Life Dissatisfaction Over the Life History: Dissatisfaction as a Driver of Behavior

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Abstract

To examine how life satisfaction evolves over the life cycle, this paper inquires into dissatisfaction. In particular, this paper employs a bio-evolutionary framework and directs attention to the aspect that dissatisfaction works as behavioral incentives. Focusing on income and spouse/partner situation, theoretical considerations predict that the level of dissatisfaction due to the lack of income or an appropriate partner peaks in the reproductive period in which the lack of them had a serious impact on fitness in our evolutionary past. Theoretical considerations also predict that the baseline level of dissatisfaction peaks in the reproductive period, reflecting the importance of behaviors on fitness in the same period. The empirical results support all the hypotheses. Using the British Household Panel Survey, regression analyses show that the impacts of income and spouse/partner situation on overall life satisfaction are greatest around thirty years of age, and that the baseline level of overall life satisfaction is U-shaped in age sinking to its lowest in one's thirties. The results provide a new insight that the baseline level of life satisfaction represents the baseline level of desires and affects behaviors and the gross level of life satisfaction over the life cycle.

***Keywords*:** Life Satisfaction; Dissatisfaction; Life Cycle; Life History; Evolution

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1. Introduction

The life-cycle profile of subjective well-being, often measured by life satisfaction and happiness, has attracted considerable attention particularly since Clark and Oswald (1994) pointed to the U-shaped age profile of baseline happiness, which represents the level of happiness after controlling for the individual's demographic and socio-economic background (Winkelmann and Winkelmann 1998; Frey and Stutzer 2002; Blanchflower and Osward 2004, 2008; Easterlin 2006; Baird et al. 2010; Brockmann 2010; Deaton 2010; Stone et al. 2010; de Ree and Alessie 2011; Lang et al. 2011; Van Landeghem 2011; Frijters and Beatton 2012; Kassenboehmer and Haisken-DeNew 2012; Baetschmann 2013; Fukuda 2013; Ulloa et al. 2013; Wunder et al. 2013). Research on this issue has gone beyond studying humans to chimpanzees and orangutans (Weiss et al. 2012). However, the empirical findings are mixed, some pointing to the U-shaped age pattern and others denying the existence of such an age pattern (see Frijters and Beatton 2012; Ulloa et al., 2013 for reviews).

Various explanations have been proposed to account for these findings. On the side supporting the U-shaped age profile, Frey and Stutzer (2002) and Blanchflower and Osward (2004) attributed the profile in their findings to unmet aspiration at young age and the adaptation to the unmet aspiration after midlife. In psychological literature, socioemotional selectivity theory supports the finding that subjective well-being rises after midlife, arguing that older people are better at managing emotions, particularly negative ones (Carstensen 1995, 2006; Gross, Carstensen, Pasupathi, Tsai, Götestam Skorpen, and Hsu 1997; Scheibe and Carstensen 2010; Brassen et al. 2012).[1] On the other hand, set point theory predicts that subjective well-being is virtually flat across ages because it returns to the genetically determined point. For example, McCrae and Costa (1994) argued that personal traits, including happiness, are stable over the life course. The hedonic treadmill theory (Brickman and Campbell 1971) also suggests that the impact of life events such as winning a lottery or marriage on subjective well-being is temporal because we eventually adapt to the changes in circumstances and the level of subjective well-being returns to the inherent baseline level (see Diener, Suh, Lucas, and Smith 1999; Pavot and Diener 2004; Fujita and Diener 2005;

[1] A selection of happier individuals is also a possible cause for the rise in subjective well-being after midlife since happier individuals tend to live longer. See Pressman and Cohen (2005), Veenhoven (2008), and Kageyama (2012) for reviews.

Lyubomirsky, Sheldon, and Schkade 2005; Clark, Diener, Georgellis and Lucas 2008; Lyubomirsky 2011 for reviews).

Turning to economics, the standard economic theory that employs the age-independent instantaneous utility function implicitly assumes that the age profile of subjective well-being is flat as long as instantaneous utility is regarded as the counterpart to subjective well-being (Blanchflower and Osward 2008).[2] Nevertheless, modifying assumptions leads to other predictions. For example, assuming that the capacity to enjoy consumption enhances in young age and incorporating the increase in mortality in old age, Deaton (2010) calculated the age profile of utility and predicted an inverted U-shaped age profile.[3] By contrast, employing the model of Grossman (1972) that incorporates health into the economic framework, Wunder et al. (2013) argued that subjective well-being declines with age, especially in old age. Furthermore, allowing preferences to be age-dependent leads to predictions of any type of age profile including the U-shaped pattern.

These arguments demonstrate that researchers are still far from reaching a consensus on this issue. In particular, the disagreement lies not only in the *actual* age profile but also in the *theoretically predicted* age profile of subjective well-being.

To tackle this issue, this paper develops hypotheses on how subjective well-being evolves over the life cycle in a biological framework and empirically tests these hypotheses. The biological framework is used because biology provides explanations of behaviors and characteristics at the evolutionary level and forms the ultimate theoretical basis in behavioral studies.[4]

The rest of the paper is organized as follows. The next section examines how dissatisfaction relates to life history, i.e, the biological life cycle, by focusing on the aspect that dissatisfaction provides behavioral incentives. Section 3 tests the derived hypotheses using the British Household

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[2] On how to reconcile the concepts of utility and subjective well-being is still an unsettled issue. For example, Benjamin et al. (2012) argued that happiness should be treated as an argument in utility, not as utility itself.

[3] Deaton (2010) also noted that "While it would be a mistake to take these predictions too seriously, they provide a framework for consideration and interpretation."

[4] We don't mean to say that explanations provided by different disciplines are exclusive to one another. Different disciplines explain the age profile of subjective well-being from different aspects.

Panel Survey. Consistent with the hypotheses, the results show that the baseline level of life satisfaction is U-shaped in age, hitting the lowest point in one's thirties, and that the impacts of income and spouse/partner situation on life satisfaction are greatest around thirty years of age. Section 4 concludes with a remark on the importance of studying the baseline level of life satisfaction for understanding subjective well-being and behaviors over the life cycle.

2. Dissatisfaction Over the Life History

2.1 Naturally Selected Strategies from a Life History Perspective

Natural selection, i.e., the selection of genotypes and associated phenotypes with a greater fitness, is the fundamental concept in biology.[5] Through the force of natural selection, genotypes that are more successful in reproduction increase their frequency in the population and often, but not necessarily, fix in the population. Using this principle, evolutionary biology explains why particular traits evolve in particular niches. An example of such traits unique to humans is the existence of post-reproductive life (Austad 1997; Hawkes et al. 1998; Hill and Kaplan 1998; Kaplan, Hill, Lancaster and Hurtado 2000; Chu and Lee 2013). Evolving together with intergenerational transfers, long growth period, short birth interval, and menopause, post-reproductive life contributed to fitness in our evolutionary past, in which our genus *Homo* lived as hunter-gatherers in small cooperative groups where people interacted, and have become one of the population's inherent characteristics.

This, however, does not mean that individuals deliberately act to increase fitness or even care about fitness. Instead, physiological features, such as the hormonal mechanism that coordinates the allocation of consumed resources among body functions, and psychological characteristics, for example, the set of preferences that prompts particular behaviors, embedded in each individual connect actual actions to inherited strategies selected in the course of evolution. We inherit these physiological and psychological characteristics although they may no longer contribute to fitness because the surrounding environment has dramatically changed in human history.[6]

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[5] This definition of national selection includes sexual selection and kin selection.

[6] See Robson (2001, 2002) and Robson and Samuelson (2010) for the introduction of this approach in economics.

Similarly, strategies selected in the course of evolution vary over the life course because life-history-related conditions, such as physiological quality, body size, and the senescence process, are by themselves parts of selected strategies and change over the life course. For example, life history theory in evolutionary biology accounts for how biologically optimal strategies change over the life course. Such strategies include the age profiles of mortality, fertility, productivity and time preference (Stearns 1992, Kaplan and Robson 2002, 2009; Walker, Hill, Kaplan, and McMillan 2002, Lee 2003, 2008; Robson and Kaplan 2003; Chu and Lee 2006, 2013; Chu, Chein, and Lee 2008, 2010; Kageyama 2011, 2013).

2.2. Dissatisfaction as a Driver of Behavior

Along this line, dissatisfaction is regarded as a psychological incentive obtained in the course of evolution. Dissatisfaction prompts actions or behaviors to remove the factors causing dissatisfaction. For example, insufficient energy within an individual leads to the dissatisfaction that causes the individual to eat.

In particular, we assume that dissatisfaction goes *deeper*, i.e., satisfaction drops, giving greater behavioral pushes as factors causing dissatisfaction were, at least in our evolutionary environment, more damaging to fitness. Here, we focus on *dissatisfaction* rather than *satisfaction* as an indicator because people may act differently to "reduce dissatisfaction" than to "enhance satisfaction". For instance, loss aversion theory (Kahneman and Tversky 1979, Thaler 1980) has demonstrated that people place more weight on the disutility from losses than on the utility from corresponding gains (see Rabin 1998; DellaVigna 2009 for reviews).

To be more specific, we assume that overall satisfaction depends on a number of factors such that the lack of these factors causes dissatisfaction. The idea can be presented with the following equation:

$$S_a = \sum_{i=1}^{n} \alpha_{xi,a} s_{xi}\left(x_i; \overline{x}_i\right) + \left(1 - \sum_{i=1}^{n} \alpha_{xi,a}\right) \overline{S} \tag{1}$$

where S_a is overall satisfaction at age a, taking a value between $\underline{S}$ and $\overline{S}$, $s_{xi}(\bullet)$ is satisfaction level specific to a factor x_i, $\overline{x}_i$ is the satisfactory level of x_i, and $\alpha_{xi,a}$ is the impact of the corresponding $s_{xi}(\bullet)$ on overall satisfaction at age a, mirroring the biological

importance of x_i in our distant past. We assume that the sum of all $\alpha_{xi,a}$ does not exceed one, and that $s_{xi}(\bullet)$ takes a value in the same interval as S_a, hitting $\overline{S}$ when x_i reaches $\overline{x}_i$. Among a number of x_i that potentially affect overall satisfaction, we will later focus on income, *y*, and spouse/partner situation, *p*, to examine their impacts.

In this equation, overall satisfaction consists of two parts. The first part, $\sum_{i=1}^{n} \alpha_{xi,a} s_{xi}(x_i; \overline{x}_i)$, is satisfaction generated by x_i, or the other way around, dissatisfaction caused by the lack of x_i. The second part, $\left(1 - \sum_{i=1}^{n} \alpha_{xi,a}\right)\overline{S}$, is the baseline level of overall satisfaction. The latter part is included to capture the idea that dissatisfaction works as a behavioral incentive and arises only if it was advantageous in the evolutionary past. For example, in an extreme case in which no psychological incentive is evolutionarily necessary, all $\alpha_{xi,a}$ would be zero and S_a would be equal to $\overline{S}$. In this case, the individual would be perfectly satisfied with life overall since s/he need not be motivated to act in any particular manner.

Turning to $\alpha_{xi,a}$, it is age-dependent because behavioral incentives change over the life history. If a particular factor x_i is evolutionary more important at a particular age, the corresponding $\alpha_{xi,a}$ would be greater to magnify dissatisfaction, providing greater behavioral incentives. For example, in the post-reproductive period in which having a reproductive partner is not as important to reproductive success as in the reproductive period, behavioral incentives to look for an appropriate partner is expected to be weaker, and consequently, $\alpha_{p,a}$ is expected to become smaller. In this case, even if the individual is dissatisfied with the spouse/partner situation, s/he is not necessarily dissatisfied with life overall and not strongly motivated to act against it.

2.3. Hypotheses

Using this framework, we consider how $\alpha_{xi,a}$ changes over the life history. We divide the life history phases into the child, adolescent, reproductive, and post-reproductive periods, each of which represents a basic growth period, an extended growth period unique to humans (see Kaplan and Robson 2002 for the importance of this period for humans), the period for giving birth and nurturing children, and the period for supporting reproduction of offspring. We particularly assess the effects of income (resources) and spouse/partner situation because the importance of these

factors is expected to depend significantly on life-history phases.

2.3.1. The Impact of Resources Over the Life History

Resources are essential to enhance reproductive success in all phases of life history in any species. Resources are invested not only in reproduction but also in growth and survival that enhance future reproduction. Thus, the lack of income is expected to cause dissatisfaction, and empirical findings support this argument.[7] At the same time, the amount of resources necessary for these investments changes over the life history. In the case of early humans, it peaked in the reproductive period because raising children, which is a part of reproduction, required a substantial amount of resources. Studies of contemporary hunter-gatherers have shown that individuals in the reproductive phase obtain resources more then they consume, and use the surplus for reproduction. Furthermore, individuals in the post-reproductive period also produce more than they consume and transfer the surplus to their offspring to support their reproduction (Kaplan 1994; Hill and Hurtado 1996; Kaplan and Robson 2002; Robson and Kaplan 2003; Lee 2003, 2008; Lee and Chu 2012; Chu and Lee 2013).

Hence, in order to give greater behavioral incentives for obtaining resources, overall dissatisfaction due to the lack of resources is expected to deepen in the reproductive period. Put differently, we can hypothesize that:

Hypothesis 1. The impact of resource satisfaction on overall satisfaction, $\alpha_{y,a}$, is greatest in reproductive period.

[7] Previous studies have shown that, while income affects subjective well-being when income is low, the absolute level of income has a subtle impact on subjective well-being when it reaches a certain level (e.g., Easterlin 1974; Diener, Suh, Lucas, and Smith1999; Diener and Biswas-Diener 2002; Clark, Frijters, and Shields 2008; Dolan, Peasgood, and White 2008). These results are consistent with the view that the lack of income, rather than a gain in income, relative to a certain positive reference point is more influential to subjective well-being.

2.3.2. The Impact of Spouse/Partner Situation Over the Life History

The biological reason for establishing a stable sexual relationship is reproduction, which includes both giving birth and nurturing. Thus, in a biological sense, having an appropriate reproductive partner is most important in the reproductive period. This suggests that overall dissatisfaction due to the lack of an appropriate reproductive partner is expected to deepen in the reproductive period in order to give greater incentives to look for a satisfactory partner. Hence, we can predict:[8]

Hypothesis 2. The impact of spouse/partner satisfaction on overall satisfaction, $\alpha_{p,a}$, is greatest in the reproductive period.

2.3.3. The Baseline Level of Life Satisfaction Over the Life History

As in the cases of resources and reproductive partnership situation, a greater number of factors would have had larger impacts on fitness in the reproductive periods than in any other periods in our distant past. Examples of such factors include social status, attractiveness, and perhaps health.[9] Along this line, we can speculate that the aggregate sum of the impacts of all factors, $\sum_{i=1}^{n} \alpha_{xi,a}$, increases in the reproductive period, and that the baseline level of overall dissatisfaction, which is presented by the second part of equation (1), deepens in the reproductive period. Hence, we predict:[10]

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[8] See, e.g., Diener, Suh, Lucas, and Smith. (1999), Diener and Seligman (2004), Clark, Diener, Georgellis and Lucas (2008), and Dolan, Peasgood, and White (2008) for the relationship between subjective well-being and marriage.

[9] By contrast, factors that would have been less important in the reproductive period include having guardian such as parents (in comparison to the child and adolescent periods) and having high-quality children who can successfully reproduce (in comparison to the post-reproductive period).

[10] This hypothesis is consistent with the finding that the value of life measured by the remaining lifetime reproductive success peaks at the beginning of the reproductive period and thus, one unit of time in the reproductive period is biologically more important than that in other life history phases

Hypothesis 3. The baseline level of overall satisfaction bottoms out in the reproductive period.

3. Empirical Analysis

3.1. Data Source

The data are taken from the British Household Panel Survey (BHPS, University of Essex 2010). The BHPS is a nation-wide, household-based survey, interviewing every adult member (16 and above) of the sampled household. We use this data set for two reasons. First and more importantly, it is a panel data set covering more than 10 years of observation. This allows us to control for unobserved individual characteristics that generate an endogeneity bias. The second reason is that it is easily accessible to researchers worldwide and has a large background literature. This means that many previous studies have used this data set for similar purposes to the present study, making the BHPS the most suitable data set to compare the results across studies.

The data set covers 20 waves starting in 1991. The 19th wave of BHPS was integrated into the 2nd wave of Understanding Society. Among these waves, we use waves 6 to 10 and 12 to 18 for which the data on overall life satisfaction, S_a, are available. We exclude waves in Understanding Society because some key variables are unavailable.

Overall life satisfaction is measured with the question, "How dissatisfied or satisfied are you with your life overall?" The answer takes a value between 1, not satisfied at all, and 7, completely satisfied. The number of observations for which the data on overall life satisfaction and individuals' demographic and socio-economic conditions are available is 153,905. The mean value of overall life satisfaction is 5.23.

3.2. Strategies

A straightforward way to test the hypotheses derived in the previous section is to use the data on *factor*-specific satisfaction, which represents $s_{xi}(\bullet)$. However, since such data are unavailable, we take the following two regression approaches.

The first approach is to use *domain*-specific satisfaction instead of factor-specific satisfaction

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(Kageyama 2011, 2013).

and estimate the impact of domain-specific satisfaction on overall life satisfaction.[11] For example, we can use satisfaction in the household-income domain to measure resource satisfaction.

The limitation of this approach is that available data are restrictive. The survey asks only about eight domains of satisfaction (health, household income, house/flat, spouse/partner, job, social life, amount of leisure time, and use of leisure time), and these eight domains, some of which are highly correlated, are not necessarily most relevant to overall life satisfaction. Another weakness in this approach is that the data on spouse/partner satisfaction are limited to those with partners, generating a selection bias. The same problem lies in job satisfaction.

The alternative approach is to regress overall life satisfaction on objective measures of income and spouse/partner situation, controlling for the individual's demographic and socio-economic conditions. Namely, this approach regresses S_a directly on x_i instead of on $s_{xi}(\bullet)$, implicitly assuming that individual differences in the satisfactory levels of x_i, $\overline{x}_i$, and their functional forms, $s_{xi}(\bullet)$, do not critically affect the results. If they do, the results would be distorted, leading to a failure to capture the effects of x_i.

These arguments demonstrate that both regression approaches have pros and cons, as is typically the case in most empirical analyses. The first approach in particular that requires the removal of observations without partners and jobs generates a strong selection bias. Thus, while employing both regression approaches, we pay more attention to the second approach.

Employing these regression approaches, we examine how coefficients change over the life history. Specifically, dividing life history phases to the adolescent (ages 16-20), early reproductive (ages 21-40), late reproductive (ages 41-60), and post-reproductive (ages 61 and above) periods, we regress separately for each life-history phase or, instead, use life-history dummies with interaction terms. The child period is omitted due to data limitation, and the reproductive period, where a sufficient number of observations exist, is separated into two periods.

With respect to the regression method, we follow previous studies that treat satisfaction levels cardinal, and that apply the ordinary least squared (OLS) method with fixed individual effects (Ferrer-i-Carbonell and Frijters 2004; de Ree and Alessie 2011; Van Landeghem 2011; Frijters and

[11] See Van Praag et al. (2003), Easterlin (2006), and references therein for the domain-of-life approach.

Beatton 2012; Kassenboehmer and Haisken-DeNew 2012; Wunder et al. 2013). Ferrer-i-Carbonell and Frijters (2004) has demonstrated that "assuming ordinality or cardinality of happiness scores makes little difference, whilst allowing for fixed-effects does change results substantially."

3.3. Domain-of-Life Approach

We first regress overall life satisfaction on domain-specific satisfaction for each life-history phase. To avoid subjectivity, we incorporate all eight domains of life rather than use only some domains. It is worth noting that the regression model includes a constant term to match the second part in equation (1). We do not expect overall life satisfaction to be the weighted sum of domain-specific satisfaction. If that were the case, the constant term would have no explanatory power.

The results, presented in Table 1, are consistent with Hypotheses 1, 2, and 3. Concerning the impact of resource satisfaction on overall life satisfaction (Hypothesis 1), the results show that the coefficient of household-income satisfaction is largest in the early reproductive period, closely followed by the late reproductive period, both at the 1% level of significance. On the other hand, the coefficient is insignificant in the adolescent period and becomes much smaller in the post-reproductive period while it is still significant at the 10% level. These results demonstrate that satisfaction in the financial domain affects overall life satisfaction most in the reproductive period, supporting Hypothesis 1.

Place Table 1 around here.

With respect to the impact of spouse/partner satisfaction (Hypothesis 2), the results show that the coefficient of spouse/partner satisfaction peaks in the early reproductive period, followed by the adolescent and late reproductive periods, all at the 1% level of significance. The coefficient in the post-reproductive period is smallest at the 5% level of significance. While these results must be interpreted with caution due to the omission of observations without partners, they are in line with Hypothesis 2, demonstrating that satisfaction in spouse/partner domain affects overall life satisfaction most in the early reproductive period.

As for the baseline level of life satisfaction (Hypothesis 3), we obtain the results that the constant term becomes smallest in the late reproductive period, closely followed by the early

reproductive period. In all periods, the coefficients are significant at the 1% level. These results support Hypothesis 3, pointing to the importance of behavioral incentives in the reproductive period.[12]

3.4. Direct Regression Approach

Next, we regress overall life satisfaction on income and spouse/partner situation, controlling for the individual's demographic and socio-economic conditions. The details of the explanatory variables appear in Table 2.

Place Table 2 around here.

There are several points to note. First, we use both the real annual household income and the real annual *household-size adjusted* income after taking logarithms. Since the household size affects consumption expenditure per person and may have a significant impact on the effect of income, we employ both variables to test if adjusting for household size changes the results in any meaningful manner.

Second, with respect to spouse/partner, we categorize observations to the married (including living as a couple), never married, and separated (including divorced and widowed). This categorization is admittedly not always appropriate. For one thing, being never married does not necessarily mean that one has no reproductive partner. For another, the impact of being married is expected to be greater in younger cohorts since the impact of being married also depends on the length of marriage. Despite these limitations, we follow this categorization for practical reasons and test how being married, as compared to being never married, affects overall life satisfaction.

Third, we treat the choice of economic activities basically endogenous and categorize together the self-employed, employed, maternity leave, family care, in government training scheme, and others as economically active.[13]

Table 3 presents the results. Regression equations (2-1) and (2-2) respectively show the results

[12] Using the random-effect ordered logit model does not change the results in any meaningful way.

[13] The results in the present study are not sensitive to these controls.

with household-size non-adjusted and adjusted incomes.

Place Table 3 around here.

The results again support Hypotheses 1, 2, and 3. With respect to Hypotheses 1, the results show that the coefficients of income are positive in the early reproductive period in RE (2-1) and in both the early and late reproductive periods in RE (2-2), all at the 1% level of significance. In contrast, the coefficients become insignificant in other life-history periods. These results demonstrate that, consistent with Hypothesis 1, the impact of income on overall life satisfaction peaks in the early reproductive period.

As for Hypotheses 2, the same tendency is observed. In both equations, the coefficients of being married are significant at least at the 5% level from the adolescent to late-reproductive periods, and turn insignificant in the post-reproductive period. The impact of being married, as compared to being never married, is greatest in the early reproductive period, followed by the late reproductive period. These results are consistent with Hypothesis 2.

Regarding Hypotheses 3, the results demonstrate that life satisfaction is *ceteris paribus* lowest in the early reproductive period and increases thereafter. In RE (2-1), using the early reproductive period as the reference group, the dummies for the late reproductive and post-reproductive periods are significantly positive at the 10% and 1% levels respectively. In RE (2-2), the dummy for the post-reproductive period is significantly positive at the 5% level. Even in other periods in which the coefficients are insignificant, they are all positive. These results support Hypothesis 3.

As for control variables, the results are as expected. Separation from the spouse/partner, number of children, unemployment, disabled to work, frequent GP visits, and relative income are negatively related to life satisfaction, and education and being students are positively related to life satisfaction.

To assess these results, we next regress the same model modifying the settings. RE (2-3) and (2-4) regress the same regression equations with balanced panel data. While the results become less significant presumably due to the reduction in the number of observations, the results are similar to those with unbalanced panel data. In both equations, the coefficients of income and being married in the early reproductive periods are significant at least at the 5% level and hit their peaks. With

respect to the baseline level of life satisfaction, the coefficients are all positive and, in RE (2-3), become significant at the 10% level in the late reproductive and post-reproductive periods.

RE (2-5) regresses the same equation selecting only for one-person households. This is to further control the household size. On top of affecting expenditure per person, the household size depends on the life history phase itself, expected to be larger in the late reproductive period. Thus, controlling for household size is important to obtain consistent results across the life history phases. At the same time, we should keep in mind that selecting only for such observations would cause other problems. This is because the characteristics of the one-person household change over the life history, creating a selection bias. Thus, we should take the results as suggestive.

Despite this selection bias, the results are again similar to previous results. The coefficients of income are significantly positive in both the early and late reproductive periods respectively at the 1% and 10% levels, but now the coefficient reaches its peak in the late reproductive period. The baseline level of life satisfaction is again highest in the post-reproductive period. Using the late reproductive period as the reference group, life-history phase dummies for the adolescent and post-reproductive periods are significantly positive respectively at the 5% and 10% levels (not shown in the table). As for spouse/partner, their coefficients become mostly insignificant, presumably due to a selection bias.

Another note-worthy point in RE (2-5) is that, with respect to income and life-history phase dummies, the results become similar to those using household-size adjusted income, tilting the life-stage importance to the late reproductive period, even though household-size non-adjusted income is used. These results suggest that adjusting income for household size is preferable to estimate with greater accuracy the impact of income on life satisfaction.

In summary, all of the regression results support Hypotheses 1, 2 and 3. Income and spouse/partner are most influential in the reproductive period, and the baseline level of life satisfaction bottoms out in the reproductive period and peaks in the post-reproductive period.[14]

[14] To further test the robustness of these results, we also regressed separately for women and men and obtained consistent results.

3.5. Application to Life Satisfaction Over the Life Cycle

Hypothesis 3 predicts that the baseline level of life satisfaction is roughly U-shaped in age, hitting its lowest in the reproductive period. The previous regression results support this prediction. To further test this and compare the present results with those in previous studies, we regress the same model subdividing observations into five-year age groups.[15] Here, we avoid parameterizing the age profile by specifying the functional form because the exact relationship between life satisfaction and age is yet unknown.

The results appear in Figures 1, 2, and 3, each of which presents the impact of income, the impact of being married, and the baseline level of life satisfaction. The dotted lines represent the 95% confidence interval, and age group 31-35 is taken as the reference group for the baseline level of life satisfaction. The full regression table is provided as supplementary material.

Place Figures 1, 2, and 3 around here.

The results are generally in line with expectation. As shown in Figure 1, the age profile of the impact of income is roughly inverted U-shaped, supporting Hypothesis 1 and the previous regression results. On the other hand, as shown in Figure 2, the age profile of being married does not show a clear pattern, whereas, consistent with the previous regression results, the peak of its impact is in age group 26-30. This points to the existence of uncontrolled heterogeneity. With respect to the age profile of baseline life satisfaction, it is roughly U-shaped, or J-shaped without the child period, as demonstrated in Figure 3. This is consistent with Hypothesis 3 and the previous regression results.

To compare these results with previous studies, we next estimate the age profile of life satisfaction using a pooled OLS model and a fixed-effect OLS model both without controlling for the age-dependency of income and spouse/partner situation. Frijters and Beatton (2012) showed that, when the age-dependency is not taken into account, the age profile of life satisfaction is U-shaped under a pooled OLS model but becomes virtually flat in young and middle ages under a

[15] We used household-size adjusted income, following the results in the previous regression model. Using household-size non-adjusted income does not change the results in any meaningful way.

fixed-effect OLS model.

Figure 4 presents the results. Consistent with Frijters and Beatton (2012), the results show that the age profile of life satisfaction is U-shaped hitting the bottom in one's forties in a pooled model but becomes much flatter in young and middle ages in a fixed-effect model.

Place Figure 4 around here.

However, as shown earlier, the age profile of life satisfaction becomes U-shaped once we take the age-dependency of income and spouse/partner situation into account. The dip is now greater than the one in a pooled model. These results show that the age profile of life satisfaction is U-shaped with a significant decline in one's thirties. This implies that people in their thirties are *ceteris paribus* much less satisfied than those in other age groups.

4. Concluding Remarks

This study examines how subjective well-being changes over the life cycle. To do this, we develop hypotheses on the relationship between dissatisfaction and life history phase in a biological perspective and test these hypotheses using a panel data set. Consistent with the hypotheses, the results show that the impacts of income and spouse/partner situation on overall life satisfaction are greatest in the reproductive period, and that the baseline level of life satisfaction is lowest in the same period. These results are consistent with the findings in previous studies that subjective well-being is U-shaped over the life cycle, and with the findings in psychological studies that midlife is a period of increased stress in various domains of life (Lachman et al. 1994), and that low income relates to the midlife increase in mental disorders (Lang et al. 2011).

These results also support the hypotheses developed in the present study. The empirical results that the impacts of income and spouse/partner situation become greater in the reproductive period uniquely support the hypotheses in the present study. At the same time, it is worth noting that the hypotheses in the present study are not exclusive but compatible with other theories. While the present study provides an explanation for the age profile of subjective well-being at bio-evolutionary (ultimate) level, physiological and psychological studies can provide explanations at the physiological and psychological (approximate) levels respectively. Economic studies can

apply these findings to ground age-dependent preferences.

Last but not least, a question on the interpretation of the baseline level of life satisfaction remains. As Easterlin (2006) pointed out, baseline satisfaction is not necessarily suitable for comparing well-being across different age groups because many conditions that affect subjective well-being, such as income, marital status, and heath condition, are age-dependent. For example, people get less healthy as they age, and consequently, comparing life satisfaction across different ages controlling for health condition, as is done in this paper, would mean asking a hypothetical question of whether people get more, or less, satisfied with age without taking into consideration that they become less healthy with age.

At this point, the present study provides a new insight. The baseline level of satisfaction, or more intuitively, the baseline level of dissatisfaction, represents the baseline level of desires that affects behaviors and gross subjective well-being over the life cycle. For example, people become *more dissatisfied* and have greater desires for income and a reproductive partner at around thirty years of age. These desires prompt actions that aim at a higher income and the pursuit of a suitable partner, and increase the chances of obtaining a higher income, having a satisfactory partner, and furthermore, raising the gross level of life satisfaction.[16]

This argument supports Easterlin's view that comparing life satisfaction across different ages with the *ceteris paribus* assumption can potentially be misleading. The baseline level of life satisfaction does not necessarily parallel the gross level of life satisfaction. However, studying baseline satisfaction should not be deemed as unimportant because baseline satisfaction endogenously influences the gross level of life satisfaction by prompting appropriate behaviors. The study on baseline satisfaction provides a crucial piece of information for understanding behaviors and subjective well-being over the life cycle.

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[16] From a policy-making perspective, this points to the potential inadequacy of policy interventions that aim to raise subjective well-being. For example, policies targeted for raising life satisfaction of young adults would distort behavioral incentives and potentially result in *lowering* their gross subjective well-being.

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Table 1: Regression Results (Dependent Variable: Overall Life Satisfaction)

	(1-1)	(1-2)	(1-3)	(1-4)
Domain-of-Life	Adolescent	Early-Reproductive	Late-Reproductive	Post-Reproductive
Health	0.110***	0.116***	0.107***	0.100***
	(0.0263)	(0.00512)	(0.00577)	(0.0207)
Household income	0.0349	0.0819***	0.0763***	0.0340*
	(0.0252)	(0.00507)	(0.00550)	(0.0188)
House/Flat	0.0657***	0.0486***	0.0506***	0.0878***
	(0.0218)	(0.00446)	(0.00615)	(0.0220)
Spouse/Partner	0.179***	0.199***	0.164***	0.0858**
	(0.0230)	(0.00608)	(0.00750)	(0.0364)
Job	0.0770***	0.112***	0.101***	0.138***
	(0.0183)	(0.00471)	(0.00552)	(0.0248)
Social life	0.124***	0.102***	0.157***	0.158***
	(0.0366)	(0.00613)	(0.00736)	(0.0311)
Amount of leisure time	-0.0130	0.0405***	0.0444***	0.0676**
	(0.0292)	(0.00521)	(0.00569)	(0.0296)
Use of leisure time	0.115***	0.114***	0.131***	0.131***
	(0.0307)	(0.00573)	(0.00725)	(0.0370)
Constant	1.706***	1.075***	0.953***	1.173***
	(0.227)	(0.0480)	(0.0572)	(0.217)
Observations	2,901	36,794	32,492	3,831
R-squared	0.251	0.345	0.344	0.342

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 2: Explanatory Variables

Variable	Description
Household-size non-adjusted income	Household annual income deflated by CPI
Household-size adjusted income	Household annual income, equivalised using the McClements 'before housing costs' scale, and adjusted for the prices of the reference month (Bardasi et al. 2012)
Marital status	Categorized to never married; married, living with couple or civil partnership; and widowed, divorced, separated, or others
Education	CASMIN education level. Categorized to 3 levels
Number of children	Categorized to 0, 1, 2, and 3 and more
Economic activity	Categorized to self-employed, employed, maternity leave, family care, in government training scheme, or other; unemployed; retired; students; and disable to work
Health status	The number of visits to general practitioner. Categorized to 0; 1 or 2; 3 to 5; 6 to 10; and 11 and more
Home ownership	1 if owned and 0 if else
Relative income	Hhs non-adjusted income (or hhs adjusted income) in the same age group in the same region in the same wave
Wave	Wave dummies

Table 3: Regression Results (Dependent Variable: Overall Life Satisfaction)

	(2-1)	(2-2)	(2-3)	(2-4)	(2-5)
Panel	unbalanced	unbalanced	balanced	balanced	unbalanced
Income	hhs-nonadjusted	hhs-adjusted	hhs-nonadjusted	hhs-adjusted	hhs-nonadjusted
Income (16-20)	0.0160	0.0213	0.0249	0.0608	-0.0390
	(0.0142)	(0.0187)	(0.0422)	(0.0738)	(0.0625)
Income (21-40)	0.0247***	0.0422***	0.0374**	0.0638***	0.0657*
	(0.00957)	(0.0119)	(0.0188)	(0.0239)	(0.0358)
Income (41-60)	0.00178	0.0374***	-0.00451	0.0450*	0.104***
	(0.0109)	(0.0135)	(0.0187)	(0.0259)	(0.0327)
Income (61 and above)	-0.0162	0.00591	-0.0225	0.00949	-0.0188
	(0.0152)	(0.0173)	(0.0266)	(0.0328)	(0.0291)
Marital status (ref: never married)					
married (16-20)	0.117**	0.141***	-0.00241	-0.0420	1.028***
	(0.0490)	(0.0535)	(0.129)	(0.179)	(0.150)
married (21-40)	0.205***	0.194***	0.193***	0.148***	0.202
	(0.0203)	(0.0233)	(0.0376)	(0.0506)	(0.164)
married (41-60)	0.143***	0.141**	0.102	-0.0255	0.274
	(0.0508)	(0.0558)	(0.0886)	(0.112)	(0.214)
married (61 and above)	0.116	0.0932	0.186	0.147	-0.286
	(0.0855)	(0.0897)	(0.155)	(0.166)	(0.211)
separated (16-20)	-0.0530	-0.0513			
	(0.268)	(0.291)			
separated (21-40)	-0.186***	-0.194***	-0.230***	-0.297***	-0.186
	(0.0398)	(0.0440)	(0.0688)	(0.0928)	(0.138)
separated (41-60)	-0.104*	-0.0836	-0.0964	-0.286**	0.0887
	(0.0576)	(0.0632)	(0.0994)	(0.128)	(0.150)
separated (61 and above)	-0.201**	-0.221**	-0.0595	-0.169	-0.0688
	(0.0898)	(0.0950)	(0.166)	(0.184)	(0.167)
Life history phase (ref: early reproductive)					
adolescent	0.195	0.292	0.267	0.111	0.905
	(0.168)	(0.213)	(0.458)	(0.750)	(0.594)
late reproductive	0.259*	0.0631	0.470*	0.306	-0.341
	(0.146)	(0.176)	(0.252)	(0.322)	(0.457)
post-reproductive	0.547***	0.534**	0.602*	0.544	1.006**
	(0.193)	(0.225)	(0.346)	(0.428)	(0.462)
Education (ref: lower)					
middle	0.190***	0.203***	0.332**	0.286*	0.244
	(0.0677)	(0.0717)	(0.130)	(0.152)	(0.249)
higher	0.220***	0.213***	0.385***	0.370**	0.361
	(0.0729)	(0.0771)	(0.149)	(0.170)	(0.249)
Number of children (ref: 0)					
1	-0.0251*	-0.0167	-0.0222	-0.0115	
	(0.0138)	(0.0148)	(0.0224)	(0.0271)	
2	-0.0560***	-0.0413**	-0.0550**	-0.0490	
	(0.0166)	(0.0180)	(0.0253)	(0.0300)	
3 and more	-0.0620**	-0.0524*	-0.0133	-0.0574	
	(0.0255)	(0.0281)	(0.0397)	(0.0486)	

Table 3 continued

Economic activity (ref: active)					
unemployed	-0.301***	-0.303***	-0.335***	-0.320***	-0.429***
	(0.0225)	(0.0245)	(0.0489)	(0.0598)	(0.0720)
retired	0.00949	0.0170	0.0414	0.0590*	-0.000631
	(0.0185)	(0.0197)	(0.0280)	(0.0316)	(0.0514)
students	0.0778***	0.0649***	0.164***	0.154**	0.212*
	(0.0213)	(0.0238)	(0.0545)	(0.0669)	(0.118)
disable to work	-0.445***	-0.438***	-0.487***	-0.459***	-0.570***
	(0.0304)	(0.0324)	(0.0601)	(0.0747)	(0.0722)
Health status (ref: 0)					
1 or 2	-0.0188***	-0.0223***	-0.0209*	-0.0311**	-0.0321
	(0.00695)	(0.00737)	(0.0107)	(0.0125)	(0.0238)
3 to 5	-0.0885***	-0.0894***	-0.0827***	-0.0886***	-0.0826***
	(0.00927)	(0.00981)	(0.0150)	(0.0172)	(0.0292)
6 to 10	-0.175***	-0.180***	-0.154***	-0.161***	-0.186***
	(0.0126)	(0.0134)	(0.0210)	(0.0238)	(0.0368)
11 and more	-0.310***	-0.306***	-0.306***	-0.300***	-0.212***
	(0.0163)	(0.0173)	(0.0284)	(0.0330)	(0.0443)
House ownership (ref: rented and other)					
own	0.00456	0.00266	-0.0133	-0.00385	-0.0661
	(0.0158)	(0.0171)	(0.0296)	(0.0369)	(0.0522)
Relative income	-0.0608	-0.0842*	-0.114	-0.192**	-0.115
	(0.0455)	(0.0487)	(0.0772)	(0.0944)	(0.154)
Observations	153,905	136,129	45,972	33,744	22,072
R-squared	0.021	0.021	0.024	0.023	0.021

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. RE (2-5): one-person households only. Wave dummies included.

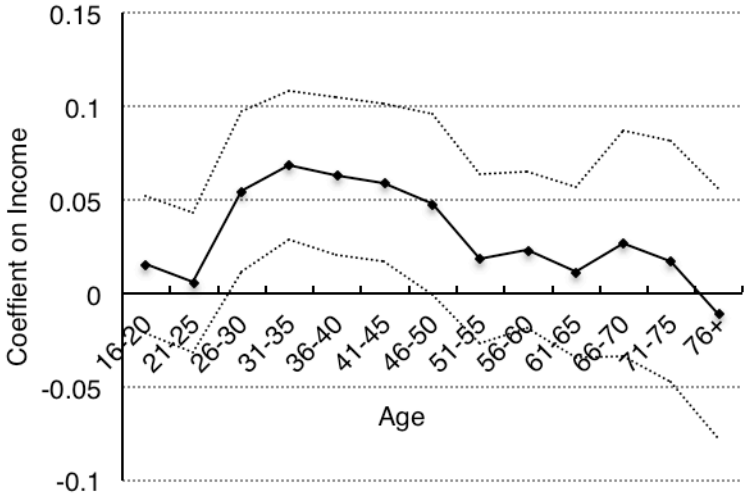

Figure 1: The Impact of Income on Life Satisfaction Over the Life Cycle

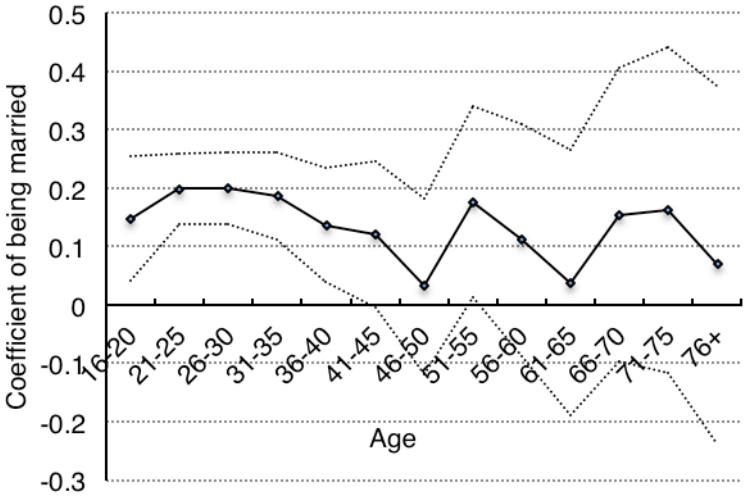

Figure 2: The Impact of Being Married on Life Satisfaction Over the Life Cycle

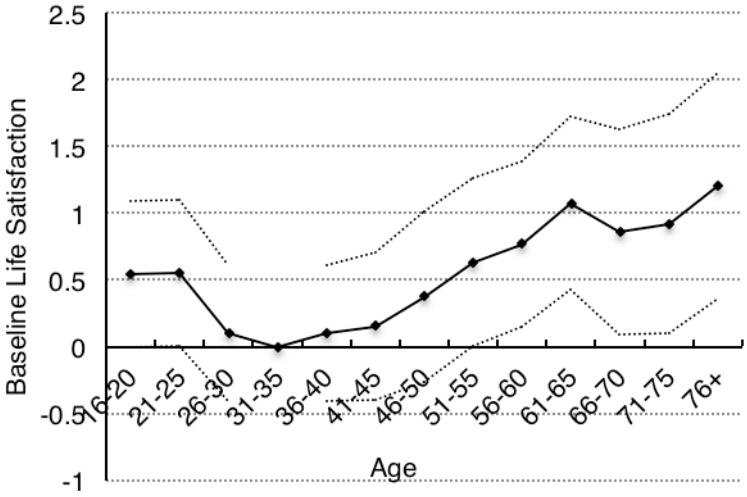

Figure 3: Life Satisfaction Over the Life Cycle

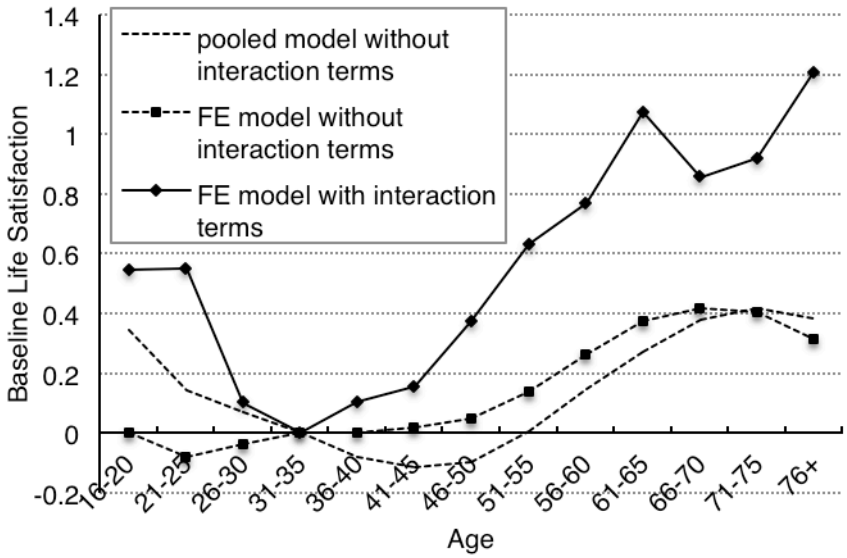

Figure 4: Life Satisfaction Over the Life Cycle (Comparison of Estimation Methods)