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ASKING ABOUT CHANGES IN HAPPINESS IN A DAILY WEB SURVEY

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Abstract

This paper investigates whether the level of happiness and integrated process of changes in happiness are the same. Using the daily data of two waves of four and six months each, we found that the level of happiness is stationary, whereas the integrated process of changes is non-stationary with a rising trend, implying that they are different series. An examination of the causes of the difference indicated that although adaptation completely influences the level of happiness, it only partially influences the change in happiness. This may be because the latter is based on a comparison between today and yesterday,.

JEL Classification Numbers: I31

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1. Introduction

In recent years, the economics of happiness, which is defined as the research area that uses data on subjective happiness, has experienced significant development (Frey and Stutzer, 2002a, b; Bruni and Porta, 2005; Dolan et al., 2008). However, no agreement has been reached regarding whether subjective happiness is actually comparable between people. Moreover, we do not completely understand how subjective happiness relates to utility.[1] Thus, the economics of happiness is still at the stage where the validity of analyses that use subjective happiness is still being examined and the relationship between subjective happiness and utility is still being investigated.

The Easterlin paradox that average happiness in a country is stable at a constant level for a long period, while the country's GDP grows substantially is an interesting phenomenon from the perspective of considering the validity of the use of happiness data (Easterlin, 1974; Clark et al., 2008).[2] This paradox suggests that economic growth is meaningless if greater happiness is the goal (Frank, 2005). This conclusion radically contradicts ordinary intuition and common sense. In comparison, higher income is expected to result in higher utility because utility is defined on the basis of a comparison between two states; no one would choose a life with lower

[1] Kimball and Willis (2006) theoretically examined the relationship between them.

[2] Stevenson and Wolfers (2008) questioned the existence of the paradox in Japan and the EU.

income, other things being equal. Utility differs from subjective happiness in this regard.

This paper proposes a new type of question for tracking subjective happiness.[3] Instead of asking about the level of happiness, which is the approach that was adopted by most of the previous surveys, we ask about the change in the level of happiness from the previous day using a daily web survey. Integrating the changes in happiness and adding the level of happiness of the first date, we reconstruct the level of happiness. The calculated level of happiness ought to coincide with the data of the level of happiness obtained directly using the web survey. If they do in fact coincide, asking regarding the change in happiness is pointless. However, the two series might be completely different, because in order to answer the question on changes in happiness, respondents need to compare today's state with yesterday's state. The answer to the question on changes in happiness and utility bear similar aspects in that both are based on a comparison.

If we find that the level of happiness and the integrated process of changes in happiness differ, then we will investigate the cause of the divergence. Our speculation is as follows: one of the causes of the Easterlin paradox is that people soon adapt to a new level of happiness. This implies that people becomes happier with an increase in income in the short-run; however, in

[3]Regarding developments in the measurement of subjective happiness, refer to Kahneman and Kruger (2006).

the long-run, a part of the increase in happiness is cancelled by adaptation (Easterlin, 2005; Di Tella et al., 2007; Clark et al., 2008).[4] Nevertheless, a change in happiness, like a change in utility, may not be significantly affected by adaptation because it is based on a comparison between today's state and yesterday's state. Under this supposition, this paper examines how the level of happiness and a change in happiness are affected by adaptation. If it is found that adaptation affects the level of happiness more than change in happiness, the integrated process of the change in subjective happiness may be a closer variable to utility than the level of happiness.

The remainder of the paper is organized as follows. Section 2 explains our daily survey, which includes questions on the level of happiness and on the daily change in happiness. Section 3 analyzes whether the integrated process of the changes in happiness differs from the level of happiness. Given the result that the series differ, Section 4 investigates three possible reasons for the difference. Section 5 discusses the implications of the obtained results to the Easterlin paradox and concludes the paper.

2. The daily survey

[4] Another cause of the Easterlin paradox is that people evaluate their happiness in comparison with others' situations. This is called the relative income hypothesis (Duesenberry, 1949; Clark and Oswald, 1996; Clark et al., 2008); however, this paper does not focus on this hypothesis.

Two waves

We solicited undergraduate and graduate students at Osaka University and requested them to report their happiness every day for several months.[5] They responded using their personal computers and mobile phones.[6] To the best of our knowledge, administering a daily survey like this for a long period of time is unique to this study. The survey enables us to estimate a happiness function with panel data, which has the merit of excluding the difference in happiness between people with a fixed (or random) effect model. In other words, it enables us to estimate a within-subjects happiness function, which is immune to a direct comparison of subjective happiness between people.

Our daily survey consisted of two waves. The first (2008-survey) was from December 1, 2007 to March 31, 2008, and the number of respondents decreased slightly during this period from 68 to 64.[7] The second wave (2009-survey) was from January 1 to June 30, 2009. During this period, the number of respondents decreased from 52 to 41.[8]

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[5]We also asked questions including valuations of personal and macro news (how good or bad they were) arriving on that day, as explained below.

[6]Most younger residents of Japan carry mobile phones that have the capability of connecting to the Internet and sending emails.

[7] The first wave started in November 1, 2006. However, the survey did not include a question on changes in happiness until December 2007.

[8] The second phase was initially planned to conclude at the end of March; however, it was extended

Questions and definition of variables

In the survey, we asked 13 questions; here, we explain those questions that were used in the analysis in the current paper.[9]

Q1. How happy are you now?

Choose a number between 0 and 10. 0 is “very unhappy,” 10 is “very happy.”

10 9 8 7 6 5 4 3 2 1 0

LEVEL is defined as the answer, which represents the level of happiness on a scale from 0 to 10.

Q5. Recall the most important personal news or event that occurred since you answered this questionnaire yesterday. How did you evaluate the news?

Choose a number between -5 and 5. 5 is “very good,” -5 is “very bad.”

−5 −4 −3 −2 −1 0 1 2 3 4 5

P_NEWS is defined as the answer, which represents the rating of the importance of the personal news that the respondent received that day.

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until the end of June. This is the reason why the number of respondents decreased substantially. In fact, the number of respondents decreased from 47 in March to 41 in April.

[9] Questions 2, 3, 4, 6, and 8 are not used in this paper; therefore, we have omitted their explanation.

Q7. Recall the most important news that was in the newspaper or on TV since you answered this questionnaire yesterday. How did you evaluate the news?

Choose a number between -5 and 5. 5 is “very good,” -5 is “very bad.”

−5 −4 −3 −2 −1 0 1 2 3 4 5

M_NEWS is defined as the answer, which represents the rating of the macro news that appeared on TV and/or in newspapers that day.

Q9. Did you sleep well last night?

1. poor sleep, 2. slightly poor sleep, 3. slept well, 4. slept very well

SLEEP is defined as the answer, which represents the quality of sleep. A larger number means better sleep.

Q10. How is your health now?

1. good, 2. generally good, 3. generally not good, 4. bad

HEALTH is defined as four minus the answer to Q10, which represents the quality of health. A larger number means better health.

Q11. Do you feel any anxiety and stress now?

1. a lot, 2. a little, 3. not much, 4. none

NOANXIETY is defined as the answer, which represents the level of anxiety and stress. A larger number means less stress.

Q12: Have you already attended a class today or are you going to attend a class today?

1. I have attended a class, 2. I will be attending a class, 3. I am attending a class now, 4. No class today

We define *NOCLASS* as 1 if the respondent has no class today, and 0 otherwise

Q13: Your happiness today compared with your happiness yesterday (before) is

1. much happier, 2. reasonably happier, 3. slightly happier, 4. same as yesterday (before), 5. slightly unhappier, 6. reasonably unhappier, 7. much unhappier

We define *CHANGE* as four minus the answer to Q13, which represents change in happiness from yesterday (or the time when they answered the last survey) and ranges from -3 (much unhappier) to 3 (much happier).

We present descriptive statistics of these variables for both waves in Table 1. In 2008-survey, the mean of *LEVEL* is 5.8, which is relatively lower than the level of happiness, 6.4, reported in “Kokumin Seikatsu Senkodo Chosa” (Survey on preferences in life of nations;

webpage of the Cabinet Office). The mean of *CHANGE* is positive, implying that the respondents were becoming happier during the observed period. The mean of *P_NEWS* is slightly positive, implying that overall, they received good news, which is consistent with the fact that the mean of *CHANGE* is positive. In contrast, *M_NEWS* is slightly negative, which implies that overall, the macro news was bad. *SLEEP* and *HEALTH* are larger than 2.5, that is, the average on the scale of 1 to 4, suggesting that overall, respondents were in good health and slept well. However, the mean of *NOANXIETY* is smaller than the average on the scale of 1 to 4, suggesting that the average respondent was bothered by stress and anxiety. The mean of *NOCLASS* is 0.68.[10]

The values of the variables of 2009-survey are not radically different from those of 2008-survey. However, the values of *LEVEL, CHANGE*, and *P_NEWS* in the 2009-survey were larger than those of the corresponding variables in the 2008-survey, thereby suggesting that the respondents of 2009-survey were happier than those of 2008-survey.

[10]Since Osaka University has 26 school days from January 1 to March 31 (there is a spring vacation in February and March), this number implies that respondents attended most of the school days and responded to the questionnaire. In 2009-survey, the mean of *NOCLASS* is 0.58, implying that they attended classes for approximately 76 days out of the 81 school days from January to June. However, “Class” in the question includes experiments at laboratories in natural science and technology departments, which are conducted on days when school is not in session. Therefore, the above assessment is crude.

Rewards

Respondents were requested to connect to the webpage and to answer the questions every day. They were paid 160 yen per answer for the daily survey. Those who responded to the daily survey for over 22 days and those who answered the hourly survey more than once a month were paid 1,300 yen as a bonus for the month, and those who responded to the daily survey for over 27 days and answered the hourly survey received 2,600 yen as a monthly bonus.[11]

Response rate

Figure 1 shows the response rate of the daily survey for each month. In both 2008- and 2009-surveys, the response rate is approximately 90%.

3. Comparison between the level of happiness and the integrated process of the change in happiness

[11] In the web survey, respondents were also requested to report their hourly happiness on one day of their choice each month. We call this the hourly survey. The hourly survey essentially follows an experience sampling method (Csikszentmihalyi and Hunter, 2003; Scollon et al., 2003), which is better than Kahneman et al.'s (2004 a, b) day reconstruction method, wherein respondents answer questions in real time, so that the responses are immune to memory biases. We do not explain the hourly survey in detail because we do not use the results in the current paper.

3.1 Comparison of the averaged data

In this section, we check if the two series of happiness, *LEVEL* (Q1; level of happiness) and *CHANGE* (Q13; change in happiness) are consistent with each other. To this aim, we define the following two variables associated with *LEVEL* and *CHANGE*.

DIFFERENCE: the difference in *LEVEL* from the day before

INTEG: the sum of the *LEVEL* on the first day and *CHANGE* of the consecutive days until the current day

Table 1 presents the descriptive statistics of *INTEG* and *DIFFERENCE*. *INTEG* widely ranged from -151 to 347 in the 2008-survey and from -167 to 476 in the 2009-survey. *DIFFERENCE* was very small in both the surveys and was not statistically different from zero.

Aside from the scaling of *CHANGE* in its definition, by mathematical definition, *DIFFERENCE* and *CHANGE* (and therefore, *LEVEL* and *INTEG*) should follow the same series. In order to check if they are in fact the same, we calculate the average of these four variables over respondents for each day. Specifically, we calculate *INTEG* by calculating the integrated process of each respondent, and then averaging them.[12] In Figure 2, the averages of *LEVEL* and

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[12] Alternatively, we can first average *CHANGE* over respondents each day and then construct an integrated process of these averages. *INTEG* constructed in this way is smoother than that in Figure 2, and it does not show an increase in volatility. This is because averaging *CHANGE* over respondents makes the variance much smaller (i.e., the variance is denominated by the number of

INTEG are presented for the two waves. It is apparent that although *LEVEL* is stabilized at a constant level in both phases, *INTEG* grows throughout the periods.[13] *INTEG* also shows growing volatility throughout the periods.[14] Thus, the figure reveals that the two series are completely different.

In Figure 3, we show *CHANGE* and *DIFFERENCE*. The figure reveals that although *DIFFERENCE* is positive and negative with similar probability, *CHANGE* is more frequently positive than negative. In fact, the hypothesis of the same mean for *CHANGE* and *DIFFERENCE* is rejected at the 1% level in both the waves. Although the mean of *CHANGE* is significantly positive, that of *DIFFERENCE* is not significantly different from zero (see Table 1).

3.2 Panel unit root tests

Figure 2 gives us the impression that *LEVEL* is a stationary series, whereas *INTEG* is non-stationary. If this is the case, the two series are certainly different. In order to check this, we

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respondents). However, it increases with time as in Figure 2, so that the essential conclusions are unaltered. See footnote 14.

[13] Comparing *INTEG* of the two phases, we found that the one in 2009-survey grows more rapidly: in the 2008-survey, it reaches 20 in four months, whereas in 2009-survey it reaches 40 in six months.

[14] This is because the disturbance term of the integrated process of an individual increases in proportion with time; therefore, its variance increases in the quadratic function of time.

conduct panel unit root tests for the four series *LEVEL*, *INTEG*, *CHANGE*, and *DIFFERENCE* for the two waves.

Specifically, we employ pooled tests based on Fisher's type statistic, as defined in Choi (2001). Choi's (2001) test combines *p*-values from a unit root test applied to each individual under the null hypothesis that all cross section units have a unit root, against the alternative that some of the panel units are stationary. Choi's (2001) test statistic, termed P_N statistic in this paper, is as follows:

$$P_{\mathrm{N}} = \frac{1}{2\sqrt{\mathrm{N}}}\sum_{i=1}^{N}(-2\ln p_{\mathrm{i}} - 2) \rightarrow N(0, 1), \quad \text{as } T \rightarrow \infty,\ N \rightarrow \infty, \qquad (1)$$

where p_i is the *p*-value associated with the unit root test statistic for individual *i*. We use two types of unit root tests: the Augmented Dickey-Fuller (ADF) test where the null hypothesis is a unit root (Dickey and Fuller, 1979) and the Kwiatkowsk-Phillips-Schmidt-Shin (KPSS) test where the null hypothesis is stationarity (Kwiatkowski et al., 1992). Because the power of the tests of the unit root null is low in small samples, testing the stationarity null is indispensable. We examine two specifications: "with constant" and "with constant and time trend (*TREND*)."

Table 2 presents the test results.[15] The upper panel shows the results of 2008-survey. In the two specifications, with or without *TREND*, the results are almost identical. As for *LEVEL*,

[15] The number of lags of the lagged difference terms of the ADF test is selected according to Akaike information criterion (AIC) for each regression. The number of lags truncation in the KPSS tests is set at 12.

DIFFERENCE, and *CHANGE*, the ADF test rejects the null of non-stationarity, and the KPSS test accepts the null of stationarity, suggesting that these series follow a stationary process. On the other hand, as for *INTEG*, the ADF test accepts the null of non-stationarity, and the KPSS test rejects the null of stationarity, suggesting that the series is non-stationary. The same results are obtained for the 2009-survey, and they are shown in the lower panel. Thus, the results unequivocally indicate that *INTEG* is non-stationary, whereas the other variables are stationary, implying that *LEVEL* and *INTEG* cannot be the same series.

As for *CHANGE* and *DIFFERENCE*, although both series are stationary, the mean of *CHANGE* is significantly positive, whereas that of *DIFFERENCE* is not significantly different from zero. In addition, their correlation coefficient is only 0.456 in 2008 and 0.417 in 2009. These results suggest that they are not the same series, even if they have some relationship.

In summary, the results of the unit root tests indicate that *LEVEL* and *INTEG* cannot be the same series. This also applies to *CHANGE* and *DIFFERENCE*.

4. Why are the two series different?

Mathematically, the results of the integrated process of *CHANGE* must be identical to the level itself. Thus, we need to question why the two series differ. We suggest and examine three possible reasons for this.

4.1 Loss aversion

Asking a question regarding the change in happiness forces respondents to measure their happiness using the level of yesterday's happiness as the reference point. Thus, loss aversion, by which a loss is evaluated as having twice the weight of a gain, may somehow affect the results (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992).

However, since *CHANGE* and *LEVEL* themselves are the evaluation of good and bad states, loss aversion would not explain the gap between *CHANGE* and *DIFFERENCE* or between *LEVEL* and *INTEG*.

The result that *CHANGE* tends to be positive simply implies that there are more good aspects so as to make *CHANGE* positive even after the evaluation owing to loss aversion.[16] Indeed, since overall, our subjects get good news, maintain good health, and get good sleep (see Table 1), it is not surprising that they tend to become happier.

4.2 Asking about happiness within a certain range

The second possibility arises from the style of the question that investigates the level of

[16]If good and bad events happen randomly with 50% probability each, and if subjects assign greater weight to bad events, the change in happiness tends to be negative, which contradicts our results.

happiness on a range from 0 (very unhappy) to 10 (very happy). Assume that the level of happiness is linearly increasing with time similarly to *INTEG*. In this case, respondents cannot report their actual level of happiness because the answer is limited by an upper bound of 10. Therefore, they may report their level of happiness by transforming the linear function to a function that is asymptotic to 10 and 0 as the level of original happiness goes to infinity and minus infinity, respectively. An example of such a function is the logistic function:

$$H = L + \frac{U - L}{1 + \exp(-r\widetilde{H})}, \qquad (2)$$

where H is the reported level of happiness, $\widetilde{H}$ is the original level of happiness, U and L are the upper and lower limits, respectively, and r is a parameter determining the slope of the function. By a simple calculation, we can recover $\widetilde{H}$ from H with the inverse function of (2), which is called the logit function:

$$\widetilde{H} = \frac{1}{r}\left(\ln(H - L) - \ln(U - H)\right). \qquad (3)$$

Let us examine whether the recovered series $\widetilde{H}$ using Equation (3) resembles *INTEG*. Specifically, we set U = 10, L = 0, and r = 0.1, and first calculate $\widetilde{H}$ for each respondent using Equation (3) and then average them.[17] The recovered $\widetilde{H}$ using the actual values of H is depicted in Figure 4.[18] As shown in the figure, $\widetilde{H}$ is a kind of enlarged figure of *LEVEL* in

[17]Here, r is chosen arbitrarily.

[18]Alternatively, we can use average H over respondents to calculate $\widetilde{H}$ with Equation (3). The results are similar to the graph in Figure 4; thus, the calculated $\widetilde{H}$ is not increasing and does not

both waves, and does not increase with time as *INTEG* does.[19]

Thus, the supposition that asking about happiness in a certain range is the cause of the gap between *LEVEL* and *INTEG* is invalid. This result is consistent with our intuition, because *LEVEL* in Figure 2 fluctuates around a constant level and does not show an increasing trend. A transformation using Equation (3) simply extends the form; therefore, it cannot be expected that a constant series will be transformed into an increasing function.

However, one may argue that the transformation using Equation (3) is biased because the extension of H is symmetrical around $H = 5$ in spite of the fact that the average of H is approximately 6. Therefore the region below H=6 should be extended more intensively compared with the region above H=6. If this is done, then the result may change. In order to address this concern, we estimate an ordered probit model of H in order to obtain the estimates of the cutoff values of 0 to 10. Then, we calculate the expected value of each class by fitting a standardized normal distribution to the actual frequencies falling in these classes. These estimates represent "standardized latent happiness," which corresponds to $\widetilde{H}$ in Equation (3). The latent happiness thus calculated is depicted in Figure 5.[20] It is apparent from the figure that

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resemble *LEVEL* either.

[19] We also depict the case of U = 7.5, L = 5.5, and r = 0.02. The graph is extended more; however, it does not show an increasing trend.

[20] In the figure, latent happiness is multiplied by 10 because the variation is too small to be observed

these estimates do not show an upward trend. Thus, the conclusion that asking about happiness in a certain range is not the cause of the difference is confirmed.

4.3 Adaptation

The last possibility examined in this paper is that although *LEVEL* (and therefore, *DIFFERENCE*) is affected by adaptation, *CHANGE* (and therefore *INTEG*) is not.

Although our respondents tend to become happier every day because of, for example, the receipt of good personal news, they may adapt themselves to the happier situation brought about by the good news and return to their original level of happiness in a few days. We speculate that *CHANGE* is less affected by adaptation than *DIFFERENCE*. In this subsection, we compare *CHANGE* and *DIFFERENCE*, rather than *INTEG* and *LEVEL*, because we conduct a regression analysis, which requires that the variables be stationary.

In our questionnaire, variables that may affect the respondents' happiness are *P_NEWS*, *M_NEWS*, *SLEEP*, *HEALTH*, *NOANXIETY*, and *NOCLASS*. We regress *CHANGE* and *DIFFERENCE* over these variables and their lagged variables and check whether the lagged variables have opposite effects on happiness to those of the current variables. If the lagged variables have opposite effects to those of the current ones, the effect of the current variables is

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otherwise.

cancelled, at least partially, in the consecutive periods (Clark et al., 2008). For the exposition, assume that happiness, *H*, depends on *P_NEWS* for four periods such that

$$H_t = \text{constant} + \alpha P\_NEWS_t - \sum_{i=1}^{3} \beta_i P\_NEWS_{t-i} + u_t, \qquad \alpha, \beta_i > 0. \quad (4)$$

Then, a one-unit increase in *P_NEWS* raises happiness by α units in the short-run (the current day); however, it raises happiness by only $\alpha - \sum_{i=1}^{3} \beta_i$ units in the long-run (three days later). If our respondents adapt to the news, such a result will be obtained by the regression of Equation (4).

Table 3 presents the results for 2008- and 2009-surveys estimated by random or fixed effect models.[21] Since the two results are essentially similar, we only explain the results for the 2009-survey (lower panel) in order to save space. The results are summarized in the following four points.

First, the coefficients of the current variables show the expected positive signs for most cases. In particular, *P_NEWS*, *HEALTH*, and *NOANXIETY* have large effects on happiness.

Second, regarding the current variables, the magnitudes of the estimates are similar for *CHANGE* and *DIFFERENCE* for all the variables except *SLEEP* and *NOCLASS*.

Third, focusing on the significant estimates, the estimates of the current variables and those of the lagged variables take the opposite signs for *P_NEWS*, *M_NEWS*, *HEALTH*, and

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[21]We selected the model based on the Hausman test.

NOANXIETY. These results imply that the long-run effect of these variables on happiness (*CHANGE* and *DIFFERENCE*) is smaller than their short-run effects, suggesting that the respondents adapt to the level of happiness brought about with these variables.

Fourth, the absolute values of the estimates of the significant lagged variables of *DIFFERENCE* are larger than those of *CHANGE* in all cases, suggesting that adaptation is larger for *DIFFERENCE* than for *CHANGE*.

The fourth fact, which is the most important fact for this paper to determine, is the cause of the difference between *CHANGE* and *DIFFERENCE* (and thus between *LEVEL* and *INTEG*). In order to confirm the difference in the degree of adaptation between *CHANGE* and *DIFFERENCE*, we calculate the short-run effect, long-run effect, and adaptation ratio, which are defined as follows: the short-run effect is the coefficients of the current variables, the long-run effect is the sum of the significant coefficients of the current and lagged variables, and the adaptation ratio is defined as $\left(1-\frac{\text{long−run effect}}{\text{short−run effect}}\right)\times 100$ (%). We do not calculate them if the coefficient of the current variable is insignificant (i.e., if the short-run effect is zero).

Table 4 presents the results. The adaptation ratios are close to 100% for all the variables for the case of *DIFFERENCE* for both waves, implying that none of the variables has any effect on happiness (*DIFFERENCE*, and therefore *LEVEL*) in the long-run. On the other hand, the adaptation ratios for *CHANGE* are approximately 50% for the 2008-survey and approximately

30% for 2009-survey, suggesting that adaptation is not perfect for *CHANGE*.

The results suggest that the reason that the mean of *DIFFERENCE* is not statistically different from zero and *LEVEL* fluctuates around a constant level is that the subjects fully adapt to the situation: although *DIFFERENCE* is significantly and largely affected by the current variables, the effect is cancelled in three days. In contrast, *CHANGE* also adapts to the situation; however, the adaptation is much weaker than that for *DIFFERENCE*. The difference in the magnitude of adaptation is the cause of the divergence between *LEVEL* and *INTEG*.

5. Discussion and conclusions

In this paper, we investigated whether the level of happiness and the integrated process of changes in happiness are the same process. We found that they follow different processes: although the level is stationary, the integration of changes is non-stationary with an apparent rising trend.

Despite the fact that mathematically, the integration of changes is the same as the level, why do these two variables diverge? We examined three possible reasons and found that *DIFFERENCE* is fully affected by adaptation, whereas *CHANGE* is partially affected by adaptation. Thus, in the long-run, the effects of various impacts on *DIFFERENCE* are completely cancelled in the following three days, whereas those on *CHANGE* are only partially cancelled. This is the reason why *INTEG*, which is the integration of *CHANGE*, and *LEVEL*, which is the integration of *DIFFERENCE*, diverge. Overall, the empirical outcomes are robust across the waves.

Our results have an important implication for the Easterlin paradox, which is the phenomenon that subjective happiness, which corresponds to *LEVEL* in this paper, is stable irrespective of whether the standard of living (GDP) improves or deteriorates. The relative income hypothesis and adaptation hypothesis are known to offer effective explanations of the paradox (Clark et al., 2008; Knight and Song, 2006), and they imply that if adaptation does not occur, the Easterlin paradox should, if not completely, partially disappear. Thus, our results suggest that if we ask about the change in happiness, *CHANGE*, and construct its integrated process, *INTEG*, then *INTEG* may not exhibit the Easterlin paradox. This inference is based on our results that adaptation affects *CHANGE* only partially, whereas it completely affects *DIFFERENCE*.

The relationship between subjective happiness and utility is not understood fully.[22] We believe, however, that an important distinction between the two is that decision utility is constructed from comparisons of two ex-ante states, whereas subjective happiness is based on

[22] Many economists think that comparison of subjective happiness among individuals lacks a solid basis, whereas researchers in the field of economics of happiness estimate the happiness function using data on subjective happiness.

the introspection of the current feelings of an individual. Since utility is based on a comparison of ex-ante states, it should be free from adaptation. Thus, utility is expected to increase when the standard of living (GDP) improves.

In fact, in a survey conducted in Japan in 2008, we asked respondents whether they would have preferred to have been born in 1910, 1950, or 1980, and many selected the later period, suggesting that they preferred a higher standard of living when they compared the periods. We also asked Japanese respondents whether they would have preferred to have been born in Italy or Indonesia, and Singapore or Mexico. These two pairs of countries differ significantly with respect to GDP, but according to the World Value Survey, the average subjective happiness of the nations is almost the same. Most respondents chose Italy (84%) and Singapore (68%); both these countries enjoy higher GDPs.

The Easterlin paradox means that economic growth does not lead to an improvement in subjective happiness, which raises a question regarding the role of economic growth. However, our results suggest that *INTEG* (*CHANGE*) may be a closer concept to utility than *LEVEL* (*DIFFERENCE*) in that the former is freer from adaptation. This implies the possibility that the paradox will disappear if we measure subjective happiness by the sum of changes in happiness.

Let us examine the above speculation on the basis of our survey conducted in Japan from fiscal years 2003 to 2009. In the survey, we investigated the level of happiness (Q1) and the change in happiness compared with the level that existed a few years ago. From the former question, we defined *LEVEL* as the average of the answer. In the latter question, respondents were requested to select from the following options: 1. Happier than a few years ago, 2. Same as a few years ago, 3. Unhappier than a few years ago.[23] We defined *CHANGE* as two minus the answer to this question, which takes the value of 1, 0, or -1. We used the average of *CHANGE* over all respondents and calculate *INTEG* as before. Figure 6 presents the values of *LEVEL* and *INTEG* obtained subsequently. Although *LEVEL* is almost constant around 6.4, *INTEG* increases from 6.4 to 7.1, reflecting that *CHANGE* is positive for all the years. Thus, the result is essentially similar to those using the daily data in this paper. In the figure, we also show "consumption of household," as a proxy for the standard of living, which seems to correspond more with *INTEG* than with *LEVEL*.[24] Indeed, its correlation coefficient is -0.22 with *LEVEL* and 0.74 with *INTEG*. These results suggest that the Easterlin paradox is seen between *LEVEL* and "consumption of household," but not between *INTEG* and "consumption of household."[25]

A problem of this analysis is that the data spans only seven years. In order to obtain more

[23] To be precise, "4. Do not know" is included in the options. In 2008 and 2009, the comparison is made with "a year ago" instead of "a few years ago."

[24] Here, "consumption of household" is normalized so that the value of the first year equals 6.38, that is, the value of *LEVEL* in that year.

[25] When we use GDP instead of consumption of household, its coefficient is -0.49 with *LEVEL* and 0.40 with *INTEG*.

reliable results, it is necessary to conduct a longitudinal survey that investigates the changes in happiness and examines if the integrated process of the change in happiness corresponds to the standard of living (GDP). This is an important subject for future research.

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Table1 Descriptive statistics

2008-survey	Mean	Standard Deviation	standard error	95% lower band	95% upper band	Min.	Max.
LEVEL	5.875	2.036	0.024	5.829	5.922	0	10
CHANGE	0.115	1.223	0.014	0.088	0.143	−3	3
INTEG	10.585	40.639	0.473	9.659	11.512	−151	347
DIFFERENCE	0.003	1.656	0.019	−0.035	0.041	−10	10
P_NEWS	0.544	2.297	0.027	0.492	0.597	−5	5
M_NEWS	−0.4	1.981	0.023	−0.445	−0.354	−5	5
SLEEP	2.645	0.984	0.011	2.622	2.667	1	4
HEALTH	2.737	0.813	0.009	2.718	2.756	1	4
NOANXIEY	2.021	0.952	0.011	1.999	2.043	1	4
NOCLASS	0.684	0.465	0.005	0.673	0.695	0	1
Number of observations	7389						

2009-survey	Mean	Standard Deviation	standard error	95% lower band	95% upper band	Min.	Max.
LEVEL	6.216	2.036	0.024	6.170	6.263	0	10
CHANGE	0.199	1.141	0.013	0.173	0.225	−3	3
INTEG	23.836	56.939	0.666	22.531	25.140	−167	476
DIFFERENCE	−0.003	1.573	0.018	−0.039	0.033	−9	10
P_NEWS	0.794	2.577	0.030	0.735	0.853	−5	5
M_NEWS	−0.064	2.068	0.024	−0.112	−0.017	−5	5
SLEEP	2.652	0.988	0.012	2.629	2.674	1	4
HEALTH	2.817	0.872	0.010	2.797	2.837	1	4
NOANXIEY	2.271	1.061	0.012	2.247	2.295	1	4
NOCLASS	0.580	0.494	0.006	0.569	0.591	0	1
Number of observations	7319						

Table 2 Results of panel unit root tests

2008-survey

without ***TREND***					**with** ***TREND***			
	ADF		KPSS		ADF		KPSS	
	P_N	p value	P_N	p value	P_N	p value	P_N	p value
LEVEL	4.745	0.000	0.096	0.924	4.473	0.000	−0.867	0.386
INTEG	−0.675	0.500	10.513	0.000	0.545	0.586	10.513	0.000
CHANGE	4.745	0.000	−0.196	0.845	2.713	0.007	−0.617	0.537
DIFFERENCE	8.210	0.000	−0.928	0.354	8.210	0.000	−0.972	0.331

2009-survey

without ***TREND***					**with** ***TREND***			
	ADF		KPSS		ADF		KPSS	
	P_N	p value	P_N	p value	P_N	p value	P_N	p value
LEVEL	8.210	0.000	−0.605	0.545	8.210	0.000	−0.299	0.765
INTEG	−0.249	0.804	10.513	0.000	0.310	0.757	10.513	0.000
CHANGE	8.210	0.000	−0.697	0.486	5.725	0.000	−0.876	0.381
DIFFERENCE	8.210	0.000	−1.000	0.317	8.210	0.000	−1.000	0.317

Note: P_N is a Fisher's statistic as defined in Choi (2001) based on a p value of the individual augmented Dickey and Fuller (1979) of null of a unit root and the individual Kwiatkowski et al. (1992) test of the null of no unit root. The lag length of the lagged difference terms to be added to the individual ADF test was selected according to Akaike information criterion (AIC) for each regression, and truncation lags in the KPSS test was set at 12. A Fisher's statistic P_N as defined in Choi (2001) has a N(0, 1) distribution under the null hypothesis.

Table 3 Estimation results on adaptation hypothesis

	2008			
	CHANGE		*DIFFERENCE*	
	fixed effect		random effect	
Variable	Coefficient	P-value	Coefficient	P-value
P_NEWS	0.302	[.000]	0.404	[.000]
P_NEWS(-1)	-0.084	[.000]	-0.363	[.000]
P_NEWS(-2)	-0.039	[.000]	-0.033	[.000]
P_NEWS(-3)	-0.025	[.000]	-0.011	[.165]
M_NEWS	0.007	[.250]	0.050	[.000]
M_NEWS(-1)	-0.009	[.174]	-0.052	[.000]
M_NEWS(-2)	-0.011	[.091]	0.001	[.889]
M_NEWS(-3)	-0.020	[.002]	-0.001	[.918]
SLEEP	0.000	[.999]	0.020	[.311]
SLEEP(-1)	-0.033	[.013]	-0.008	[.704]
SLEEP(-2)	0.011	[.418]	0.013	[.525]
SLEEP(-3)	0.005	[.680]	-0.027	[.162]
HEALTH	0.179	[.000]	0.206	[.000]
HEALTH(-1)	-0.047	[.011]	-0.165	[.000]
HEALTH(-2)	-0.035	[.061]	0.006	[.827]
HEALTH(-3)	-0.038	[.037]	-0.053	[.046]
NOANXIETY	0.293	[.000]	0.187	[.000]
NOANXIETY(-1)	-0.087	[.000]	-0.166	[.000]
NOANXIETY(-2)	-0.020	[.284]	0.026	[.348]
NOANXIETY(-3)	-0.064	[.000]	-0.039	[.142]
NOCLASS	0.078	[.004]	0.034	[.394]
NOCLASS(-1)	-0.035	[.227]	-0.093	[.034]
NOCLASS(-2)	-0.039	[.173]	-0.010	[.823]
NOCLASS(-3)	-0.016	[.541]	0.030	[.459]
constant			0.036	[.637]
adjusted R^2	0.535		0.392	
Number of observations	7249		7249	
Hausman test		[.027]		[1.000]

	2009			
	CHANGE		*DIFFERENCE*	
	random effect		random effect	
Variable	Coefficient	P-value	Coefficient	P-value
P_NEWS	0.260	[.000]	0.295	[.000]
P_NEWS(-1)	-0.050	[.000]	-0.274	[.000]
P_NEWS(-2)	-0.023	[.000]	-0.019	[.015]
P_NEWS(-3)	-0.015	[.001]	-0.011	[.129]
M_NEWS	0.047	[.000]	0.045	[.000]
M_NEWS(-1)	-0.017	[.001]	-0.042	[.000]
M_NEWS(-2)	0.004	[.405]	0.004	[.622]
M_NEWS(-3)	0.000	[.978]	-0.003	[.684]
SLEEP	0.036	[.001]	0.001	[.959]
SLEEP(-1)	0.011	[.351]	0.015	[.420]
SLEEP(-2)	-0.014	[.210]	-0.038	[.041]
SLEEP(-3)	0.006	[.601]	0.024	[.182]
HEALTH	0.172	[.000]	0.174	[.000]
HEALTH(-1)	-0.048	[.006]	-0.176	[.000]
HEALTH(-2)	-0.014	[.404]	0.008	[.773]
HEALTH(-3)	-0.012	[.466]	-0.003	[.923]
NOANXIETY	0.228	[.000]	0.288	[.000]
NOANXIETY(-1)	-0.059	[.000]	-0.301	[.000]
NOANXIETY(-2)	-0.021	[.191]	0.043	[.106]
NOANXIETY(-3)	-0.052	[.001]	-0.036	[.163]
NOCLASS	0.055	[.016]	0.008	[.838]
NOCLASS(-1)	-0.038	[.119]	-0.076	[.061]
NOCLASS(-2)	-0.001	[.969]	0.059	[.145]
NOCLASS(-3)	0.016	[.489]	-0.015	[.689]
constant	-0.564	[.000]	0.018	[.812]
adjusted R^2	0.445		0.311	
Number of observations	7211		7211	
Hausman test		[.532]		[1.000]

Table 4 Adaptation ratio of *CHANGE* and *DIFFERENCE*

		2008		2009	
		CHANGE	*DIFFERENCE*	*CHANGE*	*DIFFERENCE*
P_NEWS	short-run effect	0.302	0.404	0.260	0.295
	long-run effect	0.153	−0.003	0.172	0.003
	adaptation ratio (%)	49.3	100.8	34.1	99.1
M_NEWS	short-run effect	0	0.050	0.047	0.045
	long-run effect	NA	−0.003	0.030	0.003
	adaptation ratio (%)	NA	105.2	36.0	93.2
SLEEP	short-run effect	0	0	0.036	0
	long-run effect	NA	NA	0.036	NA
	adaptation ratio (%)	NA	NA	0.0	NA
HEALTH	short-run effect	0.179	0.206	0.172	0.174
	long-run effect	0.094	−0.012	0.125	−0.002
	adaptation ratio (%)	47.6	105.7	27.6	101.1
ANXIETY	short-run effect	0.293	0.187	0.228	0.288
	long-run effect	0.143	0.021	0.117	−0.012
	adaptation ratio (%)	51.4	88.8	48.6	104.2
NOCLASS	short-run effect	0.078	0	0	0
	long-run effect	0.078	NA	NA	NA
	adaptation ratio (%)	0.0	NA	NA	NA

Figure 1 Response rate

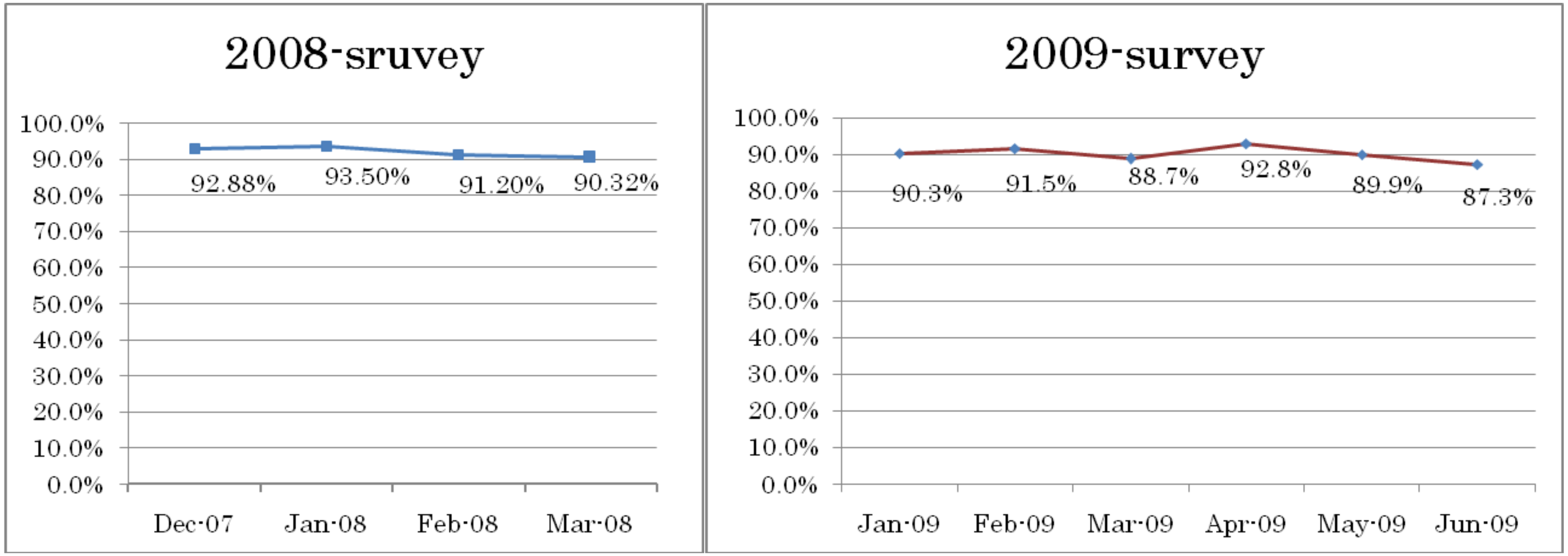
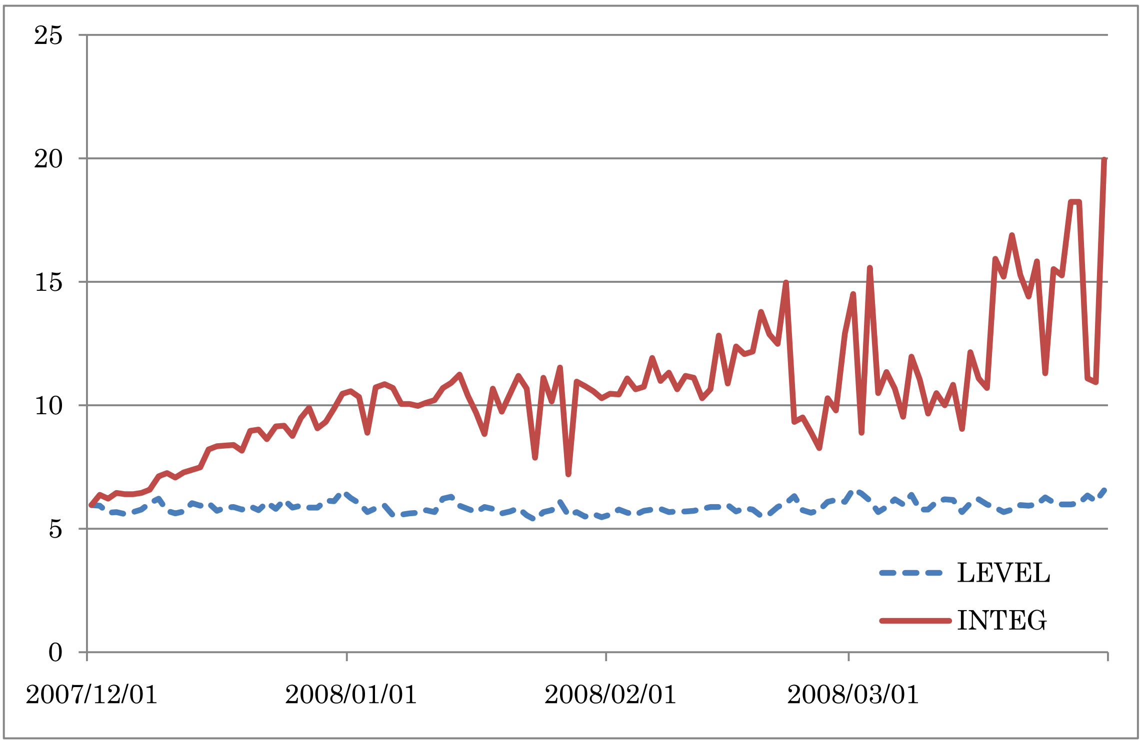


Figure 2 *LEVEL* and *INTEG*

2008-survey



2009-survey

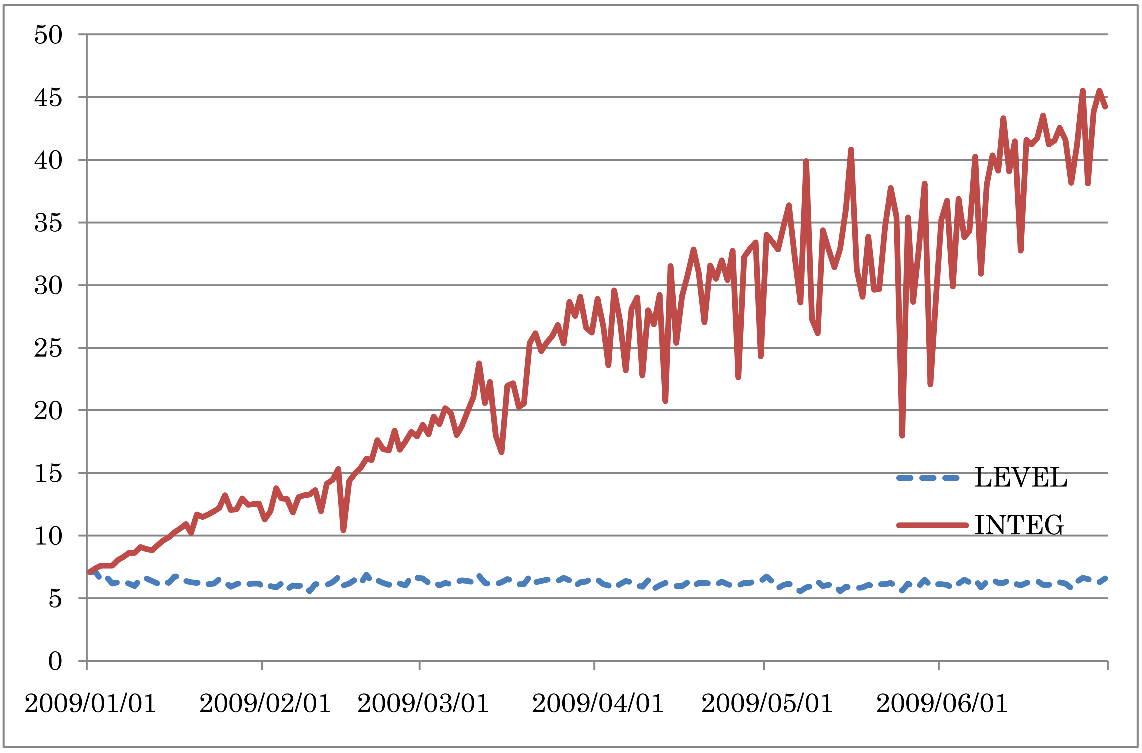
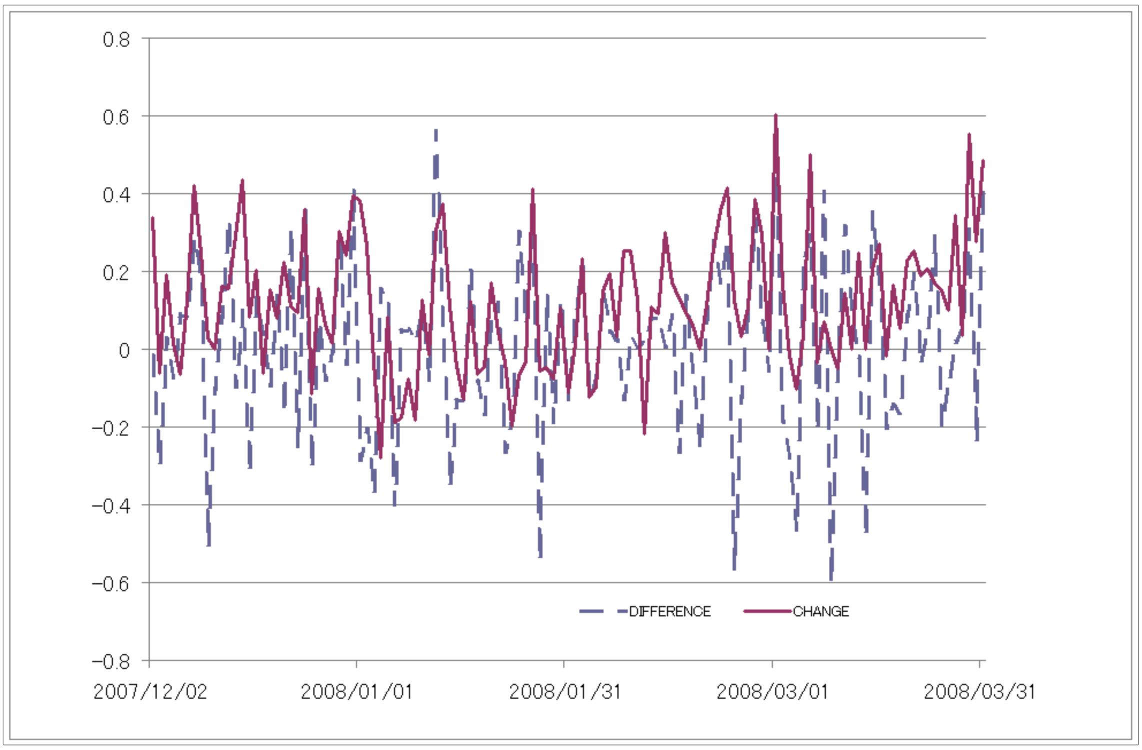


Figure3 *CHANGE* and *DIFFERENCE*

2008-survey



2009-survey

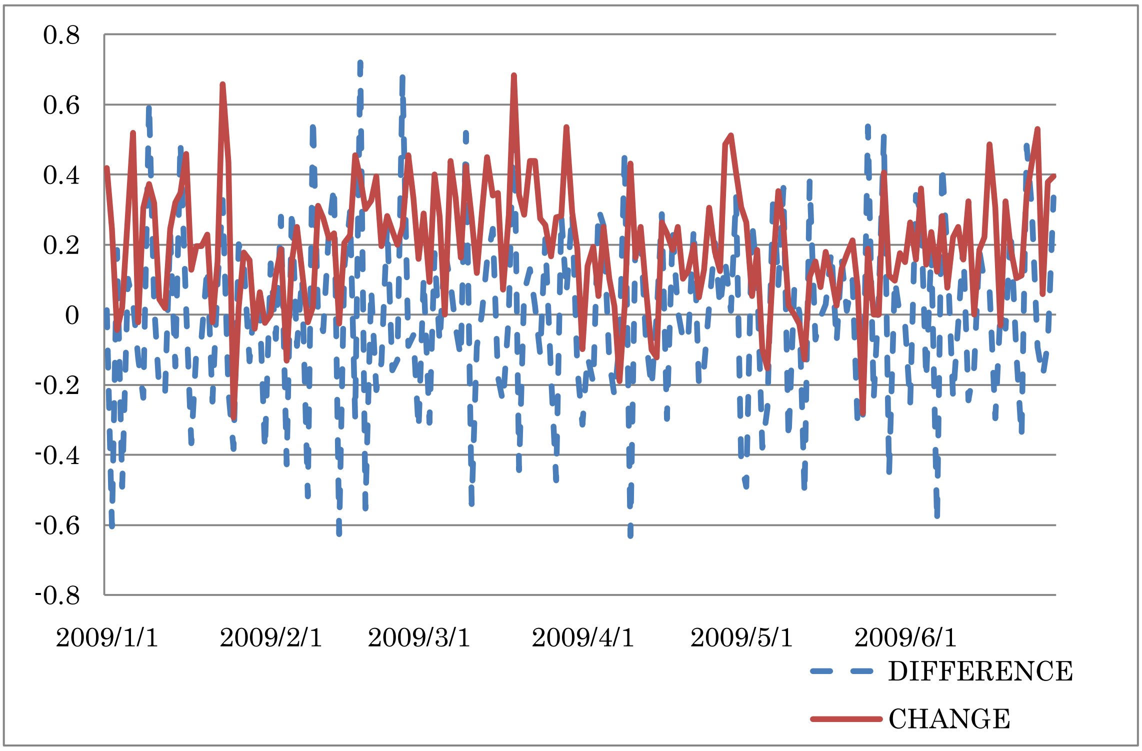
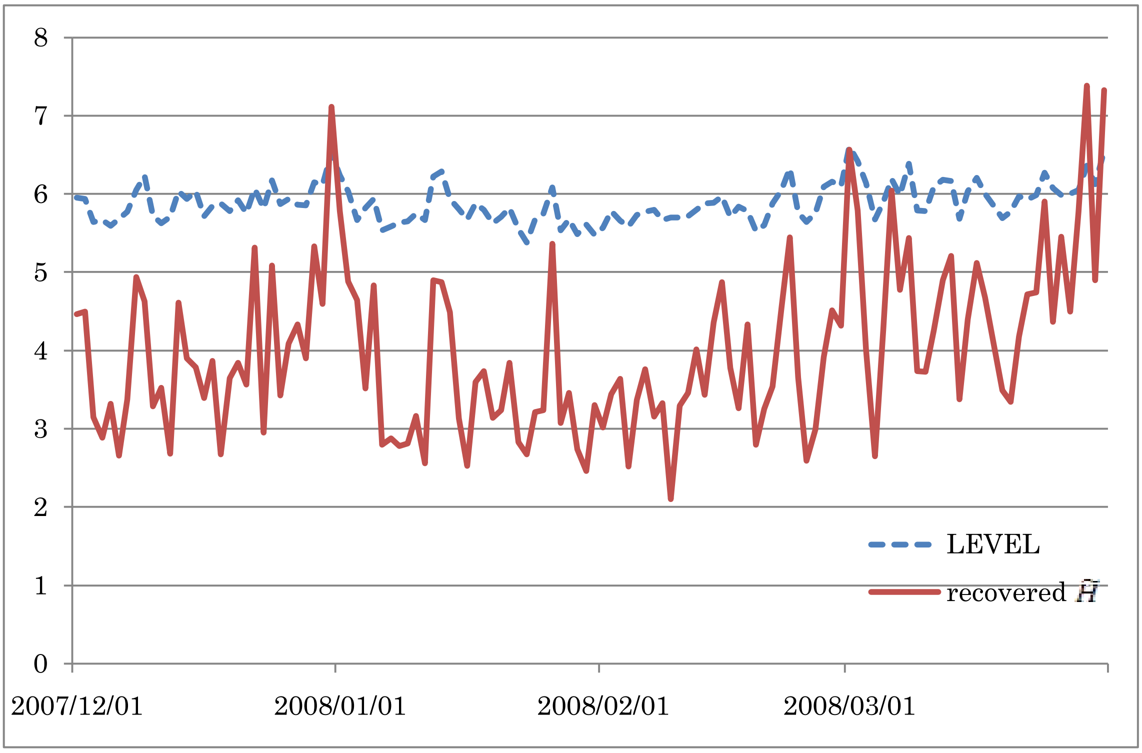


Figure 4 Recovered $\tilde{H}$ using equation (3)

2008-survey



2009-survey

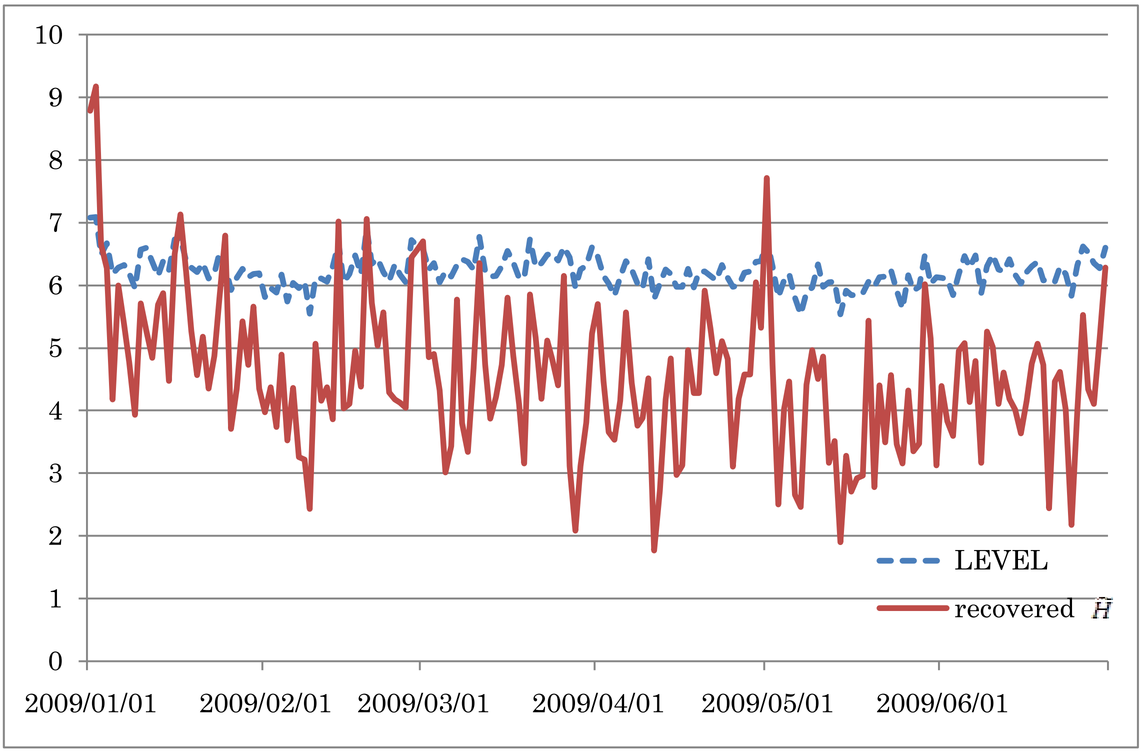
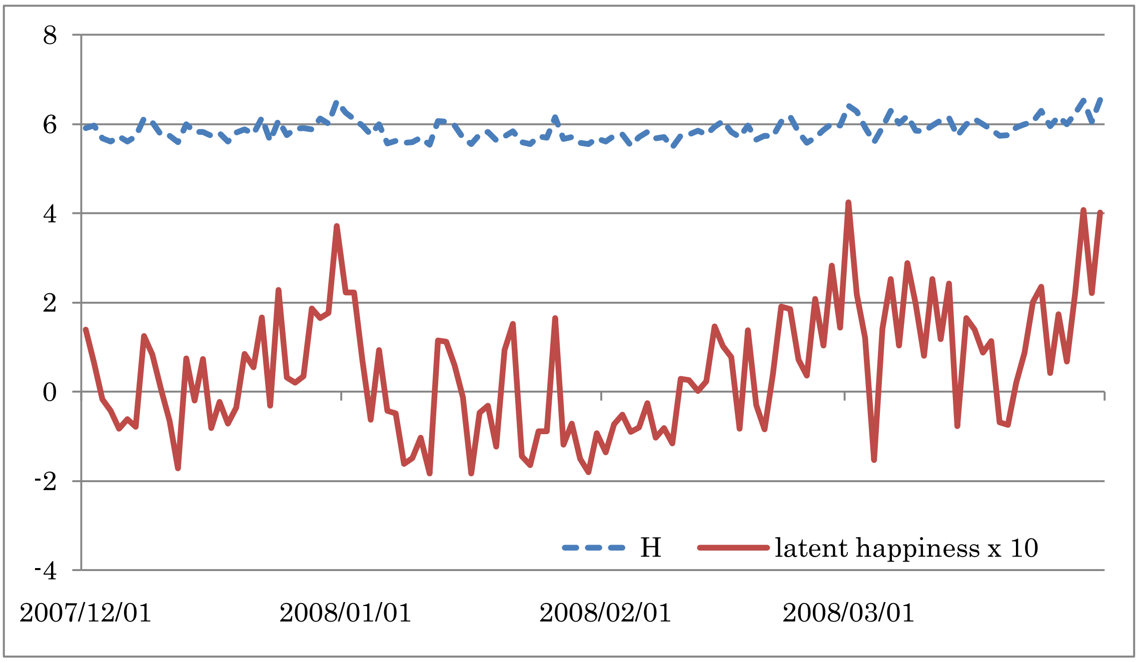


Figure 5　Latent happiness

2008-survey



2009-survey

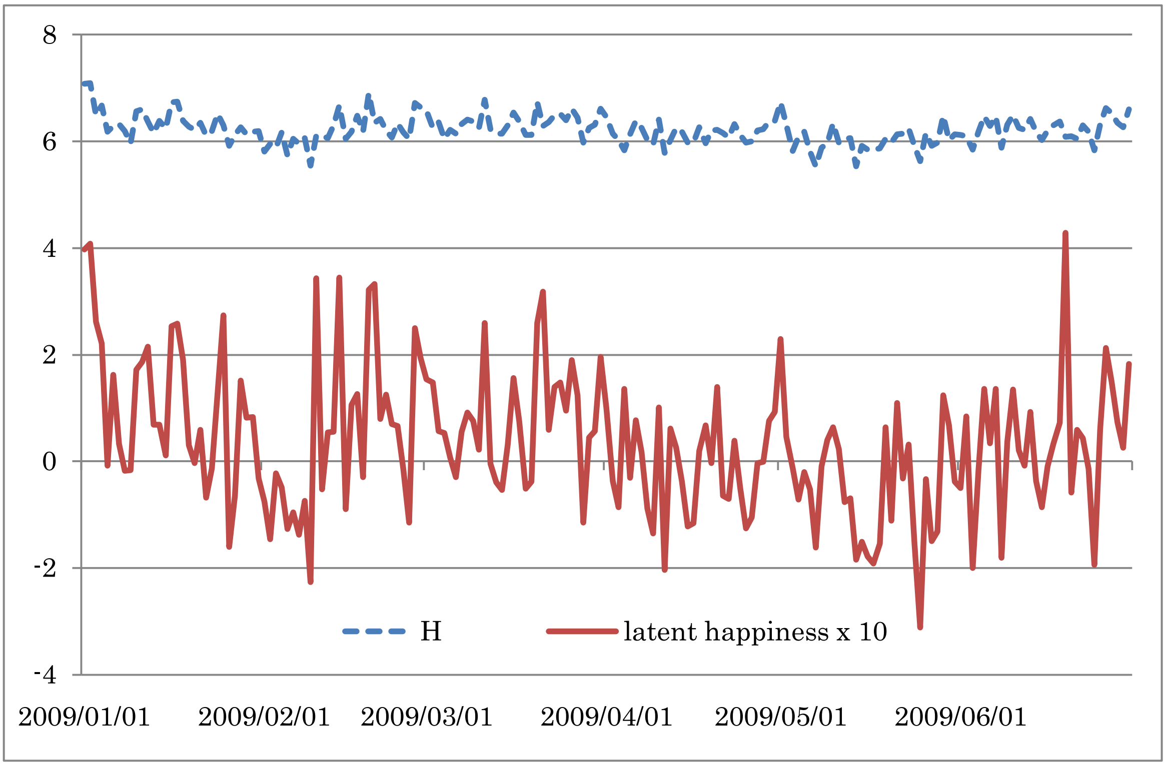


Figure 6　The Easterlin paradox