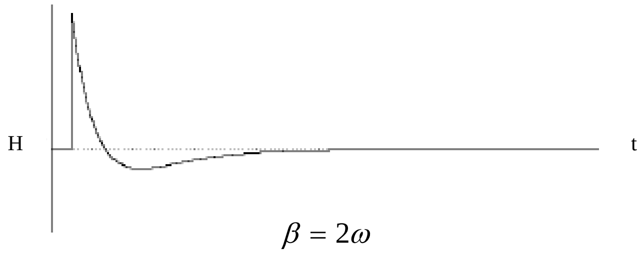
Figure 1.A



Happiness response to a one time stimulus. *Source: Sprott (2005)*

More in line with our hypothesis is the case were the oscillator is critically damped ($\beta = 2\omega$). As in both cases before, happiness soars with the stimulus. In the following period, as in both cases, nature punishes the individual for not repeating previous stimulus. As time goes by nature 'learns' that stimulus was one shot and 'punishes' the individual less as time goes by, converging rapidly to baseline level of happiness (Figure 1.B). The rate of convergence is optimal (the quickest) since oscillator is critically damped. For this reason, nature would design the system in such a way as to reproduce critically damped conditions due to the fact that it is not optimum if individual adapts slowly as in the first case and fluctuating around equilibrium is not optimum either.

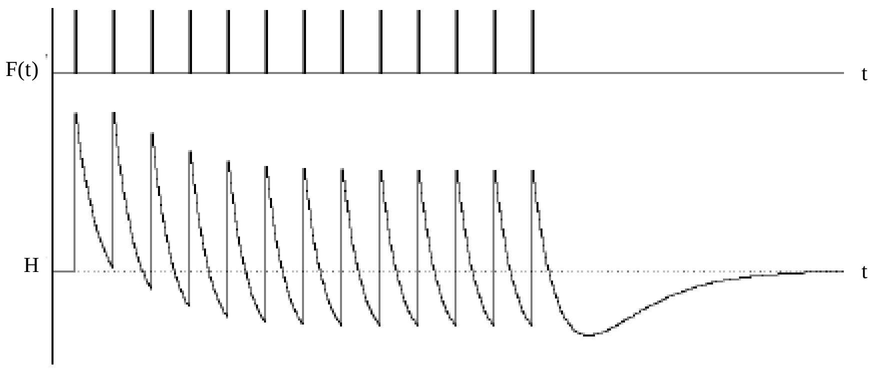
Figure 1.B



Happiness response to a one time stimulus. *Source: Sprott (2005)*

Furthermore, recall that happiness in itself is addictive. Therefore, an individual would pull down on the weight repeatedly in order to try to keep the level of happiness above its baseline level (i.e. consume drugs periodically). The effect of this repeated stimulus on happiness can be seen in Figure 1.C (when critically damped). With each stimulus, happiness increases in a decreasing rate due to adaptation (i.e. body grows resistance to drug intake). At the same time, we see the same effect as in the critically damped situation where in the period after stimulus individual is 'punished' by nature for not repeating stimulus. In order to achieve the same level of happiness as in first realization of stimulus, the individual will have to increase its magnitude (i.e. consume twice as many drugs).

Figure 1.C



Happiness response to repeated stimulus. *Source: Sprott (2005)*

Trying to permanently increase level of happiness in the context of adaptive happiness seems impossible since it always reverts to baseline level. It is very likely that the value of this baseline level of happiness is predetermined by genes. In fact, around 44-56% of variance in happiness scores is associated to genetic variation. Socioeconomic status, education, family income, marital state and religious commitment account for only about 3% of variance in happiness scores (Lykken and Tallegen, 1996). Since mean happiness score depends on genes, individuals can remain above predetermined level only by trying to augment the positive stimuli.

Since increasing stimuli in order to have a transitory higher level of happiness involves effort (time, etc.), the optimal equilibrium would seem to be not pulling down on the weight (not trying). Therefore individuals who try to increase level of happiness would seem irrational. Deeming individuals as irrational would be like beating a dead horse. Suppose that individuals are rational: this behavior may be explained by the form of discounting for future happiness used by each individual. If he/she values the present more than the future, then pulling down on the weight may be an optimal response given the costs involved in doing so. By the contrary, if the individual values future happiness more than present, his/her optimal response will be to never pull down on the weight (the Buddhist equilibrium) since level of happiness will eventually revert to baseline level. It appears that there may be no path to complete happiness.

2.3 Model of Relative Happiness

The same evolutive reasoning used for adaptive happiness can be applied to relative concerns. It is usually the case that the fitness of an individual depends on the decisions made by others. For example: mating may not only depend on the individual's effort (positively), but also on the effort made by others (negatively). As a result, nature must design an incentive scheme which includes social concerns. Jealousy has been the result of an evolutive process which is thought to have played a role as an emotion designed to alert individuals to threats, and also functioned as a motivational mechanism serving the purpose of not loosing partner to others (Buss and Haselton, 2005).

Competition is another way to guarantee optimal choice of effort for individuals. Current outcome is not only compared to past outcomes (through addictions – adaptation), but it is also compared to the outcomes of others. A direct consequence of this is that the selfish and envious desire of each individual corresponds to the maximization of the probability of survival and reproduction of the whole community. There is evidence of comparison among primates which strongly suggests that comparison has been a factor of selection in the evolution of species (Brosnan *et al*, 2003, 2005).

Envy changes the aspirations of an individual, therefore affecting level of happiness. For instance, if your neighbor has a higher level of happiness (or income), the feeling of jealousy could raise aspirations, which in turn would result in a lower level of subjective happiness. There could also be a second effect in which jealousy also raises motivation which could result in an increase of the level of happiness (happiness could be contagious). This is likely to be the case within a household where there is no competition between family members.

3. Econometric Model and Data

3.1 Empirical Identification

There is existing evidence on adaptation to income and to major life events. Di Tella *et al* (2007a) find evidence in favor of adaptation to income but not to status using the GSOEP and lagging the variables of interest. They cannot reject the null hypothesis of complete adaptation after four years to income. Additionally, many have found evidence suggesting that people adapt to main life events such as marriage, divorce, widowhood, birth of child, layoffs (Clark *et al,* 2007) and to disabilities (Oswald and Powdthavee, 2006). Conversely, Zimmermann and Easterlin (2006) find that marriage has a long lasting effect on happiness.[6]

In happiness regression literature, economists argue that a gain in happiness from a rise in income will vanish in a few periods because of adaptation to income (Di Tella *et al.*, 2007a). Psychologists argue the same, for instance, in the emotional field: someone who has found a love partner recently will enjoy an increase in happiness, but this gain will vanish gradually as he gets acquainted to be in love (Lucas *et al.* 2003). Brickman and Campbell

[6] Stutzer and Frey (2004) find evidence for selection: happier individuals are more likely to get married.

(1971) call this tendency to acclimate to one's condition (love, money, friendship, health, status, etc.) the "hedonic treadmill".

What has been widely omitted in Economics of Happiness is the fact that an increase in certain stimulus (i.e. consumption, love) may not decrease future happiness only through an increase in the need for those particular goods, but at least partially through an increase in current happiness. Therefore, in addition to the adaptation to income (or love, etc.), adaptation to happiness should be considered. As a consequence, lagged values of happiness should appear as regressors in happiness equations.

A subtle difference between models of adaptive income and the proposed model of adaptive happiness is the possibility of substitutability between sources of happiness. For instance, if income rises today then happiness will also rise. If the theory of adaptive happiness were true, then rising income tomorrow is not necessary since it could be possible to replace it by another stimulus which generates happiness (i.e. getting married). A second distinction between both models is the origin of income adaptation: it may not be hard-wired into each individual, but instead be the result of socio-cultural influence (i.e. being educated to strive for constant improvement).

3.2 Main Framework

To test our hypothesis empirically, we will make use of the British Household Panel Survey (BHPS). The BHPS is a random representative sample of the population of the United Kingdom. It began in 1991 surveying some 5,500 households and additional household were incorporated in 1999 and 2001 yielding a sample of over 10,000 household containing over 24,000 individuals. Individuals who left original household to form a new one were followed and all adults were consequentially interviewed. We make use of data from wave 6 to 15 due to the fact that questions on life satisfaction were introduced as of wave 6.

In wave 11 the question on life satisfaction was dropped[7] from the survey due to the inclusion of the Quality of Life module, introduced every 5 years. Data for wave 11 is included with missing values for happiness. This results in a panel with a maximum length of 10 waves and a mean of 7 waves per respondent.

[7] They were dropped because of constraints of space in Self Completion Schedule.

The sample is composed of respondents aged 15 onwards, the mean age throughout is 46. Around 45,5% of the sample are males. Those reported as married fluctuate around 53%, divorced 8% and widowed 7% throughout time. Average income grew from 23,715 GB pounds in wave 6 to 33,472 GB pounds (around $70,000 US dollars) in wave 15 (while average happiness remained unchanged fluctuating around 5,25; see Figure 1.A). Happiness scores are taken from question on satisfaction with life, the values ranging from 1 to 7: 1 being not satisfied at all and 7 completely satisfied. Around 1,5% have reported being not satisfied at all with life while 15% have stated being completely satisfied. Around 51% of respondents have reported being employed throughout periods while those unemployed fluctuated around 3%, and around 20% are reported retired. For more detailed statistics refer to Table 1.A.

We intend to find whether past happiness, relative happiness and income has an effect on current happiness. The baseline least square model is:

$$H_{it} = \sum_{q=1}^{Q} \delta_q H_{i,t-q} + \gamma H_{i,t}^{e} + \sum_{k=0}^{K} \theta_k y_{i,t-k} + \lambda y_{i,t}^{e} + \sum_{r=0}^{R} \beta_r X_{it-r} + \eta_i + \psi_t + \varepsilon_{it}$$

where H_{it} is self reported happiness of the individual, y_{it} is income, X_{it} is a vector of time varying individual controls, Q, K, R are the number of lags to be included, η_i is individual fixed effects, ψ_t corresponds to year effects and ε_{it} denotes the error term. The measure of income used is the logarithm of gross total annual household income, deflated to 2005 prices.[8] If the coefficient for δ is negative, we would face the case in which happiness is addictive. Conversely, for the case where the coefficient is positive, individuals could have increasing profiles of happiness: there is a way around nature's scheme.

It is important to consider the fact that income and other variables may be potentially endogenous. For instance, causality could run in the opposite direction: being happy could be a factor that makes an individual earn more money (Lyubomirsky *et al.*, 2005). Yet, there have been attempts trying to identify a causal link, as in natural experiments (Becchetti and Castriota, 2007) and controlled lab experiments (see Charness and Grosskopf, 2001; McBride, 2007).

[8] Data on CPI was taken from the UK Office of National Statistics.

We opt for estimating a structural model controlling for possible individual time varying covariates which potentially affect level of happiness, also including time and fixed effects. This approach has the benefit of external validity, increased degrees of freedom (improving efficiency of estimates) and we are better able to control for the effects of missing or unobserved variables (see Hsiao, 2003 for more details). For example, some of the control variables used are: age, household size, education indicators, employment state variables and marital state indicators.[9] A downfall of including a vast amount of control variables is that it may cloud the interpretation for certain coefficients of interest. Consider the example for income, which could improve life satisfaction through attainment of better goods and services such as health and education. Controlling for these variables would downward bias the income coefficient.

An additional factor that should be taken into consideration is the 'external norm' for income: an idea originally propounded by McBride (2001) where individuals compare their income to their reference group (by location, social relations, age, etc.). In contrast, the 'internal norm' is fixed for each individual throughout time and represents, for example, a consumption path. Furthermore, the 'internal norm' for happiness refers to personal traits which are fixed throughout time. Hence, including individual fixed effects in estimations is essential due to these unobserved characteristics which play an important role in the determination of the level of happiness.

Although the 'external norm' for income has been thoroughly examined in some papers, this analysis has not been done for happiness as far as we are concerned. Due to the fact that income may not be directly observable while happiness could, following McBride (2001), suppose the 'external norm' for happiness takes the following form:

$$H_{it}^{e} = \left(\frac{1}{Ni} \sum_{j \in C_i} H_j \right)$$

where H_{it}^{e} is the 'external norm' for happiness (y_{it}^{e} for income). An individual evaluates his/her level of happiness (or income) by assessing the overall level of happiness for reference group (C_i). An important issue is the determination of reference group

[9] For more information see Data Appendix

composition. We explore the determination by cohort groups (proposed by McBride, 2001) with $C_i \equiv \{j : age_j \in [age_i + 5,\ age_i - 5]\}$, where the age cohort interval for individuals used is a distance of 5 years. Therefore, consider an individual who is 40 years old. He/she will compare to other individuals in interval of 35-45 years of age.

An additional aspect to take into consideration is that when respondents evaluate current situation to rank their life satisfaction, income is taken into consideration. A problem arises in that each individual evaluates income conditional to their context (i.e. number of children in the household, number of working adults). Therefore, correcting income by elasticity to household size is necessary in order to avoid this possible source of bias. Following Schwarze (2003) and Pérez Truglia (2007), we will test robustness of results using corrected income (*See Appendix A for detailed description*).

3.3 Why OLS?

Due to the discrete nature of happiness variable, some authors suggest using ordered logit instead of OLS supposing an ordinal treatment of life satisfaction instead of a cardinal treatment usually supposed by psychologists when using OLS (Ferrer-i-Carbonell, 2005, 2002). Pérez Truglia (2007) suggests that using OLS may be appropriate when two conditions hold. First, the subjective value for the distance between scores reported (say 7 and 8), should be equal to that of another contiguous interval (3 and 4). In other words, if it takes 10 units of effort to advance from 3 to 4, then it also takes the same amount of units to move from 7 to 8. The subjective value between intervals is equal among all individuals. If this condition does not hold, it is argued that this may be dealt with by transforming the variable in such a way as to make this subjective value between scores vary (i.e. making center of the distribution stronger by applying a U-shaped function).

The second condition refers to the fact that the subjective value of a certain score interval (5 and 6) should be the same for all individuals. For example, if one individual requires 10 units of effort to advance from 5 to 6, all other individuals require the same amount of effort to advance at the same interval. This most likely is not the case. Therefore, introducing individual fixed effects may capture this unobservable effect (as well as it may capture part of the first condition). We do not believe that these conditions would have a significant effect on estimations. OLS will be used due to dynamic nature of intended estimation and for comparability to bulk of existing literature on the subject. Regardless of these issues, it has been shown that assuming ordinality or cardinality of happiness scores makes little difference as long as fixed effects are taken into account (Ferrer-i-Carbonell and Frijters, 2004).

3.4 Considerations for Dynamic Autoregressive Panels

As pointed out earlier, this paper makes extensive use of dynamic autoregressive panels. It is well known that introducing the lagged dependent variable may produce biased and inconsistent estimates for a small *T*. Unfortunately, household panels are characteristically short as to ignore this problem (T=10 for BHPS).

The solution adopted is that proposed by Anderson and Hsiao (1981). They suggest a transformation of the model by taking first difference in order to eliminate the constant. Consider the following model using only dependant variable:

$$(H_{it}-H_{i,t-1}) = \beta(H_{i,t-1} - H_{i,t-2}) + (\varepsilon_{it} - \varepsilon_{i,t-1})$$

The estimation of β would not be consistent by construction since $H_{i,t-1}$ is correlated to $\varepsilon_{i,t-1}$. Anderson and Hsiao suggest using instrumental variables approach in order to solve this problem. The instruments proposed were the second lagged dependent variable ($H_{i,t-2}$) or, alternatively, the second difference ($H_{i,t-2} - H_{i,t-3}$). These are correlated to the instrumented variable and not to the error component (unless errors exhibit some form of autocorrelation). Both possibilities are explored along with using an extra lag. Using levels as instruments has no singularities and smaller variance than using difference (Arellano, 1989).

An alternative is using GMM as suggested by Arellano-Bond (1991) and Arellano-Bover (1995). These models include all available moment conditions as instruments. The main reason these estimators will not be used is due to a problem with the validity of the instruments used. How valid can the 5th lag be as an instrument? Supposing that all available lags are valid instruments in these models is too strong of an assumption in the context of happiness. With this specification, a lag which is far from the instrumented variable would only be related to it through a whole lot of noise which in turn would produce biased estimates.

Using Monte Carlo simulations, many researchers have tried comparing different estimators in order to assess potential biases. There is evidence suggesting that GMM estimators may not produce superior estimates in terms of average bias or efficiency (Judson and Owen, 1999) and Anderson and Hsiao produced the lowest average bias.[10] Kiviet (1995) found that Anderson and Hsiao show smaller biases than GMM and its efficiency compares favorably. Throughout the following section Anderson and Hsiao (and OLS when specified) will also be used for estimation of the structural model proposed.

4. Results

4.1 Models of Adaptation to Income

Most studies have tried to identify the effects of income on happiness using cross section and panel data. Consider the following basic model where we suppose that happiness depends linearly on present income (proxy of consumption level), and on the differential of income (which would represent how much more an individual can consume with respect to yesterday). The model would take the form of:

$$H_{it} = \beta_1 I_{it} + \beta_2 \Delta I_{it} + \varepsilon_{it} \qquad (1)$$

where $\Delta I_{i,t} = I_{i,t} - I_{i,t-1}$. Note that a model with lagged income instead of the differential is similar. Now suppose, for instance, that income were autocorrelated:

$$I_{i,t} = \alpha_1 I_{i,t-1} + \upsilon_t \qquad (2)$$

As a result, if $\Delta I_{i,t}$ were not included in equation (1), the estimation of $\hat{\beta}_1$ would be biased. In theory, the inclusion of lags of income would be describing the process of adaptation of happiness to income. Consider Di Tella *et al.* (2007a) who find evidence in favor of adaptation to income but not to status using the GSOEP. They regress life satisfaction on income (and status) along with their lags and find that they cannot reject the null of complete adaptation after four years to income. We first estimate the baseline model supposing that $\delta_q = \gamma = \lambda = 0$ from which we obtain the following expression:

[10] They also found that Anderson and Hsiao increases efficiency as T increases.

$$H_{it} = \sum_{k=0}^{K} \theta_k y_{i,t-k} + \beta X_{it} + \eta_i + \psi_t + \varepsilon_{it}$$

We try different specifications for K and results do not vary significantly. Results for this specification are presented in the first two columns of Table 2.A. Column (1) presents the simplest version where logged income is regressed alone using individual fixed effects, time effects and time varying controls. The coefficient of income is positive and statistically significant as is to be expected. An increase in income of one standard deviation would increase happiness in 2.2% of a standard deviation. Column (2) arbitrarily reports value setting $K = 3$.[11] The coefficient on income is still positive and significant at 1% level. We cannot reject the null of no adaptation to income based on an F-test for lagged income at a level of 1%.[12] But, we do reject the hypothesis of complete adaptation to income (at a 50% level). Note that standard errors are clustered by individual in all estimations. We do so as to account for other possible idiosyncratic shocks affecting individuals which may persist throughout time.

4.2 Models of Autoregressive Happiness

Now suppose that current happiness depends additionally on past happiness. As we have discussed, this could be the result of natural evolution. Equation (1) will now take the following form:

$$H_{it} = \delta H_{i,t-1} + \beta_1 I_{it} + \beta_2 \Delta I_{it} + \varepsilon_{it} \qquad (3)$$

If this were the case, with $\delta \neq 0$ and model (1) were to be estimated, then $\hat{\beta}_2$ would be biased since $H_{i,t-1}$ would be in the error component and would be correlated to $\Delta I_{i,t}$ through $I_{i,t-1}$. Therefore including lagged happiness should be taken into account whenever lagged income is introduced in model as dependant variable. Consider the extreme case of $\beta_2 = 0$: if $\delta \neq 0$ we would find that $\hat{\beta}_2$ in equation (1) is different from the null. This would result in the income differential capturing the effect of lagged happiness. In this case not including $H_{i,t-1}$ would make income differential a determinant of happiness and the effect

[11] Results do not vary significantly for values of K<5.

[12] Following Di Tella *et al.* (2007a) we test: H0: $\sum_{k=1}^{K} \theta_k = 0$ vs. HA: $\sum_{k=1}^{K} \theta_k \neq 0$ for adaptation to income

captured by $\hat{\beta}_2$ in (1) would not be explained wholly by theory of adaptation to income, but instead by autoregressive happiness (or simply: happiness adaptation). Model (3) should be estimated using Anderson and Hsiao for reasons already discussed.

After introducing lagged happiness in OLS specification (column (3), Table 2.A) the effect of current income is still statistically significant and positive. In terms of magnitude, introducing lagged happiness increases the effect of a one standard deviation increase of income in 0.4% of a standard deviation. The level of rejection of null hypothesis of adaptation to income is larger than in the case of omitting past happiness (now 5,8%). Past happiness is negative with a coefficient of -0.119 and is statistically different from zero at a level of 1%.[13]

Estimations for Anderson and Hsiao using second lag and difference as instruments appear in columns (5) and (6) respectively. First of all, the coefficient for past happiness changes completely with respect to OLS. It is positive and statistically different from zero at a level of 1% using second lag, but not significant when using difference. The magnitude of the coefficient is larger for using level as instrument (0.051 vs. 0.022). This difference is not surprising since variance is larger for estimating with difference as instrument (Arellano, 1989). Furthermore, all coefficients for income are no longer statistically significant. This is not unforeseen since there are many substitutes of income which affect happiness and this may suggest that income in itself is not an important determinant of happiness. The problem is that the coefficients are not credible since the effect of past income would be greater than that of current income.

These results suggest that Anderson and Hsiao may not be working correctly. We will try to explore the possible sources of bias affecting estimations in the remainder of the section. A potential source of bias may be omitting other observable variables with persistence throughout time.

4.2.1 Model with lagged observables

Suppose that happiness also depends linearly on other lagged observables. For example, health problems or employment state may have a persistent effect on happiness throughout time due to adaptation. There is evidence suggesting that people adapt to main

[13] Result is robust to introduction of additional lags of happiness

life events such as marriage, divorce, widowhood, birth of child, layoffs (Clark *et al*, 2007) and to disabilities (Oswald and Powdthavee, 2006). The model now is:

$$H_{it} = \delta H_{i,t-1} + \beta_1 I_{it} + \beta_2 \Delta I_{it} + \beta_3 X_{it} + \beta_4 X_{i,t-1} + \varepsilon_{it} \qquad (4)$$

where X is a vector of individual time-varying observables. Since $X_{i,t-1}$ is correlated by construction to $H_{i,t-1}$, estimation of δ would be biased (as well as coefficients of other variables correlated to $X_{i,t-1}$). Returning to the baseline econometric model with $\delta_q \neq 0$ and $\gamma = \lambda = 0$ we now have the following:

$$H_{it} = \sum_{q=1}^{Q} \delta_q H_{i,t-q} + \sum_{k=0}^{K} \theta_k y_{i,t-k} + \sum_{r=0}^{R} \beta_r X_{it-r} + \eta_i + \psi_t + \varepsilon_{it}$$

Introducing lagged observables does not substantially change coefficients or significance. Results are presented in Table 2.A arbitrarily using $R = 1$ (note that inclusion of lagged controls is specified for each column). For OLS (column (4)) the change in coefficients is irrelevant. When using Anderson and Hsiao (column (7) and (8)), coefficients for past happiness do not change significantly. On the contrary, even though coefficients for income remain statistically insignificant, the magnitudes of coefficients are more intuitive compared to not including lagged observables. The coefficient for current income is now larger than lagged income for the case of instrumenting with lag (although problem persists when using difference as instrument). A new problem arises with the existence of lagged unobservable determinants which appear in the data generating process of happiness.

4.2.2 Model with lagged unobservables

Suppose that happiness also depends linearly on these lagged unobservables. An example of this could be satisfaction with social relationships or love (S_t). Introducing this would yield the following expression:

$$H_t = \delta H_{t-1} + \beta_1 I_t + \beta_2 \Delta I_t + \beta_3 S_t + \beta_4 S_{t-1} + \varepsilon_t \qquad (5)$$

If (4) were estimated, S_t and S_{t-1} would be part of error term. It is plausible to consider that H_{t-1} and S_t are not correlated, but S_t potentially can be correlated to I_t. This would bias $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\delta}$ (since H_{t-1} is correlated with S_{t-1} by construction). This occurrence is likely to happen since wealthier people are more likely to find better partners (conditional on the rest of their characteristics).

Additionally, note that it is not necessary to include S_{t-1} in equation (4). If ε_t were itself MA(1), then the first difference term in using Anderson and Hsiao $(\varepsilon_t - \varepsilon_{t-1})$ is MA(2). This would produce a biased estimation of $\hat{\delta}$ given that H_{t-2} would no longer be a valid instrument. This can be solved by alternatively using H_{t-3} and longer lags (see Bond, 2002). By introducing this modification we face a tradeoff between potential bias and less efficiency, since a longer lag is a 'weaker' instrument (correlation dampens throughout time). The baseline model estimated is the same as in the previous case with lagged observables.

Remember that data on happiness is missing for wave 11. This narrows our analysis to setting $Q=1$ (only one lag of happiness) when estimating by Anderson and Hsiao, since we do not count with sufficient observations to instrument extra lags. To avoid possible bias for autocorrelation of order greater than one of dependant variable we propose the use of an exogenous instrument: "the number of serious accidents in the current year". These are considered to be those accidents which require medical treatment by a doctor or a hospital visit. Some examples are: falling down stairs and breaking a leg, attacks by animals or humans resulting in injury. The number of serious accidents is negatively correlated to level of happiness (unless the individual is a masochist) and is exogenous. We instrument the first difference of past happiness with the first and second lag of the number of accidents since they directly affect $(H_{i,t-1} - H_{i,t-2})$. It is very unlikely to find that this instrument is correlated to an unobservable characteristic of individuals which may affect happiness (summary statistics of this variable is available in Table 1.A).

Estimations of the previous model using third lag and exogenous instruments are presented in columns (10)-(13) of Table 2.A. A salient result of using the third lag as an instrument is that it provides a very poor solution to a possible MA(1) error structure. Th coefficient for past happiness is unfathomable (1.406!) and statistically different from zero at level of 5% (and 10% when including lagged observables). As stated previously, the correlation between instrumented difference and longer lags reduces with the distance, but it is not a weak instrument according to Stock and Wright LM statistic (Chi-Sq(1)=15.97 and reject null hypothesis of B1=0 at level of 1%). In this case the coefficient for past happiness may be correlating noise.

Using our proposed exogenous instrument produces results consistent with the theory presented and with OLS estimates where coefficient for past happiness is negative and statistically different from zero at a 5% level. Income remains insignificant, though the magnitudes of these coefficients are the expected. An important fact is that the magnitude of coefficient for past happiness is much larger than when using OLS (-0.502 vs. -0.114). This is due to the fact that the number of serious accidents is a weak instrument (Stock and Wright LM statistic, Chi-Sq(2)=3.97 and reject null hypothesis of B1=0 at level of 13,75%) which may downward bias the coefficient.

We include an estimation using Arellano and Bond (column (14)) to compare with Anderson and Hsiao estimates. Coefficients are similar to using Anderson and Hsiao instrumented by difference. We reject the null of no autocorrelation for the Arellano-Bond test that average autocovariance in residuals of order 1 is 0 (z=-30.64 and Pr > z= 0.000). Since we cannot discard the possibility of existence of AR(1) errors, the estimation of past happiness takes on a new dimension:

4.2.3 Model with AR(1) errors

Suppose that the errors in the model are AR(1), therefore $\varepsilon_{it} = \rho\varepsilon_{i,t-1} + v_{it}$. Using Anderson and Hsiao in this context would produce biased estimate of past happiness when using $H_{i,t-2}$ as instrument. This is due to the fact that $\varepsilon_{i,t-2}$ is part of the error component of first differenced model:

$$(H_{it} - H_{i,t-1}) = \alpha(H_{i,t-1} - H_{i,t-2}) + (\rho\varepsilon_{i,t-1} - \rho\varepsilon_{i,t-2}) + (v_{it} - v_{i,t-1})$$

Therefore, the instrument would be negatively correlated to the error term. Since we know that the instrument is negatively correlated to the instrumented variable, the bias generated is positive:

$$bias = \frac{Cov(\varepsilon_{it} - \varepsilon_{i,t-1}, H_{i,t-2})}{Cov(H_{i,t-2}, H_{i,t-1} - H_{i,t-2})} > 0$$

4.2.4 Model with Individual Specific Time Trends

A second potential source of a positive bias in estimations of lagged happiness is the existence of individual specific time trends. If individuals had a positive trend for happiness, using levels as instruments would capture the effect of the trend, therefore biasing coefficient on past happiness upward. Suppose the first-order version of our model now takes the following form:

$$H_{it} = \gamma_t + \alpha H_{i,t-1} + \delta_t \eta_i + \varepsilon_{it}$$

where the model includes an interaction of time and individual effects ($\delta_t \eta_i$). Taking first difference of this model produces:

$$(H_{it} - H_{i,t-1}) = (\gamma_t - \gamma_{t-1}) + \alpha(H_{i,t-1} - H_{i,t-2}) + (\delta_t \eta_i - \delta_{t-1}\eta_i) + (\varepsilon_{it} - \varepsilon_{i,t-1})$$

Since the model has individual specific time trends, taking first difference of baseline model does not eliminate individual fixed effects. Since we cannot suppose that individual effects are strictly exogenous, the estimation for α will be upward biased (due to omission of individual specific time trend). Arellano (2003) proposed the following solution by taking quasi-differences:

$$(H_{it} - \pi_t H_{i,t-1}) = (\gamma_t - \pi_t \gamma_t) + \alpha(H_{i,t-1} - \pi_t H_{i,t-2}) + (\varepsilon_{it} - \pi_t \varepsilon_{i,t-1})$$

where $\pi_t = \delta_t / \delta_{t-1}$. Using this strategy eliminates the individual effects term. The problem with applying the suggested quasi-difference is that we need an estimate for δ.

Positive individual trends may be related to the fact that individuals could be 'learning' to answer the household survey. Imagine an individual who is asked to report his/her subjective level of happiness for the first time. Since they have never done this exercise before, the level of aspirations used in evaluation may force an undervaluation of subjective happiness. As time goes by, individuals better calibrate their evaluation and may be more perceptive of their relative position with regards to the reference group (as well as being conscious of previous reported scores). This learning process may produce this upward trend in level of happiness.

It is possible to test for the existence of a learning effect by generating a variable for the amount of time spent by an individual in the sample. The effect of learning is positive when included in (full) baseline OLS specification, with a coefficient of 0.071 and is statistically different from zero at the 10% level. Consequently, learning could have an impact on individual time trends, biasing coefficients upwards for Anderson and Hsiao estimations with levels (or difference) of dependant variable as instruments.

4.3 Model of Relative Happiness

Sociologists have been voicing the idea that happiness is relative for quite some time (Veenhoven, 1991). Many have studied the effects of relative income on happiness (see for example D'ambrosio and Frick, 2007; Easterlin and Zimmermann, 2008; Knies *et al.*, 2007; McBride, 2001) and effect of social relations on happiness (Powdthavee, 2005). A problem with using income as only means for comparison is that it is not easily observable between individuals. This may not seem obvious to a researcher using micro data, where income is perfectly measured. On the other hand, individuals could be signaling wealth by means of conspicuous consumption. But, it may not be a very reliable base for comparison.

Alternatively, happiness could be potentially directly observed. There is evidence suggesting that happier people tend to smile and laugh more (Pavot et al., 1991). Additionally, in comparison to conspicuous consumption where an expensive watch could be a fake, there is a certain type of smile, the 'Duchenne smile', which is only produced in moments of genuine happiness. It is suggested that humans may have evolved in a way as to distinguish this smile because it plays an important communicative role (Williams et al., 2001). Therefore individuals would also take relative happiness into account. If coefficient on 'external' happiness is positive it could be said that happiness is contagious. By the contrary, a negative coefficient would point to the case of 'happiness jealousy'. Again, not including this in estimation could potentially be a source of bias since it is part of data generating process for happiness. We now proceed to estimate the full structural model. Recall it takes the form of:

$$H_{it} = \sum_{q=1}^{Q} \delta_q H_{i,t-q} + \gamma H_{i,t}^{e} + \sum_{k=0}^{K} \theta_k y_{i,t-k} + \lambda y_{i,t}^{e} + \sum_{r=0}^{R} \beta_r X_{it-r} + \eta_i + \psi_t + \varepsilon_{it}$$

Estimations for relative happiness and income are shown in Table 3.A. Introducing relative measures do not significantly alter previous results for past happiness and income. Relative income has a negative effect on current happiness but is only statistically different from zero when using OLS (column (1)). When estimating by Anderson and Hsiao, the coefficient for relative income differs greatly depending on instrument used (it changes sign when using 3rd lag) and is no longer statistically significant. This finding would be consistent with the idea of income not being directly observable between individuals.

The novelty here is finding that the coefficient for relative happiness is positive and statistically different from zero at a 1% level for all specifications. The coefficient for relative happiness is similar regardless of estimation technique. One immediate interpretation of this result is that happiness may be contagious. This is consistent with psychological and biological findings where individuals are ‘infected’ by emotions of others (Wild *et al.*, 2001, 2003). Since we determined reference group by age cohort, reference group may be considered as being too ‘wide’ of a measure and, therefore, would only capture the effect of random noise. Relative measures should be tested using smaller geographic units as reference group for greater robustness.

4.4 Model of Adaptive Happiness

Now suppose that a cardinal and objective measure of happiness exists and is observed by individuals. When individuals answer the survey question of “How is life overall?”, they must give a discrete and limited response between 1 and 7. The process behind the decision of happiness score is giving 1 a lower bound reference and 7 a superior reference. For example, an individual could use information on levels of happiness of other individuals. Alternatively, it may be determined by internal comparison: the lower bound reference could be based on the worst situation that individual experienced and the upper limit on the best experience (i.e. $H1_{it} = \min\{H^*_{it}\}_{t=0}^{T}$ and $H7_{it} = \max\{H^*_{it}\}_{t=0}^{T}$).

Consequently, individuals would not be reporting their real level of happiness. Instead they report that their happiness lies between $H1_i$ and $H7_i$. Therefore, stated happiness H_{it} is the following function of real happiness (H^*_{it}):

$$H_{it} = f(\overset{(+)}{H}{}^*_{it}, \overset{(+)}{H}1_{it}, \overset{(-)}{H}7_{it})$$

For instance, a 30 year old married woman with two children would probably answer the question “Are you happy?” by comparing her situation with those of other 30 year old married women with children in her neighborhood. Including age, marital state and number of kids in the happiness regression may not be enough since we should include all their interactions to control for complex effects (i.e. an additional child may increase happiness of a married woman more than a single woman). But if reference group is relatively stable throughout time ($H1$ and $H7$ constant), then problem may simply be solved by including individual fixed effects.

On the other hand, for the case of internal comparison the variability is temporal. For example, if an individual were to determine limits by worse and best life experience. The scale for happiness aspirations ($H1$ and $H7$) would be determined to great extent by past life experiences. If an individual experiences greater unhappiness in a previous year, we could have two effects: individual may know that it is possible to be worse than what he/she thought (and $H1$ drops), or the individual could realize that in that unfortunate situation he/she is better off than thought (in that case $H1$ increases). This could potentially bias the coefficient for past happiness in any direction.

Since the reported happiness score is all that is observed, isolating the effects of a change in real happiness (H_{it}^{*}) from a change in aspirations ($H1$-$H7$) is not possible. Many have claimed that in the last 50 years happiness has not increased or even that people were happier before (a century ago). Happiness scores may show a constant behavior over time, but this does not mean that happiness has not changed over the years. As a matter of fact, real happiness could have increased as well as aspirations, resulting in happiness scores with little or no variation.

4.5 Further Implications

One of the objectives of this paper is to assess whether including autoregressive happiness in regressions modifies the main results of happiness literature. Table 4.A contains a selection of variables usually considered important determinants of happiness. Columns (1) through (3) are estimations obtained in this paper. Column (4) and (5) contain the results of Oswald and Powdthavee (2006) and Clark *et al.* (2007) respectively. Consider the case of marriage and widowhood: the coefficients are positive and negative respectively (as expected) and statistically different from zero. They do not differ greatly in terms of magnitude for widowhood and marriage (except for the estimates in (4)).

Additionally, the effect of unemployment is negative and statistically different from zero at the level of 1% in all cases. Clark *et al.* (2007) find a negative and significant effect of lagged unemployment on current happiness (column (5)). Our results for past unemployment differ: they are not statistically significant for any specification.

An interesting result obtained is that the birth of a child (using whether an individual is on maternity leave as a proxy) is statistically significant and economically relevant: the birth of a child may account for an increase of 0.2 in level of subjective happiness. This is also consistent with the coefficient for number of children which is also positive and significant. An interesting observation is that an additional child in the past has a negative (and significant) effect on current happiness. Our results are consistent to great extent with those obtained in by others.

4.6 Robustness Check

Panel attrition may be a source of bias if the probability of dropping out of sample were not random. There is no concrete measure of whether an individual leaves the sample (except in the case of death). Additionally, there are many alternative definitions of attrition (Uhrig, 2008). For the sake of simplicity, we consider that an individual leaves the sample if final response was not the last wave for which we have data (wave 15).[14] We explore whether attrition leads results by creating a variable for time left for individual to leave sample and include this variable in OLS regression, instrumenting it by average time to leave sample for region they belong to. Coefficient for time remaining in sample is not statistically significant. Coefficients on variables of interest are not affected by including the time remaining to leave sample.

In order to not make any assumptions on distribution of standard errors, we try bootstrapping main regressions using 500 repetitions. Results are robust to bootstrapped clustered standard errors and to income corrected by household elasticity. Accounting for equivalence scale corrected income is an interesting approximation to the real valuation of

[14] Using our definition for attrition, we find that around 11% (approximately 1300 individuals) of those who leave the sample do so because of death throughout time. Happiness scores for those who die are significantly lower but it is not significant when included in regressions. Consider the dynamics of attrition for the first couple of waves (where measure is more credible): in wave 7, around 450 individuals leave the sample for unknown reasons (600 for wave 8; 540 for wave 9; 940 for wave 10).

level of income conditional to household characteristics of respondents. Coefficients and statistical significance do not vary when using equivalence scale corrected income.

It may be the case that the real value for the coefficient of past happiness in regression is positive. This may have very interesting implications: in the very beginning, nature developed this system of 'prize and punishment' to ensure the survival of the primitive man (the hunter-gatherer). But times have changed. The world has become unimaginably more complex in every way (culturally, technologically, etc.). Nature's plan has worked well, in the past, ensuring survival and reproduction of man. But today with the technological advances, individuals may have finally found a way around nature's scheme.

4.6.1 Additional Shortcomings

Accomplishing proposed goals usually takes a certain amount of time. When formulating aspirations, individuals set objectives with a finite time to achieve goals. They may re asses current situation with respect to aspirations every 3, 6, 9 months or every year. Since the BHPS is surveyed yearly, the information on happiness may capture an individual within his/her own 'happiness cycle'.

5. Conclusions

The results obtained in this paper depend greatly on which model is correct. Standard strategies to address the problem of autoregressive models suggest a positive association between past and present happiness, while the use of proposed exogenous instrumental variable suggests a negative relation. We find it necessary to include past happiness in happiness regressions. This may modify the way we understand happiness. Future studies must find a 'clean' identification strategy in order to determine the true sign of the parameters of interest.

The theoretic model proposed suggests that addiction is the optimal incentive mechanism designed by nature to ensure reproduction and survival of mankind. In the last thousands of years, humanity has developed at an ever increasing rate surpassing nature's ability to modify the design. What may have been an optimal design for the times of man as a hunter-gatherer running on the never ending 'hedonic treadmill' may no longer work today: mankind might have finally found the path to perpetuate happiness as a way to meet the ever increasing demands due to its addictive nature. Maybe after all, happiness IS a warm gun.

Appendix

Figure 2.A

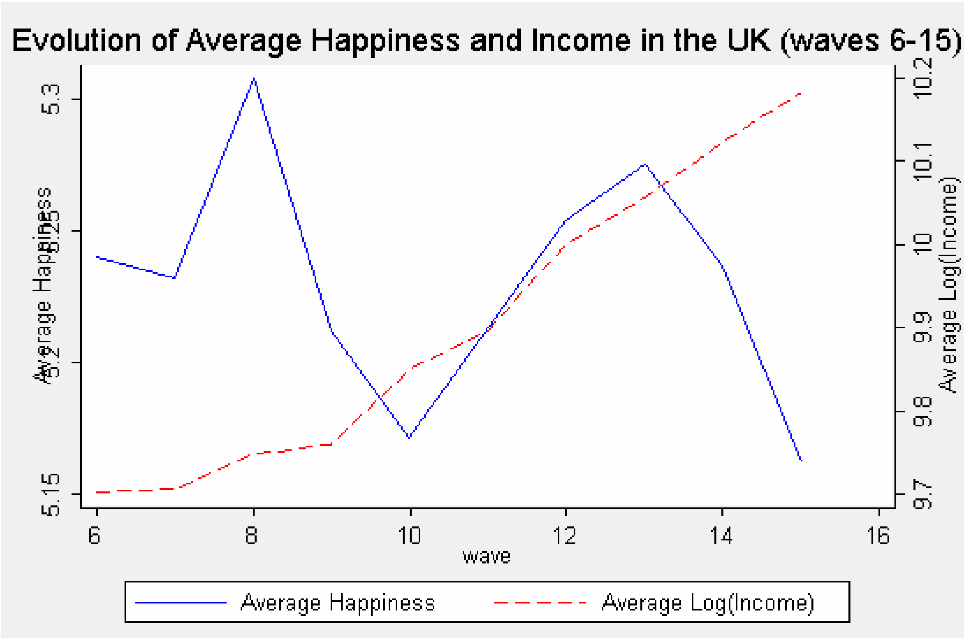


Table 1.A

Descriptive Statistics for BHPS wave 6-15

Variable	Description	Mean	Std. Dev.	Min.	Max.	No. of Obs.
Happiness	1 - 7 Scale	5.230	1.306	1	7	N = 117603
- between			1.122	1	7	n = 24811
- within			0.806	-0.104	10.230	T (avg) = 4.74
Current level of total household income	2005 Great Britain Pounds	27974.590	22411.060	0	1205210	N = 136092
- between			18608.860	1.2	283023.9	n = 25974
- within			13709.750	-218105.9	1077885	T = 5.239
Current level of total household income (*logs*)	"	9.920	0.801	-0.587	13.973	N = 136092
- between			0.751	0.125	12.451	n = 25974
- within			0.437	1.338	14.057	T = 5.239
No. of Serious Accidents	In days	0.122	0.393	0	4	N = 135513
- between			0.300	0	4	n = 25714
- within			0.321	-2.211	3.722	T = 5.27
Income Satisfaction	1 - 7 Scale	4.555	1.624	0	7	N = 118004
- between			1.406	0	7	n = 24811
- within			1.000	-0.778	9.698	T = 4.756
Age	In Years	45.796	18.447	15.583	99.25	N = 136070
- between			19.467	15.583	97.417	n = 25974
- within			2.234	36.062	59.731	T = 5.239

Table 2.A

Effects of Income and Past Happiness on Current Happiness for BHPS Waves 6-15

	OLS				Anderson & Hsiao								Arellno-Bond
Dep. Var.: Happiness	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)	(13)	(14)
Past level of Happiness													
Happiness in t-1			-0.114	-0.119	0.051	0.022	0.049	0.02	1.406	-0.502	1.682	-0.545	0.038
			(0.008)***	(0.008)***	(0.012)***	(0.019)	(0.012)***	(0.020)	(0.694)**	(0.229)**	(0.926)*	(0.253)**	(0.012)***
Current level of HH income													
Income in year t	0.036	0.034	0.044	0.042	0.008	0.013	0.011	0.021	-0.011	0.019	0.011	0.019	0.012
	(0.008)***	(0.012)***	(0.014)***	(0.014)***	(0.015)	(0.018)	(0.015)	(0.018)	(0.039)	(0.014)	(0.042)	(0.013)	(0.015)
Past levels of HH income													
Income in year t-1		-0.013	-0.01	0	-0.011	-0.004	-0.001	0.014	-0.006	-0.009	0.031	0	0
		(0.011)	(0.013)	(0.014)	(0.013)	(0.016)	(0.014)	(0.018)	(0.034)	(0.013)	(0.043)	(0.014)	(0.014)
Income in year t-2		-0.015	-0.015	-0.011	-0.008	-0.024	-0.004	-0.019	0	-0.017	0.015	-0.015	-0.004
		(0.012)	(0.012)	(0.012)	(0.013)	(0.016)	(0.013)	(0.016)	(0.035)	(0.012)	(0.041)	(0.013)	(0.013)
Income in year t-3		-0.021	-0.016	-0.015									
		(0.010)**	(0.012)	(0.012)									
Anderson & Hsiao Instrument	-	-	-	-	2nd Lag	Diff	2nd Lag	Diff	3rd Lag	Exogenous	3rd Lag	Exogenous	-
+ Lagged Controls	No	No	No	Yes	No	No	Yes	Yes	No	No	Yes	Yes	Yes
R-squared	0.000	0.024	0.037	0.042	.	.	.	.	.	0.213	.	0.212	.
Observations	117603	56577	46903	46773	37002	25670	36919	25602	25670	36924	25602	36850	25722
Individuals	24811	15707	15349	15317	14852	14229	14828	14207	14229	14842	14207	14819	12551

Notes: Fixed effects, time effects and Individual time-varying controls included in all estimations (+ 1 lag when specified). HH income is ln(household annual income). Columns (1) to (4) contain OLS estimates, Columns (5) to (13) were estimated using Anderson & Hsiao, coefficients reported belong to the first difference of variables described. Exogenous instrument used in column (11) & (13) is the number of serious accidents suffered by individual in given year. Column (14) contains Arellano-Bond estimates. Clustered standard errors by individual reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 10%

Table 3.A

Effects of Income and Past Happiness on Current Happiness for BHPS Waves 6-15

Dep. Var.: Happiness	(1)	(2)	(3)	(4)	(5)
Past level of Happiness					
Happiness in t-1	-0.12	0.048	0.019	1.704	-0.551
	(0.008)***	(0.012)***	(0.019)	(0.938)*	(0.254)**
Current level of HH income					
Income in year t	0.045	0.012	0.021	0.012	0.019
	(0.014)***	(0.015)	(0.018)	(0.043)	(0.013)
Past levels of HH income					
Income in year t-1	0.003	0	0.015	0.032	0.001
	(0.014)	(0.014)	(0.018)	(0.043)	(0.014)
Income in year t-2	-0.008	-0.005	-0.019	0.015	-0.015
	(0.012)	(0.013)	(0.016)	(0.041)	(0.013)
Income in year t-3	-0.012				
	(0.012)				
Relative Measures					
Relative Happiness in t	0.461	0.541	0.532	0.898	0.43
	(0.157)***	(0.175)***	(0.194)***	(0.507)*	(0.146)***
Relative Income in t	-0.452	-0.017	-0.042	0.398	-0.26
	(0.195)**	(0.305)	(0.335)	(0.782)	(0.280)
Anderson & Hsiao Instrument	-	2nd Lag	Diff	3rd Lag	Exogenous
R-squared	0.043	.	-	-	0.211
Observations	46773	36919	25602	25602	36850
Individuals	15317	14828	14207	14207	14819

Notes: Fixed effects, time effects and Individual time-varying controls (+ lags) included in all estimations. HH income is ln(household annual income). Column (1) contains OLS estimates, Columns (2) through (5) were estimated using Anderson & Hsiao, coefficients reported belong to the first difference of variables described. Exogenous instrument used in column (5) is the number of serious accidents suffered by individual in given year. Reference group for relative measures given by age cohort. Clustered standard errors by individual reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 10%

TABLE 4.A

Estimation Effects of Observables on Current Happiness for BHPS Waves 6-15					
	OLS	Anderson and Hsiao		OLS	
Dep. Var.: Happiness	(1)	(2)	(3)	(4)	(5)
HH Size	-0.04	-0.023	-0.025	-0.019	-
	(0.014)***	(0.015)	(0.013)*	(0.009)**	
No. Kids	0.063	0.039	0.061	0.015	-0.023
	(0.021)***	(0.023)*	(0.022)***	(0.015)	(0.010)**
No. Kids in t-1	-0.06	-0.044	-0.011	-	-
	(0.021)***	(0.024)*	(0.025)		
Married	0.249	0.129	0.153	0.05	0.186
	(0.055)***	(0.056)**	(0.050)***	(0.042)	(0.030)***
Married in t-1	-0.171	-0.074	-0.018	-	-
	(0.050)***	(0.052)	(0.055)		
Widowed	-0.219	-0.164	-0.241	-0.172	-0.257
	(0.124)*	(0.122)	(0.124)*	(0.066)**	(0.133)*
Widowed in t-1	0.04	0.112	0.09	-	
	(0.119)	(0.122)	(0.112)		
Unemployed	-0.262	-0.225	-0.284	-0.345	-0.765
	(0.049)***	(0.047)***	(0.048)***	(0.031)***	(0.048)***
Unemployed in t-1	0.018	0.048	-0.11		-0.78
	(0.047)	(0.043)	(0.077)		(0.080)***
Maternity Leave	0.219	0.156	0.14	-	-
	(0.071)***	(0.077)**	(0.063)**		
Maternity Leave in t-1	0.1	0.067	0.143	-	-
	(0.068)	(0.072)	(0.074)*		
Days in Hospital	-0.005	-0.003	-0.004	-0.006	-
	(0.001)***	(0.001)**	(0.001)***	(0.001)***	
Days in Hospital in t-1	-0.004	-0.001	-0.003	-	-
	(0.001)***	(0.001)	(0.002)**		
Anderson & Hsiao Instrument	-	2nd Lag	Exogenous	-	-
Household Panel	BHPS	BHPS	BHPS	BHPS	GSOEP
R-squared	0.04289	-	0.2107	0.0199	-
Observations	46773	36919	36850	59,709	61570
Individuals	15317	14828	14819	21517	7160

Notes: Fixed effects, time effects, individual time-varying controls (+ lags), past happiness and relative measures for columns (1) - (3). Column (1) contains OLS estimates. Column (2) - (3) were estimated using Anderson & Hsiao, coefficients reported belong to the first difference of variables described. Exogenous instrument used in column (3) is the number of serious accidents suffered by individual in given year. Clustered standard errors by individual reported in parentheses for columns (1) - (3). Column (4) reports coefficients obtained in Table 6(I) by Oswald and Powdthavee, 2006. Column (5) reports coefficients obtained in Table 3(I) by Clark *et al.* , 2007. * significant at 10%; ** significant at 5%; *** significant at 10%

Appendix A

Estimating elasticity to household size using the method proposed by Schwarze (2003) will yield needed results. The BHPS contains a question regarding satisfaction with income. This variable is scaled from 1 to 7 (with the lowest number meaning least satisfied and the highest: most satisfied). The model proposed takes the form of:[15]

$$S_{it} = \alpha X_{it} + \beta \ln\left(Y_{it}^{e}\right) + \varphi_t + \mu_{it}$$

Where S_{it} is the individual's satisfaction with income, X_{it} is a vector of control variables (age, employment state, education and a constant), φ_t are year effects and μ_{it} corresponds to error component. Finally, Y_{it}^{e} is the scaled income where

$$Y_{it}^{e} = \frac{Y_{it}}{H_{it}^{\theta_0 + \sum_k \theta_k h_{it}^k}}$$

Household size, H_{it}, is corrected by equivalence scale elasticity made up of θ_0, a constant, and a linear combination between number of: kids, teenagers, employed and retired individuals in household (h_{it}^k). This is used to scale Y_{it}, annual total household income. After some rearranging it is possible to obtain the following expression:

$$S_{it} = \alpha X_{it} + \lambda_0 \ln\left(Y_{it}\right) + \lambda_1 \ln(H_{it}) + \sum_k \lambda^k h_{it}^k \ln(H_{it}) + \varphi_t + \mu_{it}$$

Where $\lambda_1 = -\lambda_0 \theta_0$ and $\lambda_k = -\lambda_0 \theta_k$.[16] Rearranging these expressions we can obtain the elasticity to household size by solving $\theta_0 = -\lambda_1 / \lambda_0$ and $\theta_k = -\lambda_k / \lambda_0$ for each *k*. Estimation results for both BHPS and GSOEP are presented in Table 5.A. Household income is statistically significant and has a positive coefficient, just as one would expect. Household elasticity is decreasing in number of kids and teenagers, and increasing in number at employment and retiring age (although not statistically significant).

The elasticities obtained from estimations are comparably lower than those suggested by OECD[17] and are closer to those obtained by Schwarze (2007). The estimated household size

[15] Using notation from Pérez Truglia (2007)

[16] $\lambda_0 = \beta$ from original expression

[17] The OECD assigns weights of 1.0 for the first adult, then 0.5 for every additional one and 0.3 for additional children.

elasticity has a constant, θ_0, equal to 0.27 (compared to 0.27 obtained by Schwarze, 2003). Consider the following examples: a household composed of 2 working adults and 2 kids have an elasticity of 0.25, compared to 0.34 in Schwarze (2003) and much lower than 0.53 suggested by the OECD; a household with 4 working adults are assigned an elasticity of 0.41, contrasted to 0.66 proposed by OECD and 0.42 in Schwarze (2003).

Table 5.A

Elasticity to Household Size for BHPS, waves 6-15

Dependant Variable:	Satisfaction With Household Income
	(1)
ln(HH income)	0.262
	[0.012]***
ln(HH size)	-0.072
	[0.039]*
ln(HH size)*Number of kids age 11 and under	0.012
	[0.008]
ln(HH size)*Number of teens age 12 to 18	0.024
	[0.008]***
ln(HH size)*Number at employment age	-0.009
	[0.007]
ln(HH size)*Number at retirement age	-0.015
	[0.020]

Notes: Fixed effects, time effects and Individual time-varying controls included in estimation (see Data Appendix for complete list of controls used). Clustered standard errors reported in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Data Definitions

Happiness / Satisfaction with Life: Individual response to question: "How satisfied or dissatisfied are you with your life overall?" [1 Not satisfied at all] - [7 Fully satisfied]

Satisfaction with Household Income: Individual response to question: " How satisfied or dissatisfied are you with the income of your household?" [1 Not satisfied at all] - [7 Fully satisfied]

Relative Happiness: mean value of happiness for individuals belonging to reference group of individual. Reference group may be defined by age cohort.

Income: Household Gross Income deflated to prices of 2005 using information on CPI from UK statistics. Including all income perceived by household: labor, transfers, welfare, etc.

Relative Income: mean value of income for individuals belonging to reference group of individual. Reference group may be defined by age cohort.

Equivalence corrected Income: elasticity to household size correction for income, using equivalence scale elasticity obtained by regressing variables against satisfaction with household income.

No. of Serious Accidents: number of accidents which require medical treatment by a doctor or a hospital visit.

Control Variables:

Household Composition variables: includes number of children, employed, retired individuals in household.

Household Size: number of people in household.

Employment state: set of dummies for different employment states derived from the following question: "Which best describes your current situation?" [1 Self Employed], [2 Paid Employment], [3 Unemployed], [4 Retired], [5 Maternity Leave], [6 Looking After Family], [7 Attending Classes], [8 Sick or Disabled] and [9 Government Training]. Plus dummy for having a second job.

Age: age in months derived from date of interview and individual responses to the question about the birth dates.

Marital State: set of dummies (Married, Separated, Divorced, Widowed and Never Married) obtained from question: "What is your legal marital status? [1 Married], [2 Separated, [3 Divorced], [4 Widowed] and [5 Never married]

Education: set of dummy variables derived from individual responses to the question: "Which is the highest qualification he/she has got? [1 Training Certificate], [2 Trade Apprenticeship], …, [11 University Diploma], …, [13 University Higher Degree]".

Health State: a set of dummies on diverse health problems obtained from question: "Have any of the health problems listed on this card? (i.e. difficulty seeing, diabetes, breathing problems, etc.)"

Smokes: a dummy variable derived from the individual responses to the question: "Do you smoke cigarettes? [1 Yes] [2 No]".

No of Cigarettes: derived from question: "How many cigarettes did you smoke in the last 7 days?"

Days in Hospital: number of days respondent spent in hospital derived from question: "Since (date), in all, how many days have you spent in a hospital or clinic as an in –patient?"

References

[1] Anderson, T. W. and Hsiao, C. (1981) "Estimation of Dynamic Models With Error Components". *Journal of the American Statistical Association*, Vol. 76, Number 375, pp. 598-606

[2] Arellano, M (1989) "A note on the Anderson-Hsiao estimator for panel data" *Economics Letters*, Vol. 31, No. 4, pp. 337-341

[3] Arellano, M (2003) "Panel Data Econometrics: Advanced texts in econometrics" – Oxford University Press

[4] Arellano, M. and Bond, S. (1991) "Some Test of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations". *The Review of Economic Studies*, Vol. 58, No. 2, pp. 277-297

[5] Arellano, M. and Bover, O. (1995) "Another look at the instrumental variable estimation of error-component models". *Journal of Econometrics*, Vol. 68, pp. 29-51

[6] Becchetti, L. and Castriota, S. (2007) "Does Money Affect Happiness and Self-esteem? The poor borrowers' perspective in a natural experiment". *Tor Vergata University, CEIS Departmental Working Paper*, No. 259

[7] Bond, S. R. (2002) "Dynamic panel data models: a guide to microdata methods and practice". *CeMMAP working papers CWP09/02, Centre for Microdata Methods and Practice, Institute for Fiscal Studies.*

[8] Brickman P. and Campbell, D. T. (1971) "Hedonic Relativism and Planning the Good Society" *Adaptation level theory: A symposium*. *Academic Press*

[9] Brosnan, S. F. and De Waal, F. B. (2003) "Monkeys Reject Unequal Pay". *Nature*, Vol. 425, pp. 297-299

[10] Brosnan, S. F., Schiff, H. C. and De Waal, F. B. M. (2005) "Tolerance for inequality may increase with social closeness in chimpanzees". *Proceedings - Royal Society of London. Biological sciences*, Vol. 272, No. 1560, pp. 253-258

[11] Buss, D. M. and Haselton, M. (2005) "The evolution of jealousy" *Trends in Cognitive Science*, Vol. 9, No. 11, pp. 506-507

[12] Camerer, C, Lowenstein, G. and Prelec, D. (2005) "Neuroeconomics: How Neuroscience Can Inform Economics". *Journal of Economic Literature*, Vol. 43, pp. 9-64

[13] Charness, G. and Grosskopf, B. (2001) "Relative Payoffs and Happiness: An Experimental Study". *Journal of Economic Behavior & Organization*, Vol. 45, No. 3, pp. 301-328

[14] Clark, A. E., Diener, E., Georgellis, Y. and Lucas, R. (2007) "Lags and Leads in Life Satisfaction: A Test of the Baseline Hypothesis" *Centre for Economic Performance* Discussion Paper No. 836

[15] Dalgleish, T. (2004) "The Emotional Brain". *Nature Reviews Neuroscience 5*, pp. 582-589

[16] D'Ambrosio, C. and Frick, J. R. (2007) "Individual Well-Being in a Dynamic Perspective". *IZA Discussion Paper* No. 2618

[17] Di Tella, R., Haisken-De New, J. and MacCulloch, R. (2007a) "Happiness Adaptation to Income and to Status in an Individual Panel". *NBER Working Paper No.* W13159

[18] Easterlin, R. A. and Zimmermann (2008) "Life Satisfaction and Economic Conditions in East and West Germany Pre- and Post-Unification". *SOEPpapers on Multidisciplinary Panel Data Research.*

[19] Esch, T. and Stefano, G. B. (2005) "The Neurobiology of Love". *Neuroendocrinology Letters*, Vol. 26, No. 3, pp. 175-192

[20] Ferrer-i-Carbonell, A. and Frijters, P. (2004) "How Important is Methodology for the Estimates of the Determinants of Happiness?" *The Economic Journal*, Vol. 114, No. 497, pp. 641-659

[21] Ferrer-i-Carbonell, A. (2005) "Income and Wellbeing: an empirical analysis of the comparison income effect" *Journal of Public Economics*, Vol. 89, No. 5-6, pp. 997-1019

[22] Hernandez, L. and Hoebel, B. G. (1988) "Food reward and cocaine increase extracellular dopamine in the nucleus accumbens as measured by microdialysis". *Life Sciences*, Vol. 42, No. 18, pp. 1705-1712

[23] Hsiao, C. (2003) "Analysis of Panel Data" *Cambridge University Press.*

[24] Judson, R. A. and Owen, A. L. (1996) "Estimating Dynamic Panel Data Models: A

Practical Guide for Macroeconomists". *Federal Reserve Board of Governors*.

[25] Kiviet, J. F. (1995) "On bias, inconsistency, and efficiency of various estimators in dynamic panel data models". *Journal of Econometrics*, Vol. 68, pp. 53-78

[26] Knies, G., Burgess, S. and Propper, C. (2007) "Keeping up with the Schmidts: An empirical test of relative depravation theory In the neighborhood context". *SOEPpapers on Multidisciplinary Panel Data Research*.

[27] Larsen, R. J. (2000) "Toward a Science of Mood Regulation". *Psychological Inquiry*, Vol.11, No. 3, pp. 129-141

[28] Lucas, R. E., Clark, A. E., Georgellis, Y. and Diener, E. (2003) "Reexamining adaptation and the set point model of happiness: Reactions to changes in martial status" *Journal of Personality and Social Psychology*, Vol. 84, No. 3, pp. 527-539

[29] Lykken, D. and Tellegen, A. (1996) "Happiness is a Stochastic Phenomenon". *American Psychological Society*, Vol. 7, No. 3, pp.186-189

[30] Lyubomirsky, S., King, L. and Diener, E. (2005) "The Benefits of Frequent Positive Affect: Does Happiness Lead to Success?". *Psychological Bulletin*, Vol. 131, No. 6, pp. 803-855

[31] McBride, M. (2001) "Relative-income effects on subjective well-being in the cross section". *Journal of Economic Behavior & Organization*, Vol. 45, pp. 251-278

[32] McBride, M. (2007) "Money, Happiness, and Aspirations: An Experimental Study". *Working Paper* 060721

[33] Nesse, R. M. and Berridge, K. C. (1997) "Psychoactive drug use in evolutionary perspective" *Science*, Vol. 278, No. 5335, pp. 63-66

[34] Nesse, R. M. (2004) "Natural selection and the elusiveness of happiness" *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences*, Vol. 359, no. 1449, pp. 1333-1347

[35] Olds, J. and Milner, P. (1954) "Positive reinforcement produced by electrical stimulation of septal area and other regions of rat brain" *Journal of comparative and physiological psychology*, Vol. 47, No. 6, pp. 419-27

[36] Oswald, A. J. and Powdthavee, N. (2006) "Does Happiness Adapt? A Longitudinal Study of disability with Implications for Economists and Judges". *IZA Discussion Paper* No. 2208

[37] Pavot, W., Diener, E., Colvin, C. R. and Sandvik, E. (1991) "Further Validation of the Satisfaction With Life Scale: Evidence for the Cross-Method Convergence of Well-Being Measures". *Journal of Personality Assessment*, Vol. 57, No. 1, pp. 149-161

[38] Perez Truglia, R. N. (2007) "Can a Rise in Income Inequality Improve Welfare?" Available at SSRN: http://ssrn.com/abstract=1078523

[39] Powdthavee, N. (2005) "Identifying Causal Effects with Panel Data: The Case of Friendship and Happiness". *Unpublished Paper, University of Warrick.*

[40] Rayo, L. and Becker, G. (2005) "Evolutionary Efficiency and Happiness". *Journal of Political Economy*, Vol. 115, No. 2

[41] Saah, T. (2005) "The evolutionary origins and significance of drug addiction". *Harm Reduction Journal*, Vol. 2 : 8

[42] Sanfey, A. G., Loewenstein, G., McClure, S. M. and Cohen, J. D. (2006) "Neuroeconomics: cross-currents in research on decision-making". *TRENDS in Cognitive Sciences*, Vol. 10, No. 3, pp. 109-116

[43] Schwarze, J. (2003) "Using Panel Data on Income Satisfaction to Estimate Equivalence Scale Elasticity". *Review of Income and Wealth*, Vol. 49, No. 3, pp. 359-372

[44] Sprott, J. C. (2005) "Dynamical Models of Happiness". *Nonlinear Dynamics, Psychology, and Life Sciences*, Vol. 9, No.1, pp. 23-36

[45] Stuphorn, V. (2006) "Neuroeconomics: Cardinal Utility in the Orbitofrontal Cortex?" *Current Biology*, Vol. 16, No. 15, pp. R591-R593

[46] Stutzer, A. and Frey, B. S. (2006) "Does Marriage Make People Happy, or do Happy People Get Married?". *Journal of Socio-Economics*, Vol.35, No. 2, pp. 326-347

[47] Taylor, Marcia Freed (ed). with John Brice, Nick Buck and Elaine Prentice-Lane (2006) *British Household Panel Survey User Manual Volume A: Introduction, Technical Report and Appendices.* Colchester: University of Essex.

[48] Uhrig, S. C. N. (2008) "The Nature and Causes of Attrition in the British Household Panel Survey". *Institute for Social and Economic Research, University of Essex*.

[49] University of Essex. Institute for Social and Economic Research, *British Household Panel Survey: Waves 1-15, 1991-2006* [computer file]. *3rd Edition*. Colchester, Essex: UK Data Archive [distributor], June 2007. SN: 5151.

[50] Veenhoven, R. (1991) "Is Happiness Relative?". *Social Indicators Research 24*, pp. 1-34

[51] Verbeek, M. (2004) "A Guide to Modern Econometrics" – Wiley; 2nd Edition

[52] Wallen, K. (2001) "Sex and Context: Hormones and Primate Sexual Motivation" *Hormones and Behavior*, Vol. 40, No. 2, pp. 339-357

[53] Wild, B., Erb, M. and Bartels, M. (2001) "Are emotions contagious? Evoked emotions while viewing emotionally expressive faces: quality, quantity, time course and gender differences" *Psychiatry Research*, Vol. 102, No. 2, pp. 109-124

[54] Wild, B., Erb, M, Eyb, B., Bartels, M. and Grodd, W. (2003) "Why are smiles contagious? An fMRI study of the interaction between perception of facial affect and facial movements." *Psychiatry Research*, Vol. 123, No. 1, pp. 17-36

[55] Williams, L. M., Senior, C., David, A. S., and Loughland, C. M. (2001) "In Search of the 'Duchenne Smile': Evidence from eye movements". *Journal of Psychophysiology*, Vol. 15

[56] Zimmermann, A. C. and Easterlin, R. A. (2006) "Happily Ever After? Cohabitation, Marriage, Divorce, and Happiness in Germany". *Population and Development Review*, Vol. 32, No. 3, pp. 511-528