Should Bads Be Inflicted All at Once, Like Machiavelli Said?

Evidence From Life-Satisfaction Data

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Abstract

Is wellbeing, measured by life satisfaction, higher if the same number of negative events is spread out rather than bunched in time? Is it better if positive events are spread out or bunched? We answer these questions empirically, exploiting biannual data on six positive and twelve negative life events in the Household, Income and Labour Dynamics in Australia panel. Accounting for selection, anticipation, and adaptation, we find a tipping point when it comes to negative events: once people experience about two negative events, their wellbeing depreciates disproportionally as more and more events occur in a given period of time. For positive events, effects are weakly decreasing in size. So for a person's wellbeing it is better if both the good and the bad is spread out rather than bunched in time. This corresponds better with the classic economic presumption of diminishing marginal effects rather than Machiavelli's prescript of inflicting all injuries at once, further motivating the use of life satisfaction as a suitable proxy for utility. Yet, differences are small, with complete smoothing of all negative events over all people and periods calculated to yield no more than a 12% reduction in the total negative well-being impact of negative events.

Key Words:

Wellbeing, Life Satisfaction, Life Events, Non-Linearities, Hedonic Adaptation, Welfare Analysis

JEL Codes:

I31, D1

1. Introduction

"Injuries, therefore, should be inflicted all at once, that their ill savour being less lasting may the less offend; whereas, benefits should be conferred little by little, that so they may be more fully relished." – Niccolò Machiavelli, The Prince

Ceteris paribus, would one inflict bad things all at once or spread them out? And would one do the same or the opposite with positive events? Machiavelli urges us to bunch the bad and space the good. We address this question empirically by looking at the non-linearity in the effects of positive and negative events on self-reported life satisfaction in a large panel of Australians observed since 2002, to shed light on the shape of the utility function. If our empirical life-satisfaction function turns out to be in line with classic economic assumptions on the shape of the utility function, life satisfaction could be be interpreted as a suitable proxy for utility, which would further motivate its use for policy analysis.

In classic economic parlance, Machiavelli's reasoning assumes an S-shaped utility function that is concave in positive and convex in negative shocks, much like the shape of the value function by Kahneman and Tversky (1979). Then, the average absolute impact of negative shocks would decrease in their size (or number), with the same holding for positive effects. Under classic economic assumptions, on the other hand, there is concavity everywhere (diminishing marginal utility), which means that the average absolute impact of negative shocks would increase in their size. Figure 1 illustrates the shapes of these different functions.

[Figure 1 about here]

Implicit in Machiavelli's argument is adaptation to shocks: when he suggests inflicting all injuries at once rather than conferring them little by little, Machiavelli argues that, in doing so, *"their ill savour [would be] less lasting"*, which implies that these different strategies would exhibit different adaptation profiles over time. The same holds, in the opposite direction, for benefits.

The notion of 'hedonic adaptation' has a long tradition in psychology, dating back at least as far as Brickman's and Campbell's *Hedonic Relativism and Planning the Good Society* (Brickman and Campbell, 1971). There is now an established body of evidence on adaptation to various positive or negative life events in the psychology and applied economics literature, most of which uses individuals' self-reported life satisfaction as outcome. It covers changes in marital status (Lucas, 2005; Lucas and Clark, 2006; Oswald and Gardner, 2006; Stutzer and Frey, 2006), disability (Menzel et al., 2002; Oswald and Powdthavee, 2008), income (Di Tella et al., 2010; Kuhn et al., 2011), or unemployment (Clark et al., 2008), as well as studies using measures of life satisfaction to look at anticipation and adaptation to life shocks in relative comparison (Clark et al., 2008; Frijters et al., 2011; Clark and Georgellis, 2013). Adaptation is also central to the idea of a set point of life satisfaction around which individuals fluctuate, and often thought to be one reason (besides relative comparisons) behind the lack of a strong relation between GDP and life satisfaction in rich countries over time.[1] If we want to study Machiavelli's prescript empirically by looking at non-linearity in the effects of positive and negative life events on life satisfaction, we must, therefore, pay attention to the phenomenon of hedonic adaptation in order to separate that issue from the issue of non-linearity that determines the optimal spacing of events.

[1] The notion that economic growth did not coincide with growth in life satisfaction in developed countries over the last fifty years or so dates back to Easterlin (1974).

Apart from these studies, which have a particular focus on hedonic adaptation, there is a large literature on how individuals' life satisfaction (or subjective wellbeing more generally) reacts to various positive or negative life shocks, including, for example, shocks to income and wealth (Gardner and Oswald, 2007; Adda et al., 2009; Schwandt, 2018), war time experiences (Johnston et al., 2016), crime victimisation (Johnston et al., 2017), own criminal behaviour (Corman et al., 2011), homelessness (Curtis et al., 2013), and various other life shocks (Lindeboom et al., 2002). However, despite the large interest in this topic, the question of optimal spacing of events has never been posed, to our knowledge. This reflects, in part, the inherent difficulty in finding random variation in enough life events simultaneously to be certain about their cumulative effect. Researchers, therefore, have typically restricted themselves to look at single events in isolation, such as unemployment or marital breakdown, or else have been interested in particular psychological mechanisms that hold for many events, such as adaptation or the relation between decisions and experiences (Kahneman et al., 1997).

Yet, the question of spacing, in particular its optimality, is important: to the extent that individuals may have control over certain life events (for example, getting married or divorced, retiring, or going for promotion), they may make 'clean breaks' (all at once), 'bite the bullet' (all at once), 'take it one at a time' (one by one), and so on. Often, policy-makers must decide when to implement certain reforms with negative or positive wellbeing consequences over the legislative period. Is it better to implement all reforms at once, or rather spread them out? Hence, it would be insightful for such deliberations to know whether – as Machiavelli's puts it – it is better if 'injuries' or 'benefits' are bunched or spread out, *ceteris paribus*.

We use the analogy of life events and test Machiavelli's prescript empirically, by specifying and estimating various life-satisfaction functions with life events as arguments. We find evidence that life satisfaction is concave in *both* positive and negative domains: accounting for selection, anticipation, and adaptation, and holding the number of negative events constant over an individual's life, we show that overall life satisfaction decreases when negative events occur all at once as opposed to being spread out. For positive events, the same holds, meaning that – from a welfare perspective – it is better if *both* the good and the bad are spread out. The findings from our empirical life-satisfaction functions, therefore, reject Machiavelli's prescript. If data on life satisfaction are anything to go by (an issue discussed more later on), our findings are suggestive of a utility function that is globally concave, in line with classic economic assumptions.

We use data on six positive and twelve negative life events in the Household, Income and Labour Dynamics in Australia (HILDA) panel. HILDA has several advantages over comparable datasets: it uniquely tracks the 18 life shocks we use for the entire duration of the panel (2002-now), has a large numbers of individuals (about 20,000), consistently measures life satisfaction in every survey year, and records life events on a quarterly basis. The panel dimension allows us to look at within-person variation in life events and life satisfaction, reducing some of the bias resulting from selection into particular events. The availability of quarterly event information allows us to account for the adaptation profile of each event on a precise level.

In our most simple specification, we pool all positive life events into a single count variable and all negative events into another, finding clear evidence of a non-linear effect of life events on life satisfaction. This specification assumes that all events have equal magnitude and the same temporal effect profile, which are both unlikely. So in our extended specification, where each event has its own anticipation and adaptation profile, we use empirical indices of negative and positive events, finding the same overall pattern.

Another legitimate worry is that events might arise from choice behaviour rather than befalling individuals randomly. In sensitivity analyses, we show that the results remain qualitatively the same when following the literature and looking only at a specific subset of more exogenous and unanticipated events in our data (like winning the lottery, experiencing the death of a close friend, or being a victim of crime). Further robustness checks, including tests for selective attrition, respondents' fidelity and engagement with the survey questions, and alternative estimation procedures, are all in line with our main findings.

We then ask: how much does the non-linearity in life events matter when it comes to overall welfare, measured as the sum of life satisfaction over the population over time? We find that if losses were spread evenly in a given period of time, the overall welfare loss from these losses would reduce by about 10%. If gains were spread evenly, the overall welfare gain would rise by about 2%. In sum, this would yield an overall net welfare gain of about 12% relative to the *status quo*. Note that this is 12% of the status quo effects of all positive and negative events, not 12% of welfare or life-satisfaction variation.

Our findings add to two streams of literature: first, there is a literature in applied economics and psychology that exploits data on subjective wellbeing (in particular on self-reported life satisfaction) focussed on the non-linearity around the reference point. A general finding is that financial worsening looms larger for life satisfaction than financial improvement of the same absolute size, which would be in line with prospect theory and the kink at the reference point of value functions experimentally identified by Kahneman and Tversky (1979). Using nationally representative longitudinal household data from the British Household Panel Survey (BHPS) and the SOEP panel, Boyce et al. (2013) find that, over a relatively long time horizon, positive changes in income from one year to another yield a lower absolute change in life satisfaction than negative changes. A similar asymmetry is found by De Neve et al. (2018) at the macro level when it comes to positive and negative fluctuations in economic growth. Likewise, Vendrik and Woltjer (2007) provide evidence of a globally concave life-satisfaction function in the context of relative income, with a (slight) kink at a zero relative income gap. Gonza and Burger (2020) also claim an S-shaped function in some of their estimates for the effects of the economic downturn of 2008 on life satisfaction.

Second, there is an established literature studying anticipation and adaptation in self-reported life satisfaction to various life events, both positive and negative. Clark et al. (2008) use annual data on four negative (unemployment, divorce, widowhood, and lay-off) and two positive life events (marriage and childbirth) from the German Socio-Economic Panel Study (SOEP), showing that respondents anticipate and later fully adapt to most life events when it comes to their life satisfaction. Frijters et al. (2011) extend this analysis by studying life satisfaction dynamics around changes in employment status (being promoted and being laid off), changes in family life (births, deaths, and divorce), and changes related to the physical person (victimisation and health) in the HILDA panel. The authors confirm that respondents hedonically adapt to most changes in life circumstances. Dore and Bolger (2018) extend that methodology to allow for heterogeneous response patterns to negative shocks they call 'stressors'.

We join both streams of literatures, allowing for a non-linearity at the reference point while focussing primarily on non-linearities further away from it. Most importantly, we account for the dynamics of life events by explicitly modelling anticipation and adaptation regarding each life event at a precise quarterly level.

The rest of this paper is organised as follows: Section 2 gives an overview of the data we use and provides summary statistics on the life events we study. Section 3 introduces the empirical strategy, including different types of estimation and different ways to operationalise the occurrence of life events in a given period of time. Section 4 presents our main findings and scrutinises their robustness regarding alternative operationalisations and explanations. Section 5 calculates overall welfare counterfactuals. Finally, Section 6 concludes and discusses potential implications for individual and policy choices.

2. Data

We use nationally representative longitudinal household data from the HILDA panel for the period 2002 to 2017. HILDA was first conducted in 2001 on a representative sample of 7,682 Australian households and 19,914 individuals. Since then, every year, interviews have been conducted with all members of a household who are at least fifteen years old at the time of the interview.[2] Information is collected on a wide range of topics including educational attainment, health status, labour force dynamics, and income. The survey also asks household members about their overall life satisfaction, and importantly, whether major life events occurred during the last year, identifying the timing of each event on a precise quarterly basis relative to the interview date.

Our outcome is a respondent's self-reported *life satisfaction*, a global, evaluative measure of subjective wellbeing, which is obtained from a single-item eleven-point Likert scale asking respondents: "All things considered, how satisfied are you with your life?" Answer possibilities range from zero ("completely dissatisfied") to ten ("completely satisfied"). In our analyses, the largest sample with a complete set of information on both life events and life satisfaction includes 176,280 person-year observations. In this sample, mean life satisfaction is about 8.0, with a standard deviation of about 1.4, suggesting, in line with panel data evidence from other countries, that Australians are, on average, rather satisfied with their lives.

There is an ongoing debate as to whether measures of subjective wellbeing – global, evaluative measures such as life satisfaction but also momentary, experiential measures such as happiness – are measures of utility itself, proxies of utility, or merely arguments in an individual's utility function (alongside others such as, for example, health). Crucially, whether one sees life satisfaction as a reasonably proxy for utility or not, some governments are openly adopting life satisfaction on that basis, meaning that there are direct public policy implications

[2] Unfortunately, we cannot use data from 2001 since life events have only been sampled from 2002 onwards.

of findings on life satisfaction. The UK public service in July 2021 became the first bureaucracy to openly adopt the WELLBY, which is derived from life satisfaction in its linear form, as a cardinal measure of the quality of life of individuals (HM Treasury, 2021). It hence treats linearised life satisfaction (i.e. the raw scores) as if they measure the utility experienced by individuals. Other bureaucracies are likely to follow, spurred by various reports and new handbooks (e.g. O'Donnell et al., 2014; Frijters and Krekel, 2021).

The argument that life satisfaction is a reasonable proxy for utility has been looked at a lot in recent decades. Overall, measures of subjective wellbeing have been shown to correlate positively with objective, physical wellbeing, for example lower blood pressure (Blanchflower and Oswald, 2008) or stronger immune systems (Cohen et al., 2003; Diener and Chan, 2011). They have also been shown to correlate positively with various life outcomes: people who report higher life satisfaction are typically employed, in good physical and particularly mental health, partnered, have higher income, and are typically younger or older (i.e. not in their mid-life, cf. Clark et al., 2018). Using a random sample of 1.3 million US citizens from the 2005 to 2008 Behavioral Risk Factor Surveillance System (BRFSS), Oswald and Wu (2010) document that objective measures of quality-of-life at the state level correlate strongly with subjective wellbeing ($r = 0.6$, $P < 0.001$).

Yet, there are also studies finding systematic deviations between revealed behaviour and subjective wellbeing. Using the same data as Oswald and Wu (2010), Glaeser et al. (2016) show that people move to cities that have been in long-term decline and that score low in terms of subjective wellbeing, suggesting that people trade off wellbeing with other outcomes and that it is, therefore, merely an argument in an individual's utility function.[3] Counter to this argument

[3] There are also studies casting doubt on cardinality and hence interpersonal comparability of subjective wellbeing data. Bond and Lang (2019) show that various ordered probit findings from the literature do not hold and can even be reversed if these models are not homoskedastic (because the mean rank is not identified). Chen et al. (2019), on the contrary, salvage these findings when ranking happiness outcomes (and other ordinal data) by the median rather than the mean.

is research on cognitive boundaries and biases which documents that people make systematic errors when making decisions (e.g. Kahneman et al., 1991), which has led Kahneman et al. (1997) to argue for a differentiation between 'decision utility' and 'experienced utility'. Krekel and Odermatt (2021), for example, show that people who move to unhappy cities systematically overpredict how happy they will be there.

While settling this debate is out of the scope of our paper, we note that – with the exception of health – people have been shown to care a great deal about their subjective wellbeing. Using vignette studies, Adler et al. (2017) find that people tend to rank life choices according to how high they score in terms of subjective wellbeing, in particular life satisfaction and happiness. Similar results have been documented by Benjamin et al. (2012), which has led them to suggest that, although people may not maximise wellbeing exclusively, it is 'a uniquely important argument of the utility function' (p. 2107).[4]

We thus follow a large body of literature going back to Easterlin (1974) that uses data on self-reported life satisfaction to provide insights into the shape of the utility function. For modelling purposes, we implicitly assume a utility function that is additively separable over time and that utility is cardinally comparable across individuals.

Our variables of interest are major life events, both positive and negative. These are obtained from a battery of binary items asking respondents about whether a specific life event occurred during the past twelve months. If respondents report to have experienced a specific event, they are then asked in which quarter of the last year it occurred, i.e. whether it occurred up to three months ago, three to six months ago, six to nine months ago, or nine to twelve months ago.

[4] In a more recent paper, Benjamin et al. (2021), asking people directly what they think when responding to subjective wellbeing questions, show that subjective wellbeing data do not directly correspond to conventional notions of utility (i.e. flow or lifetime, regarding self or other-regarding).

We are initially agnostic about which life events to include and exploit all eighteen major life events available in the HILDA panel. These can be broadly categorised into six positive and twelve negative life events.

Positive life events are:

1. Birth or adoption of a new child
2. Major improvements in finance (e.g. won lottery)
3. Got promoted
4. Got married
5. Retired
6. Got back together with spouse

Negative life events are:

1. Death of a close friend
2. Death of an extended family member or relative
3. Death of a spouse or a child
4. Major worsening of finances (e.g. went bankrupt)
5. Made redundant
6. Serious illness or injury to a family member
7. Serious personal illness or injury
8. Family member detained in jail
9. Detained in jail (self)
10. Victim of property crime (e.g. theft, breaking and entering)
11. Victim of physical violence (e.g. assault)
12. Separated or divorced from spouse

Table 1 shows summary statistics on these life events, split by positive and negative events, including the number of occurrences of each event in our sample. It also reports means conditional on experiencing a particular event, including the average number a respondent reports positive or negative event (including the particular event itself) and at which age, years of education, and household income.

[Table 1 about here]

Table 1 Column 1 shows that the positive life event reported most often is being promoted, followed by the birth or adoption of a new child; the least frequently reported is getting back together with a spouse after prior separation. The negative life event that is reported most often is serious illness or injury of a family member, followed by the death of an extended family member or a relative; the least frequently reported is being detained in jail.

Column 2 shows that respondents reporting to have experienced a promotion report, on average, about 4.1 positive events (including the promotion itself), respondents reporting to have experienced serious illness or injury of a family member about 9.6 negative events (including the serious illness or injury itself). Thus, respondents reporting to have experienced a positive life event report, on average, between 3.6 and 4.1 positive events, while respondents reporting to have experienced a negative life event report between 8.4 and 11.1 negative events. The three positive life events that occur together most often during the twelve months preceding an interview are getting promoted, major improvements in finance, and getting married, whereas the three negative life events occurring together most often are serious illness or injury to a family member, the death of an extended family member or relative, and the death of a close friend.

Column 3 shows that there are some average age differences between people experiencing positive or negative events, with birth and jail happening more often to younger individuals, and retirement and the death of a spouse more often to older individuals. Those experiencing positive events have, on average, slightly more educational attainment (Column 4) and higher household income (Column 5). To net out such differences between people experiencing positive and negative events, we routinely control for age, education, and log household income throughout our analyses. Table A1 in Appendix A shows, in addition, the distribution of life events, split by positive and negative events, over the past twelve months as counts of person-year observations. Here, we observe, for example, that 421 individuals experience five negative life events in the same year, but less than 200 experience three or more positive events, which implies that the statistical power to identify non-linearities in the positive domain will be weaker than the power to identify non-linearities in the negative domain.

3. Empirical Strategy

We exploit information about the timing of each life event to account for anticipation and adaptation, which have been shown to be important features surrounding major life events (see Clark et al. (2008), Huang et al. (2018), or Clark and Georgellis (2013), for example). To account for anticipation, we create dummy variables for periods preceding the interview in which the event was reported (i.e. leads), including dummies for, respectively, up to six months before, six to twelve months before, twelve to eighteen months before, and eighteen to 24 months before. Similarly, to account for adaptation, we create dummy variables for periods succeeding the interview in which the event was reported (i.e. lags), including dummies for, respectively, six months ago, six to twelve months ago, twelve to eighteen months ago, eighteen to 24 months ago, and more than 24 months ago. Implicitly, we assume that respondents cannot anticipate life events further than two years into the future, and that any adaptation is complete within two years after the interview so that the dummy for an event which occurred more than 24 months ago picks up the long-run effect of that event. To avoid small cell sizes, we recode the occurrence of life events from a quarterly to a biannual basis, implying that our leads and lags are defined over half years.[5]

We start with the parsimonious model shown in Equation 1, which is linear, treats life events as count variables, and initially does not account for dynamics around events (i.e. anticipation and adaptation):

$$Y_{it} = \beta_0 + \gamma_0\#Pos + \gamma_1\#Pos^2 + \gamma_2\#Neg + \gamma_3\#Neg^2 + \beta_1 X_{it}' + u_i + \varepsilon_{it} \qquad (1)$$

where Y_{it} is *life satisfaction* of individual *i* in year *t*; *#Pos* is the number of positive and *#Neg* the number of negative life events during the last year (we suppressed the subscripts *i* and *t*); X_{it} is a vector of controls, including age, age squared (divided by 100), years of education, and log household income.[6] u_i are individual fixed effects to net out time-invariant unobserved heterogeneity at the individual level.

Including individual fixed effects acknowledges that preferences are not homogeneous in the population and that people may differ in their ability to anticipate and/or adapt to life events (Lucas, 2007; Buddelmeyer and Powdthavee, 2016; Etilé et al., 2019). Including individual fixed effects also ensures that variation comes from *within* individuals, reducing some of the bias from selection into particular life events.

[5] Using annual rather than biannual periods yields very similar findings.

[6] Across specifications, our results remain the same regardless of whether we control for age and age squared (divided by 100) or for age bin dummies in five-year brackets. Likewise, they remain the same regardless of whether we control for log household income or not.

Our coefficients of interest are γ_0, γ_1, γ_2, and γ_3. Machiavelli's proposition – neglecting dynamics around life events for the time being – would lead one to expect that $\gamma_0 > 0$ and $\gamma_1 < 0$ (i.e. the relationship between positive life events and life satisfaction is concave) and $\gamma_2 < 0$ and $\gamma_3 > 0$ (i.e. the relationship between negative life events and life satisfaction is convex).

An alternative, more flexible way to specify Equation 1 is to use binary instead of count measures of life events. This is shown in Equation 2:

$$Y_{it} = \beta_0 + \gamma_0 Pos_{3+} + \gamma_1 Pos_2 + \gamma_2 Pos_1 + \gamma_3 Neg_1 + \gamma_4 Neg_2 + \gamma_5 Neg_3 + \gamma_6 Neg_4 + \\ + \gamma_7 Neg_5 + \gamma_8 Neg_{6+} + \beta_1 X_{it}' + u_i + \varepsilon_{it} \qquad (2)$$

where $Pos_{\#}$ and $Neg_{\#}$ are now dummy variables (we again suppressed the subscripts i and t) equal to one if a respondent experienced, respectively, # positive or # negative life events during the last year, the remainder being the same as before. In this case, Machiavelli's proposition would lead one to expect that *(i)* coefficients for positive events have positive signs and coefficients for negative events have negative signs, and *(ii)* there is a concave relationship between life satisfaction and positive events as well as a convex relationship between life satisfaction and negative events.

These initial models, however, do not take into account anticipation and adaptation regarding life events, implicitly assuming that no life events are anticipated and full adaptation occurs after exactly 12 months. Thus, to account for more flexible dynamics around life events, we extend our parsimonious model in Equation 1 to become Equation 3a:

$$Y_{it} = \beta_0 + g(W^{pos}{}_{it}, W^{neg}{}_{it}) + \beta_1 X_{it}' + u_i + \varepsilon_{it} \qquad (3a)$$

where W^{pos}_{it} and W^{neg}_{it} are now positive and negative events indices that themselves include both anticipation and adaptation elements, such that the main question reduces to whether *g(.)* is concave in both W^{pos}_{it} and W^{neg}_{it}. We construct these negative and positive events indices as shown in Equations 3b.1 and 3b.2:

$$W^{pos}_{it} = \sum_{j \in Jpos} \sum_{s} z_{ji,t+s} y_{j,t+s} \qquad (3b.1)$$

$$W^{neg}_{it} = \sum_{j \in Jneg} \sum_{s} z_{ji,t+s} y_{j,t+s} \qquad (3b.2)$$

Here, J_{pos} and J_{neg} are sets of positive and negative events; $z_{ji,t+s}$ is the positive or negative life event *j* experienced by individual *i* in biannual period *t+s*, with $s \in S$ = *{more than -24 months,-24 to -18 months, -18 to -12 months, -12 to -6 months, 0 to 6 months, 6 to 12 months, 12 to 18 months, 18 to 24 months}*. This means anticipation is allowed up to 24 months before an event whilst the long-run effect is presumed to be reached 24 months after the event. For each positive or negative event, we hence estimate eight parameters.[7]

We start by estimating Equation 3a in two steps, by assuming in a first step linearity (i.e. $g(W^{pos}_{it}, W^{neg}_{it}) = W^{pos}_{it} + W^{neg}_{it})$) to estimate the parameters *y*, which allows for the construction of the indices W^{pos}_{it} and W^{neg}_{it} in Equations 3b.1 and 3b.2. In a second step, we estimate Equation 3a using the imputed values of W^{pos}_{it} and W^{neg}_{it}, allowing us to study the effects of the non-linearities *versus* the initial specification without them. In an alternative specification, we estimate Equation 3a in one go, which requires a non-linear regression as *g(.)* can be various non-

[7] Including leads and lags of our controls (which may be correlated with the leads and lags of our life events) leaves our results unchanged. Note that, while life events are recorded on a quarterly basis, controls are only recorded on an annual basis.

linear parametrisations of the positive and negative events indices.[8] We should mention that estimating Equation 3a in two steps or in one go makes little difference: our main finding is slightly stronger if it is estimated in one go, but the two-step procedure is easier to interpret.

The positive and negative events indices explicitly take into account anticipation and adaptation regarding life events by aggregating events weighted by their coefficient estimates, that is, by their relative contributions to the life satisfaction dynamics around the respective event. Note that the positive events index has a positive and the negative events index a negative sign. Our indices implicitly take into account that positive and negative events may *not* be symmetric and may differ from each other in terms of nature and magnitude of impact. This relaxes the assumption that changes in life satisfaction due to different life events in the positive and negative domain must be the same. Instead, it means we now look at the effect of the degree of negative influences in a period, which is a continuous notion of negativity.[9]

As to the choice of *g(.)* in the second step of our two-step estimation, we are initially agnostic and assume two different parametrisations: first, we assume a simple quadratic polynomial whereby the question of concavity is determined by the sign of the quadratic terms:

$$Y_{it} = \beta_0 + \theta_0 W^{pos}{}_{it} + \theta_1 W^{pos}{}_{it}{}^2 + \theta_2 W^{neg}{}_{it} + \theta_3 W^{neg}{}_{it}{}^2 + \beta_1 X_{it}' + u_i + \varepsilon_{it} \qquad (3c.1)$$

[8] See Appendix A Tables A2a and A2b for the parameters of the positive and negative index numbers estimated via Equation 3a. Since these are in line with estimates from previous studies, we do not discuss them in more detail. The most important thing to note is that positive events have cumulative positive and negative events cumulative negative effects.

[9] Of course, the index itself could be subjected to anticipation and adaptation, but its leads and lags would be fully collinear with the anticipation and adaptation profiles of its constituent elements, which would boil down to the same results.

Second, we use a weighting on the positive and negative domains depending on these indices:

$$Y_{it} = \beta_0 + \theta_0 W^{pos}_{it} + W^{pos}_{it} / (1 + \theta_1|W^{pos}_{it}|) + \theta_2 W^{neg}_{it} + W^{neg}_{it} / (1 + \theta_3|W^{neg}_{it}|) + \beta_1 X_{it}' + u_i + + \varepsilon_{it} \qquad (3c.2)$$

Here, the positive and negative events indices W^{pos}_{it} and W^{neg}_{it} enter the model in a non-linear manner: θ_0 and θ_2 capture the main impacts of life events, whereas θ_1 and θ_3 capture accelerating or decelerating impacts. As these models must be estimated using non-linear least squares, and non-linear least squares estimation cannot readily be applied to the individual fixed effect u_i, we transform the non-linear model by subtracting the first observation, i.e. we estimate the transformed model $Y_{it}^* = Y_{it} - Y_{i0}$.

We are initially agnostic whether Equation 3c.1 or 3c.2 fits the data best, and therefore let our model choice be guided by goodness-of-fit. In Equation 3c.1, Machiavelli's proposition boils down to the same conditions as in Equation 1: it is true if $\theta_0 > 0$ and $\theta_1 < 0$ (i.e. the relationship between positive life events and life satisfaction is concave) and $\theta_2 > 0$ and $\theta_3 > 0$ (i.e. the relationship between negative life events and life satisfaction is convex), implying that losses loom larger than gains in absolute terms and that there is no tipping point for losses. Note that we expect $\theta_2 > 0$ (rather than $\theta_2 < 0$) since the negative events index is, by definition, negative, so that θ_2 yields the strength of the correlation between negative life events and life satisfaction. In contrast, in Equation 3c.2, concavity in both domains boils down to $\theta_0 > 0$, $\theta_1 > 0$, $\theta_2 < 0$, and $\theta_3 < 0$.

4. Results

4.1. Baseline Results

Table 2 shows our baseline results. We first look at Column 1, which corresponds to the linear model of Equation 1 that lacks anticipation and adaptation effects. Recall that all specifications control for demographics, including age and age squared (divided by 100), years of education, and log household income as well as individual fixed effects.

[Table 2 about here]

Column 1 shows that the number of positive life events experienced during the past twelve months has a significant positive effect on life satisfaction, whereas the number of negative events has a significant negative effect, both at the 1% significance level. Unlike for positive events, the quadratic for negative events also has a significant negative effect at the 1% level, which is, however, smaller in size; the quadratic for positive events fails to meet a conventional significance level. From this parsimonious model without temporal dynamics, it seems that there is a linear relationship between positive life events and life satisfaction, but a concave one for negative life events, whereby life satisfaction is decreasing at an increasing rate in the number of negative events. This rejects Machiavelli's proposition, and is more in line with a tipping point interpretation for negative events: incurring all injuries at once would bring about greater welfare loss than incurring the same amount of injuries little by little during a given period of time. Note, however, that we cannot yet reject the null that the positive and negative profiles are the same in this parsimonious model without temporal dynamics.[10]

Column 2 corresponds to Equation 2 and uses, instead of counts, binary measures corresponding to how many positive or negative events were experienced during the past twelve months. This binary parametrisation is more flexible, yet a similar picture arises as for the count

[10] We tested equivalence between positive and negative profiles using an F-test: the empirical value of $F(2; 26{,}447) = 1.3$ did not exceed the critical value of 4.6.

parametrisation: there seems to be a linear (or slightly concave) relationship between positive life events and life satisfaction, with life satisfaction increasing linearly (or at a slightly decreasing rate) in the number of positive events (significance levels tend to decrease in the number of positive events). The picture for negative life events is less clear but also suggestive of a concave as opposed to convex relationship, pointing again towards a tipping point interpretation for negative events. Figure A1 in Appendix A plots coefficient estimates obtained when estimating Equation 2.

Column 3 corresponds to the two-step linear model in Equation 3c.1, with positive and negative life events entering the model as indices in both levels and quadratics. Accounting for anticipation and adaptation within these indices, a similar picture arises as before: the index for positive life events has a strong, significant positive effect on life satisfaction at the 1% level, whereas the quadratic effect of the positive life events has the expected sign (negative). However, its t-value of 1.6 fails to meet the conventional levels of statistical significance. The index for negative life events and its quadratic are, on the contrary, both significant at the 1% level. Note that the index for negative events is, by definition, negative itself, so that a positive sign for the coefficient estimate shows the strength of the correlation between negative life events and life satisfaction only. The negative on the quadratic, which is itself always positive, implies a concave relationship.

Overall, our results are in line with the previous, showing a linear (or slightly concave) relationship between positive life events and life satisfaction and a concave relationship for negative events. This is again in line with a tipping point interpretation for negative events: incurring all injuries at once would bring about greater damage than incurring them little by little during a given period of time. Figure 2 plots coefficient estimates obtained when estimating Equation 3c.1: there is concavity between gains and life satisfaction as well as concavity between losses and life satisfaction. In other words, at least for life events as specific arguments into the life-satisfaction function, the life-satisfaction function seems to be concave everywhere and not S-shaped. Note that we are agnostic about whether there exists a kink at the reference point, since our measure of life events is not on a single continuous dimension that would allow us to cardinally compare the positive with the negative.[11]

[Figure 2 about here]

We ran joint hypotheses tests to check more formally whether we can reject linearity in the effects of positive and negative life events on life satisfaction. For positive events, we cannot reject the null that the coefficient for the positive events index in levels equals one and the quadratic equals zero: $F(2; 18{,}709) = 1.26$; $Prob > F = 0.28$. For negative events, however, we can reject the null that the coefficient for the negative events index in levels equals one and the quadratic equals zero: $F(2; 18{,}709) = 6.27$; $Prob > F = 0.002$. These hypotheses tests confirm linearity in the positive and concavity in the negative domain, as shown previously.

Column 4 corresponds to Equation 3c.2, which inserts the indices in a non-linear manner (i.e. $\theta_0 W^{pos}_{it} + W^{pos}_{it} / (1 + \theta_1 |W^{pos}_{it}|)$ and $\theta_2 W^{neg}_{it} + W^{neg}_{it} / (1 + \theta_3 |W^{neg}_{it}|)$), whereby γ_0 and γ_2 capture the main impacts of events and γ_1 and γ_3 accelerating or decelerating impacts. It is again in line with the previous results: positive events (θ_0) have a positive effect on life satisfaction which is significant at the 1% level, whereby the dampening effect (θ_1) also has a strong positive coefficient. However, it fails to reach statistical significance at a conventional level ($t = 1.7$). This suggests a linear (or slightly concave) relationship between positive life events and life

[11] If one looks at the two life events that potentially allow one to construct a cardinal, one-dimensional interpretation (that is, predicted income changes when respondents report positive or negative financial shocks), the resulting non-linearity around the reference point is indeed roughly a factor of two (Frijters et al., 2011), which is similar to the kink in the value function under prospect theory (Kahneman and Tversky, 1979).

satisfaction. In contrast, both θ_2 and θ_3 have significant negative coefficients, in line with a concave relationship. Figure A2 in Appendix A plots the predicted relation between the events indices and life satisfaction estimated from Equation 3c.2.

We again ran joint hypotheses tests to check more formally for linearity in the relationships between life satisfaction and positive or negative life events. In case of our non-linear model, we conducted likelihood-ratio tests. For positive events, we reject the null that the coefficients for the positive events index (first term) and for its absolute value (second term) equals zero: LR $\chi^2(2) = 26.87$; Prob > $\chi^2 = 0.0000$. Likewise, for negative events, we reject the null: LR $\chi^2(2) = 118.18$; Prob > $\chi^2 = 0.0000$. Once again, this is in line with concavity in both positive and negative domains.

4.2. Heterogeneous Effects

Do these findings hold for different types of people? To find out, we run a heterogeneity analysis on our preferred model according to goodness-of-fit, Equation 3c.1. Table 3 shows the results when splitting the estimation sample by gender, education, age, and extraversion *versus* introversion as dimensions on the Big-5 personality traits spectrum that have been shown to be relevant for life satisfaction (Schimmack et al., 2002, 2004).[12]

[Table 3 about here]

Our baseline result – a concave relationship between life satisfaction and life events – holds across different demographic and personality characteristics. There are, however, slight differences in curvature between different types of respondents. Table 3 Columns 1 and 2 show that

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[12] Table A3 in Appendix A replicates this exercise for Table 2 Column 4, that is, the non-linear model accounting for anticipation and adaptation, which is our second-best model according to goodness-of-fit.

men benefit, relative to women, more strongly from positive life events but also show stronger diminishing returns. Moreover, men experience a less strong initial decrease in life satisfaction following negative life events but at the same time a stronger depreciation as more and more negative events occur in a given period of time. This may relate to differences in risk preferences between gender (as evidenced by Borghans et al. (2009), Sapienza et al. (2009), or Charness and Gneezy (2012), amongst others). The relationship is not straightforward, though: it seems there is more to win for men with positive life events but also more to lose if multiple negative events occur. One could similarly say that women are more sensitive to small negative but more resilient when it comes to larger negative shocks compared to men.

While people with low education (defined as having no high school degree) have a similar profile when it comes to positive life events as people with higher education, they show a larger decrease in life satisfaction following a negative life event, thus being more sensitive to negative events. However, people with higher education report a steeper decline once more and more negative events occur in a given period of time. Age differences are minor, with the exception that people above 40 years of age show a significant quadratic on positive life events, providing evidence for diminishing returns.

Following Buddelmeyer and Powdthavee (2016) and Etilé et al. (2019), we also test for sensitivity between people with different personality traits: compared to extroverted people, introverts exhibit stronger diminishing returns to positive life events while, at the same time, a steeper decline once more and more negative events occur.

4.3. Robustness to Variable Selection and Sampling Issues

We next run a series of robustness checks using our preferred specification in Equation 3c.1. Results are presented in Table 4; Figure 3 plots coefficient estimates from these robustness checks. We discuss them in turn.[13]

[Table 4 about here]

4.3.1. Exogenous and Unanticipated Life Events

One obvious worry is the potential endogeneity of life events, which could, for instance, bias our results if it was true that most of the occasions in which a person experienced a single positive or negative event were the result of conscious choices and thus already anticipated long ago, but where this would not be true for individuals hit by many shocks. We would then underestimate the importance of single shocks *versus* multiple shocks.

To investigate this further, we focus only on more exogenous positive and negative events which individuals are less likely to have initiated or anticipated. We choose these events in two ways. First, in Column 1 of Table 4, we let our choice be guided by the related literature in economics, in which death and bereavement of a family member, relative, or friend are often taken as exogenous negative (see Goudie et al. (2014), Oswald et al. (2015), or Liberini et al. (2017), for example) and a financial improvement due to a lottery win as an exogenous positive life event (see Gardner and Oswald (2007) or Kuhn et al. (2011), for example).[14] Naturally,

[13] Corresponding results for Equation 3c.2 can be found in Table A4 in Appendix A. See Figure A3 for the plotted coefficients of these robustness checks.

[14] The HILDA panel includes many more life events than other datasets. More exogenous positive life events are *major improvements in finance (e.g. won lottery)*, more exogenous negative ones *death of a close friend*, *death of an extended family member or relative*, *death of a spouse or a child*, *major worsening of finances (e.g. went bankrupt)*, *made redundant*, *serious illness or injury to a family member*, *serious personal illness or injury*, *family*

lottery players may have different preferences than the general population but (time-invariant) differences in preferences are captured by our individual fixed effects. Second, in Column 2 of Table 4, we focus only on those events that have been shown empirically in our regressions to involve insignificant levels of anticipation.[15]

The signs, sizes, and significance levels of the coefficients in Column 1 closely mimic those of our preferred specification, showing that picking the life events that are more exogenous makes little difference. Almost the same is true in Column 2 when restricting the sample to respondents experiencing events for which we do not find significant anticipation effects. One exception is that the quadratic for the positive events index turns significant, showing more clearly a concave relationship between positive life events and life satisfaction. Overall, restricting the sample to respondents experiencing more exogenous events strengthens our initial conclusions.

In Appendix C, we conduct a range of additional robustness checks to investigate the exogeneity of life events. In particular, we cross-tabulate the number of positive life events conditional on negative life events, and vice versa. We show that, as individuals remain in the panel for longer, the number of positive or negative life events is (almost) invariant, or unconditional, on the other. When re-estimating our baseline specification for individuals who remain in the panel for longer, our results are left unchanged. Moreover, we show that observables have little predictive power in explaining the experience of positive or negative life events. Finally,

member detained in jail, *detained in jail (self)*, *victim of property crime (e.g. theft, breaking and entering)*, and *victim of physical violence (e.g. assault)*.

[15] Positive life events without significant anticipation are *major improvements in finance (e.g. won lottery)*, *retired*, and *got back together with spouse*. Negative life events are *death of a close friend*, *death of an extended family member of relative*, *made redundant*, *family member detained in jail*, *detained in jail (self)*, *victim of property crime (e.g. theft, entering and breaking)*, and *victim of physical violence (e.g. assault)*.

we show that our results are left unchanged when restricting our sample to those individuals who experience at least one positive and one negative life event. Taken together, these additional robustness checks provide further evidence that selection into positive or negative life events is rather unlikely to be a key driver behind our results, and that we are indeed teasing out the shape of the life-satisfaction function as opposed to group-level heterogeneity.

4.3.2. Selective Attrition

Another worry is selective attrition: respondents who are most positively affected by positive life events (for example, a lottery win) may be more likely to drop out of the sample. By the same token, respondents who are most negatively affected by negative life events (for example, the death of a friend) may be more likely to drop out. In both cases, systematic out-of-sample-selection biases our results downwards, potentially with knock-on effects for our non-linearities. To investigate this, in Column 3, we show the results when restricting our estimation sample to respondents who are present during the entire observation period.

As expected, we find that, when excluding drop-outs *ex-ante*, coefficient estimates are slightly smaller in size in the positive domain than those in our preferred specification; in the negative domain, they are only negligibly different. Taken together, this suggests that selective attrition has little impact on our findings.

4.3. Estimation Procedure: Two-Step Versus One-Go

It is important to note that the two-step procedure for estimating Equation 3c.1 essentially imposes first-step estimates on elements of *g(.)* in the second step. This can lead to bias if the first-step estimates are themselves picking up non-linearities via sample correlations between the underlying non-linearities and particular shocks. We therefore check next whether the results remain the same when estimating both the indices and the non-linearities in one go.

[Table 5 about here]

Table 5 shows the results of this exercise, with Column 1 presenting the results of the two-step procedure for estimating Equation 3c.1 and Column 2 the corresponding results when estimating the same equation in one go. The reason why the linear terms for the negative and positive events have no standard errors in the one-step model is because there is perfect collinearity between the coefficients of the events indices and the coefficients of the events in these indices in the one-go procedure, so we have one degree of freedom that requires a parameter normalisation. To keep the results easy to compare, we therefore set the linear terms to coincide with their counterparts in the two-step procedure.

Importantly, our results strengthen when using the two-step procedure in the sense that the coefficient estimate of the quadratic of the positive events index becomes even more negative and now statistically significant (-0.588 now *versus* -0.415 in our preferred specification). Likewise, the coefficient estimate of the quadratic of the negative events index becomes more negative and significant (-1.644 *versus* -0.201).

The R^2 requires careful interpretation as the underlying models do not naturally yield comparable estimates of explained variance. This is due to the fact that the implicit individual fixed effects in the two-step model differ from those in the one-step. We therefore have to define the relevant baseline variation against which the explained variation of the two models can be judged. We chose within-person variation, i.e. the total variation as the sum of the squares of individual outcomes less their first observed outcome. If we use this as our baseline variation, we find that the one-step model fits the data slightly better than the two-step model (0.0752 *versus* 0.0711).

4.4. Additional Robustness Checks

We conduct a series of additional robustness checks, including *(i)* the use of meta-survey measures of respondents' engagement with survey questions to check how serious respondents took them, *(ii)* testing for interactions of successive life events over time, and *(iii)* using alternative, non-linear estimators (i.e. panel-data ordered logit models with individual fixed effects, cf. Baetschmann, 2012; Baetschmann et al., 2015). These additional checks, which can be found in Appendix B, confirm our key finding of a globally concave life-satisfaction function.

5. Counterfactuals and Social Welfare Implications

How relevant are the non-linearities we detect? To answer this question, we assume – purely hypothetically – that we could reallocate events over time and over individuals. After all, this is the perspective Machiavelli takes: that of someone powerful enough to choose when to 'inflict' injuries. To gauge the potential for gains from optimal spacing, we look at hypothetical policies in which the negative and positive events are spaced out in time and over people rather than how they are distributed in the actual data. For this hypothetical exercise, we make no comment as to whether such a policy would be feasible or how it could be implemented, but only look at the potential gains, *ceteris paribus*, of spreading events.

Different events have different effects that furthermore have complicated patterns over time. Also, there are rather a lot of them. So in stead of considering the effect of changing the timing of any particular event, we will consider the effect of changing the index of positive or negative events in any year.

To calculate potential gains from changing the timing of events, we first need estimates for how much life satisfaction is changed in the actual data by positive events and negative events, on average per year. This is relatively straightforward: it is the predicted average value of the positive and negative indices. For these estimates, we use Table 2 Column 3.

The *status quo* currently yields the following life satisfaction effects for positive events:

$$\frac{1}{n}\sum_{i}^{n}\overline{\hat{g}(positive\ index)}$$

$$= \frac{1}{n}\sum_{i=1}^{n}\frac{1}{t_i}\sum_{t=1}^{t_i}(1.141 * positive\ index_{it} - 0.415 * positive\ index\ {_{it}}^{2})$$

$$= 0.0521$$

The equivalent life satisfaction loss for negative events is given by:

$$\frac{1}{n}\sum_{i}^{n}\overline{\hat{g}(negative\ index)}$$

$$= \frac{1}{n}\sum_{i=1}^{n}\frac{1}{t_i}\sum_{t=1}^{t_i}(0.816 * negative\ index_{it} - 0.201 * negative\ index\ {_{it}}^{2})$$

$$= -0.1012$$

These are hence the status quo effects of all positive and negative events, which respects their current distribution over time and over individuals. As there are twelve negative and six positive events in the data, it is not entirely surprising that the total positive effects are about half those of the total negative effects. These somewhat low average effects reflect the fact that many individuals report no life events in a particular year, and that many events have somewhat small impacts.

If we first think about the gain that individuals could get if the events they individually experienced in the actual data were evenly spaced (rather than arrive in lumps as they do in the data), we can calculate total effects as, respectively:

$$\frac{1}{n}\sum_{i}^{n}\overline{\hat{g}\left(\overline{positive\ index}\right)_{at\ individual\ mean}}$$

$$= \frac{1}{n}\sum_{i=1}^{n}[1.141 * (\frac{1}{t_i}\sum_{t=1}^{t_i} positive\ index_{it}) - 0.415 * \left(\frac{1}{t_i}\sum_{t=1}^{t_i} positive\ index_{it}\right)^2] = 0.0533$$

$$\frac{1}{n}\sum_{i}^{n}\overline{\hat{g}\left(\overline{negative\ index}\right)_{at\ individual\ mean}}$$

$$= \frac{1}{n}\sum_{i=1}^{n}[0.816 * (\frac{1}{t_i}\sum_{t=1}^{t_i} negative\ index_{it}) - 0.201 * \left(\frac{1}{t_i}\sum_{t=1}^{t_i} negative\ index_{it}\right)^2] = -0.0988$$

These formulas show the gain for individuals of spreading the events they experienced in the sample completely evenly, so by smoothing their individual positive and negative indices over time (but not across individuals). The results imply that the gain to an individual from spreading his or her positive events over time is about 2% compared to the *status quo*, whereas the gain from spreading his or her negative events over time is about 2.5%. In points of life satisfaction, the gains from spreading are small compared to the literature, only +0.0012 for spreading the positive events and +0.0024 for spreading the negative events.

Importantly, these counterfactuals do not assume that individuals will have fully adapted to all life events by the end of the observation period: what is spread is the index of effects from life events, which includes both anticipation and adaptation effects. Hence, individuals are not 'done' anticipating the next events at the end of the period, nor are they 'done' adapting to events at that point. In the hypothetical, we are only spreading all effects associated with positive and negative events evenly over the observation period. In reality, such a thing would only be practically possible if one would be able to have fractional negative events, which in many cases is impossible, for example when it comes to death. We are thus establishing an upper bound of the benefits of spreading events, noting that it is not a trivial mathematical exercise to determine the best spread over time of a finite set of actual events.[16]

We next consider the potential benefits of not only spreading events over time but also spreading events over individuals. We find that spreading positive events evenly over time *and* individuals yields the following life satisfaction gain, which is slightly larger (about 3%) than the *status quo*:

$$\frac{1}{n}\sum_{i}^{n}\overline{\hat{g}(\overline{positive\ index})_{at\ population\ mean}} = 1.141 * (\frac{1}{N}\sum_{j=1}^{N} positive\ index_{itj}) - 0.415 * \left(\frac{1}{N}\sum_{j=1}^{N} positive\ index_{itj}\right)^2 = 0.0629$$

[16] To see the difficulties of thinking about the spread of dichotomous events over time, consider that one would effectively assume one can do away with all anticipation effects by having all negative events happen at time zero. Also, the anticipation benefit of all positive events together with adaptation benefits are optimised by having a positive event happen in the middle of a bounded time period. Such implications are not in the spirit of the idea of optimal spreading and would require fairly *ad-hoc* additional conditions to avoid. Simply spreading the index respects both anticipation and adaptation effects and hence concentrates the discussion on the benefits of optimising the non-linearity of effects.

What hence happens in these formulas is that we allocated to everyone the average positive index over all individuals in a period, rather than their own experienced one. Equivalently, spreading negative events evenly over time *and* individuals yields the following life satisfaction gain, which is lower (about 5%) than the *status quo*:

$$\frac{1}{n}\sum_{i}^{n} \overline{\hat{g}\left(\overline{negative\ index}\right)_{at\ population\ mean}} = 0.816 * \left(\frac{1}{N}\sum_{j=1}^{N} negative\ index_{itj}\right) - 0.201 * \left(\frac{1}{N}\sum_{j=1}^{N} negative\ index_{itj}\right)^2 = -0.0961$$

An optimal, net life satisfaction-maximising allocation, which is one that inflicts all injuries and confers all benefits little by little (as opposed to all at once) and which is spread evenly over time and individuals thus yields a life satisfaction gain of +0.0108 for positive events and +0.0051 for negative events. The fact that the gain of spreading positive events over individuals is larger than spreading negative events basically comes from the empirical reality that positive events are far more unequally distributed over individuals than negative events, many of which are experienced in roughly equal measure by everyone (like death of the parents). Taken together, a total reallocation of events would mean about 12% of the absolute effect of life events.[17]

[17] Given that our life events are already rather spread out within individuals, we also calculated a counterfactual in which the entire sum of the index for individuals (including anticipation and adaptation) is assumed to occur within one period (i.e. 'total bunching'): while the counterfactual for negative events remains largely the same, that for positive events increases by a factor of about three.

7. Conclusion

We set out by asking whether it makes a difference for net life satisfaction if a given number of losses and gains incur all at once or little by little during a given period of time. Machiavelli, in his treatise on political philosophy, argued that injuries should be inflicted all at once, whereas benefits should be conferred little by little. If we were to translate Machiavelli's prescript into economic terms using the notion of a utility function, his reasoning assumes an S-shaped function that is concave in gains and convex in losses. Under classic economic assumptions, however, the utility function is concave in *both* positive and negative domains, which would lead to a different conclusion: it would be better if *losses* were *not* bunched but spread out.

We test Machiavelli's prescript empirically using the analogy of life events and data on self-reported life satisfaction. We show that our empirical life-satisfaction function is concave in *both* negative and positive life events, which leads us to reject Machiavelli's prescript, at least for life events and life satisfaction. If data on life satisfaction can provide insights into the shape of the utility function, our finding would be suggestive of a utility function that is concave everywhere, much in line with classic economic assumptions. The non-linearity is particularly strong for more than two negative events, with five negative events in the same year rated as just as bad as eleven events each experienced in different years. This finding continues to hold after allowing for selection, anticipation, and adaptation, as well as for event-specific effects. Moreover, we arrive at the same result when using only events that individuals themselves say were unanticipated, or when following the economics literature and using only the most exogenous events in our sample – the best we can do to overcome potential endogeneity. Finally, our findings also hold when including meta-measures of how seriously respondents have answered the questions, addressing the possibility that the results may be based on frivolous respondents, as well as when using alternative, non-linear estimators (i.e. panel-data ordered logit models with individual fixed effects).

Whilst potentially important for individuals who experience many positive or negative life events, we find that the benefits of a hypothetical spreading of events over time are modest on average, simply because in empirical reality negative and positive events are already quite spaced in time. Thus, a hypothetical spreading of all events evenly over all time periods and individuals would increase the positive effects by 0.0108 and decrease the negative effects by 0.0051 – a modest improvement, especially when compared to preventing negative events altogether. Indeed, average improvements in life satisfaction of such an extreme spacing over time and individuals would only be about +0.016 per individual on a zero-to-ten scale.

There are two main research and policy take-aways: first, if data on life satisfaction can be used to provide insights into the shape of the utility function, the classic economic assumption of a globally concave utility function is borne out by the data. Moreover, the tipping point that occurs when too many negative events happen in a given period of time underlines the importance of policy to focus on groups at the bottom of the wellbeing distribution, for which this occurrence is relatively more likely. Second, while there is clear evidence for non-linearities in the negative and positive life events we looked at, these are of second-order consideration relative to their sheer occurrence, unless one is specifically interested in the very left or right tail of the wellbeing distribution. For these extremes, however, one wants to know more about implications of having many negative and positive life events, such as the costs imposed on others and the possibility that adaptation becomes slower if one has experienced many negative shocks in quick succession. These considerations should be part of future inquiries.

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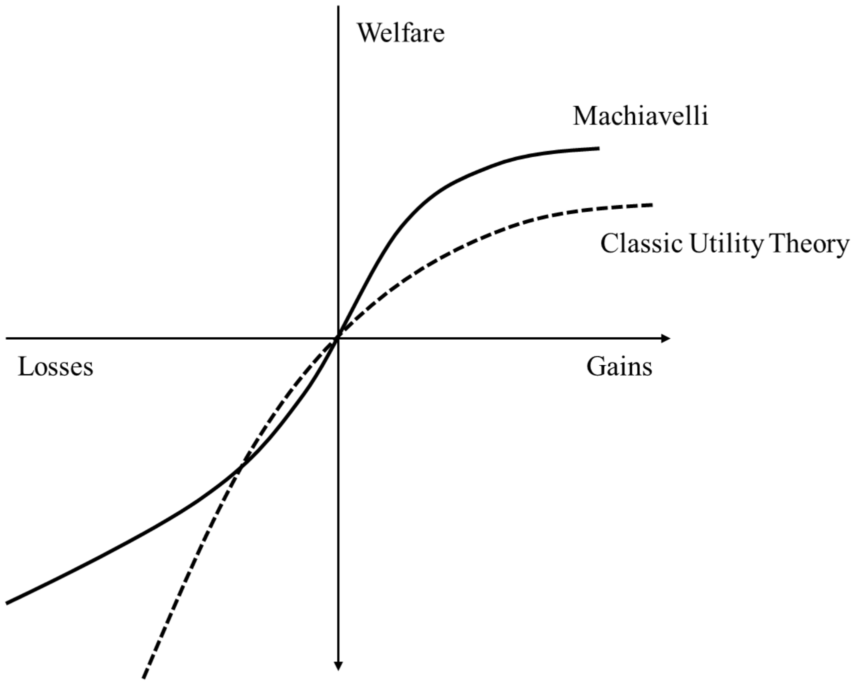
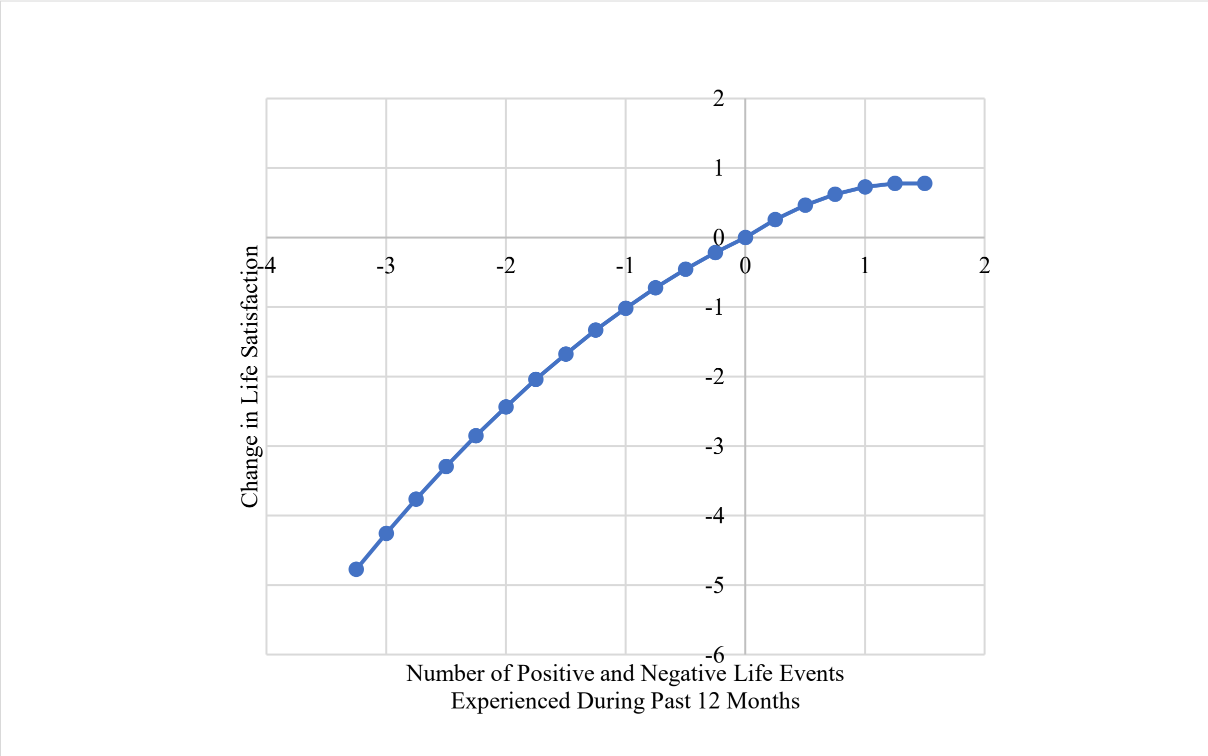
Figures

Figure 1: Assumptions on Different Shapes of Utility Function



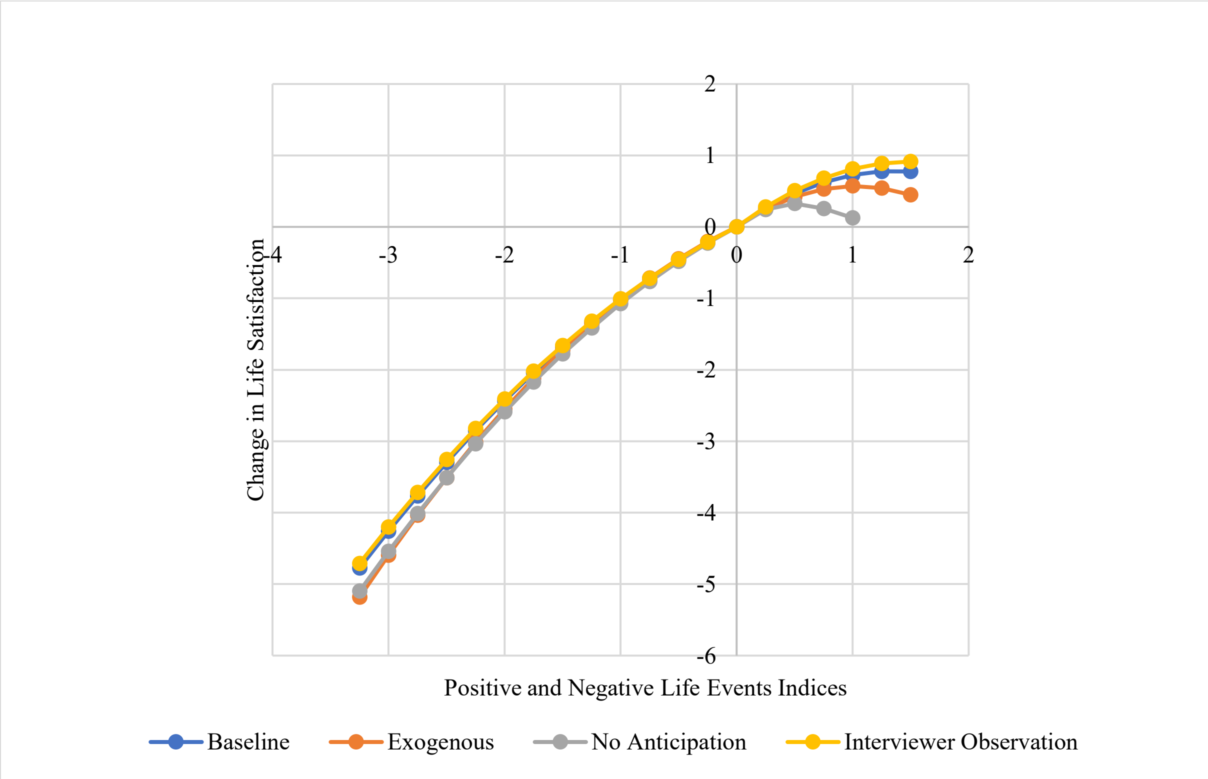
Source: own illustration.

Figure 2: Baseline Results – Linear Model, Anticipation/Adaptation, Index



Notes: Figure plots life satisfaction predicted from estimates obtained when estimating Equation 3c.1 (Table 2 Column 3). Life satisfaction is measured on a zero-to-ten scale. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Figure 3: Robustness Checks – Linear Model, Anticipation/Adaptation, Index



Notes: Figure plots life satisfaction predicted from estimates obtained when estimating Equation 3c.1 (Table 2 Column 3 for baseline; Table 4 Column 1 for exogenous, Colum 2 for no anticipation, and Column 3 for interviewer observation). Life satisfaction is measured on a zero-to-ten scale. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Tables

Table 1: Summary Statistics by Life Event

Life Events	Number of Occurrences	Means Conditional on Occurrence of Life Event			
		Life Events	Age	Years of Education	Annual Household Income (AUD)
Panel A: Positive Life Events					
Birth or Adoption of a New Child	6,736	4.038	31.728	13.050	71,040
Major Improvements in Finance	5,536	3.620	44.920	12.790	62,693
Got Married	4,339	3.802	35.313	12.881	77,420
Got Promoted	11,448	4.102	33.778	13.224	93,714
Retired	4,040	2.945	60.820	11.661	30,977
Got Back Together with Spouse	1,781	3.665	34.997	12.196	45,026
Panel B: Negative Life Events					
Death of a Close Friend	18,566	9.849	52.412	11.79	35,137
Death of an Extended Family Member or a Relative	19,730	8.57	44.223	12.172	52,945
Death of a Spouse or a Child	1,171	10.003	54.836	11.397	19,053
Major Worsening in Finances	5,083	11.133	43.475	12.384	40,255
Made Redundant	5,091	8.819	37.795	12.356	62,193
Serious Illness or Injury of a Family Member	27,333	9.557	45.7	12.363	50,869
Serious Personal Illness or Injury	14,620	9.969	49.324	12.123	38,446
Family Member Detained in Jail	2,332	10.246	39.133	11.587	37,198
Detained in Jail	333	10.387	33.174	11.088	23,389
Victim of Property Crime	7,359	9	38.92	12.544	54,502
Victim of Physical Violence	2,496	11.047	32.834	11.875	35,775
Separated from Spouse	6,363	8.413	35.239	12.152	40,255

Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table 2: Baseline Results

Dependent Variable: Life Satisfaction (0-10)

	Linear Model		**Anticipation/Adaptation**	
	No Anticipation/Adaptation		**Linear Model**	**Non-Linear Model**
	Count Measures	**Binary Measures**	**Index**	**Index**
Variables of Interest	**(1)**	**(2)**	**(3)**	**(4)**
Number of Positive Life Events	0.074***			
	(0.017)			
Number of Positive Life Events Squared	0.017			
	(0.012)			
Number of Negative Life Events	-0.070***			
	(0.007)			
Number of Negative Life Events Squared	-0.015***			
	(0.003)			
Experienced 3 or More Positive Life Events		0.281*		
		(0.113)		
Experienced 2 Positive Life Events		0.212***		
		(0.022)		
Experienced 1 Positive Life Event		0.093***		
		(0.008)		
Experienced 1 Negative Life Event		-0.083***		
		(0.006)		
Experienced 2 Negative Life Events		-0.194***		
		(0.010)		
Experienced 3 Negative Life Events		-0.367***		
		(0.021)		
Experienced 4 Negative Life Events		-0.449***		
		(0.046)		

Experienced 5 Negative Life Events		-0.900^{***}		
		(0.095)		
Experienced 6 or More Negative Life Events		-1.187^{***}		
		(0.177)		
Positive Life Events Index			1.141^{***}	
			(0.085)	
Positive Life Events Index Squared			-0.415	
			(0.259)	
Negative Life Events Index			0.816^{***}	
			(0.058)	
Negative Life Events Index Squared			-0.201^{***}	
			(0.060)	
Positive Life Events Index				0.359^{***}
				(0.107)
Positive Life Events Index / (1 + Coefficient *|Positive Life Events Index|)				1.071
				(0.627)
Negative Life Events Index				-0.234^{***}
				(0.063)
Negative Life Events Index / (1 + Coefficient *|Negative Life Events Index|)				-0.181^{***}
				(0.025)
Controls	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.017	0.0172	0.0711	0.0305
N	176,280	176,280	116,959	116,959

Robust standard errors clustered at individual level in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table 3: Heterogeneous Effects – Linear Model, Index

Dependent Variable: Life Satisfaction (0-10) *Variables of Interest*		**Male** **(1)**	**Female** **(2)**	**< High School** **(3)**	**>= High School** **(4)**	**< 40 Years** **(5)**	**>= 40 Years** **(6)**	**Extro-verted** **(7)**	**Intro-verted** **(8)**
Positive Events Index		1.203***	0.957***	1.097***	1.033***	1.043***	1.289***	0.997***	1.162***
		(0.139)	*(0.077)*	*(0.113)*	*(0.064)*	*(0.105)*	*(0.118)*	*(0.105)*	*(0.100)*
	p-value for significant difference	0.518		0.073		0.000		0.570	
Positive Events Index Squared		-0.569	0.232	-0.225	-0.274	-0.051	-0.812***	0.106	-0.471*
		(0.382)	*(0.230)*	*(0.296)*	*(0.233)*	*(0.268)*	*(0.295)*	*(0.344)*	*(0.277)*
	p-value for significant difference	0.322		0.203		0.000		0.621	
Negative Events Index		0.658***	0.872***	0.900***	0.709***	0.804***	0.808***	0.853***	0.766***
		(0.074)	*(0.077)*	*(0.065)*	*(0.078)*	*(0.074)*	*(0.071)*	*(0.070)*	*(0.097)*
	p-value for significant difference	0.045		0.034		0.361		0.790	
Negative Events Index Squared		-0.366***	-0.147*	-0.117*	-0.321***	-0.228***	-0.197***	-0.168**	-0.230**
		(0.078)	*(0.080)*	*(0.066)*	*(0.074)*	*(0.080)*	*(0.067)*	*(0.073)*	*(0.100)*
	p-value for significant difference	0.003		0.005		0.842		0.876	
Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared		0.0763	0.0641	0.0528	0.0659	0.0753	0.0576	0.0613	0.0663
N		55,036	61,923	79,919	37,040	63,287	53,672	62,318	45,359

Robust standard errors clustered at individual level in parentheses.

* *p < 0.05,* ** *p < 0.01,* *** *p < 0.001*

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table 4: Robustness Checks – Linear Model, Index

Dependent Variable: Life Satisfaction (0-10) *Variables of Interest*	**Exogenous Events Only** **(1)**	**Events Without Significant Anticipation** **(2)**	**Balanced Panel** **(3)**	**Including Interviewer Observation Controls** **(4)**
Positive Events Index	1.118***	1.279***	0.985***	1.121***
	(0.169)	*(0.133)*	*(0.085)*	*(0.085)*
Positive Events Index Squared	-0.546	-1.252**	0.101	-0.400
	(0.634)	*(0.499)*	*(0.348)*	*(0.258)*
Negative Events Index	0.766***	0.857***	0.809***	0.812***
	(0.065)	*(0.104)*	*(0.075)*	*(0.056)*
Negative Events Index Squared	-0.255***	-0.219***	-0.232***	-0.196***
	(0.070)	*(0.063)*	*(0.088)*	*(0.057)*
Controls	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.0619	0.0104	0.0627	0.0734
N	116,959	116,959	41,074	116,931

Robust standard errors clustered at individual level in parentheses.

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table 5: Estimation Procedure: Two-Step Versus One-Go

Dependent Variable: Life Satisfaction (0-10)

	Anticipation/Adaptation	
	Two-Step	**One-Step**
	Linear Model	**Linear Model**
	Index	**Index**
Variables of Interest	**(1)**	**(2)**
Positive Life Events Index	1.141***	1.141***
	(0.085)	*N/A*
Positive Life Events Index Squared	-0.415	-0.588***
	(0.259)	*N/A*
Negative Life Events Index	0.816***	0.816***
	(0.058)	*N/A*
Negative Life Events Index Squared	-0.201***	-1.644***
	(0.060)	*N/A*
Controls	Yes	Yes
Individual Fixed Effects	Yes	Yes
R-Squared	0.0711	0.0752
N	116,959	116,959

Robust standard errors clustered at individual level in parentheses.

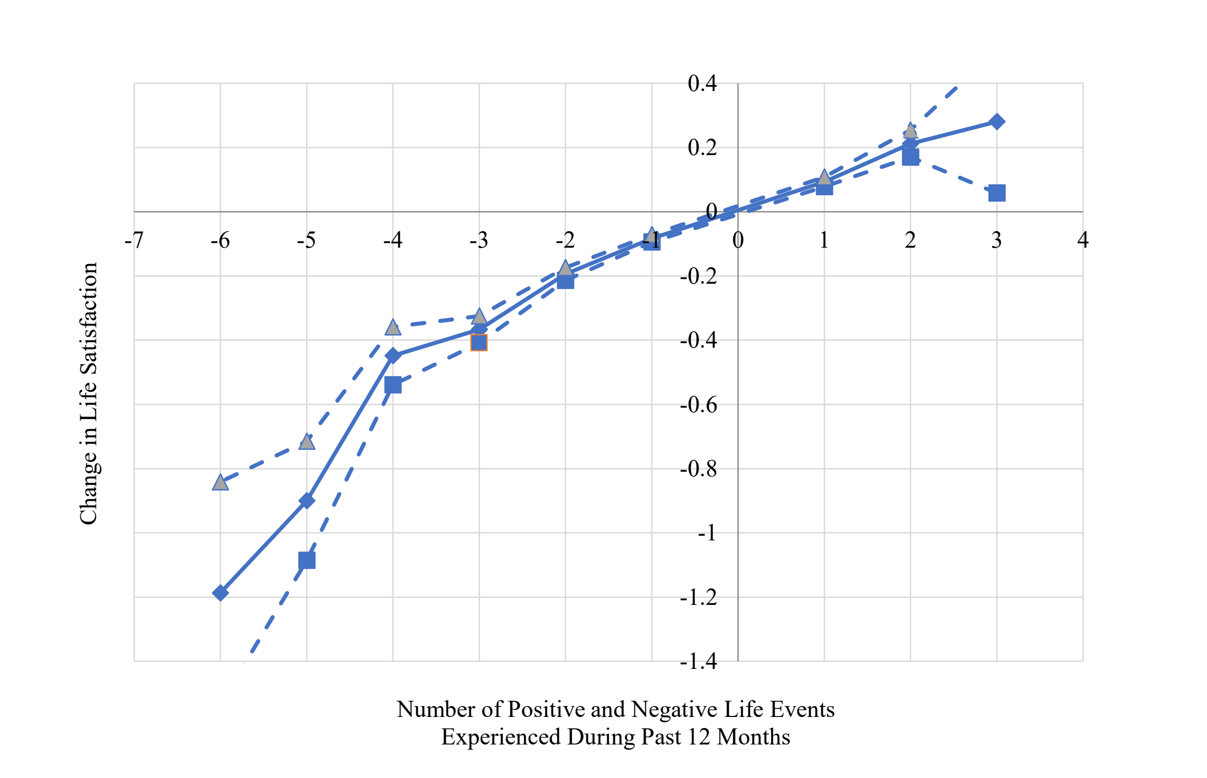
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared divided by 100, years of education, and log household income. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Appendix A

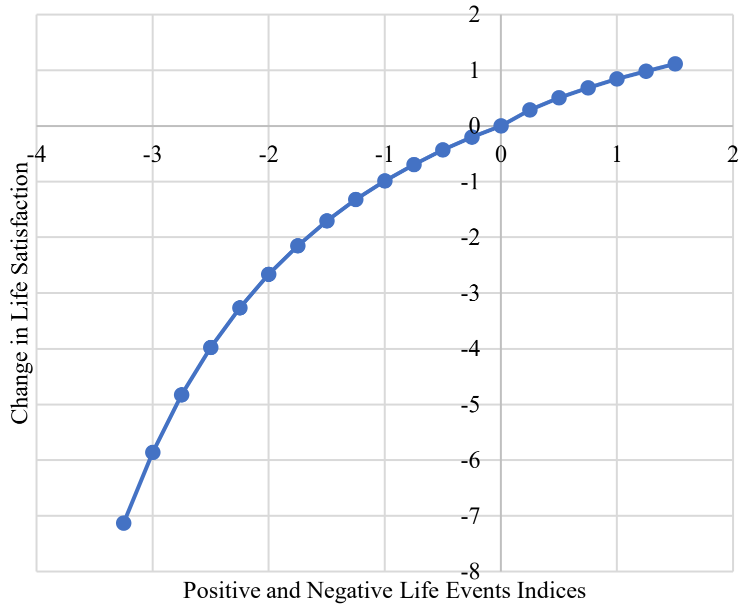
Figures

Figure A1: Baseline Results – Linear Model, No Anticipation/Adaptation, Binary Measures



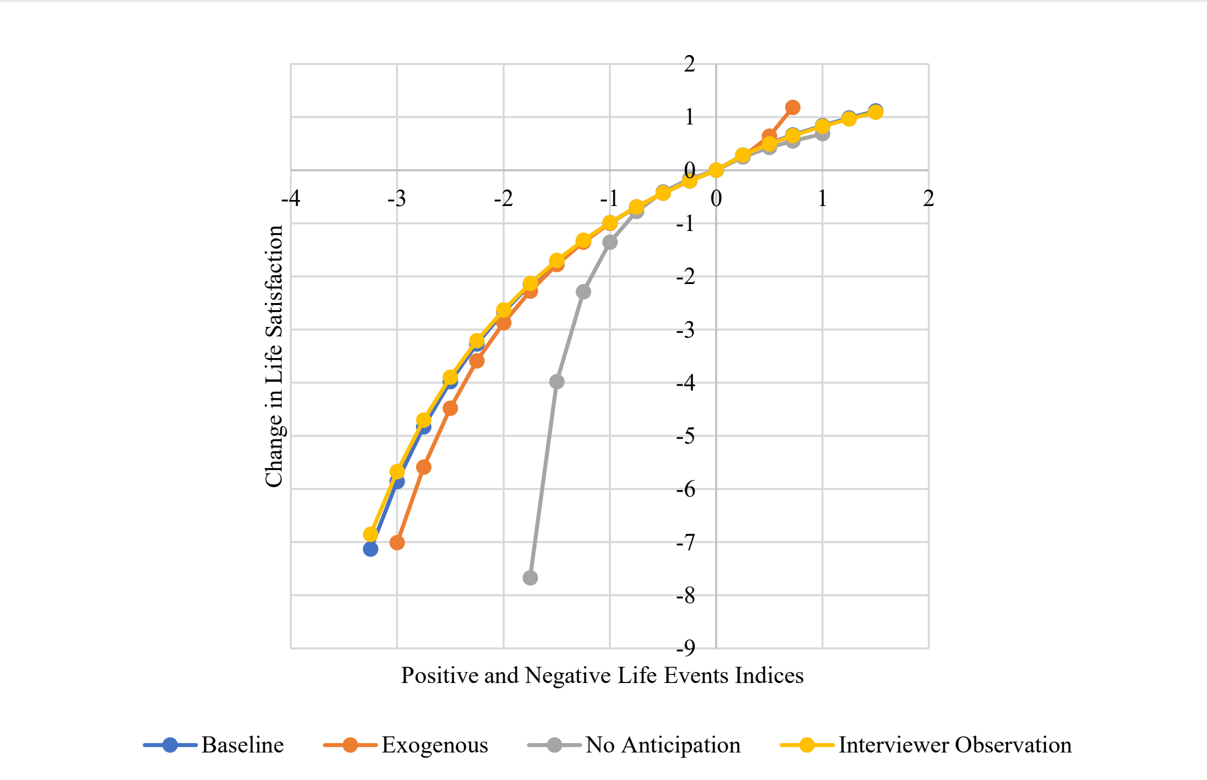
Notes: Figure plots life satisfaction predicted from estimates obtained when estimating Equation 3b (Table 2 Column 2). Life satisfaction is measured on a zero-to-ten scale. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Dashed lines are 95% confidence bands.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Figure A2: Baseline Results – Non-Linear Model, Anticipation/Adaptation, Index



Notes: Figure plots life satisfaction predicted from estimates obtained when estimating Equation 3c.2 (Table 2 Column 4). Life satisfaction is measured on a zero-to-ten scale. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Figure A3: Robustness Checks – Non-Linear Model, Anticipation/Adaptation, Index



Notes: Figure plots life satisfaction predicted from estimates obtained when estimating Equation 3c.2 (see Table 2 Column 4 for baseline; Table A4 Column 1 for exogenous, Column 2 for no anticipation, and Column 3 for interviewer observations). Life satisfaction is measured on a zero-to-ten scale. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table A1: Distribution of Life Events in Last 12 Months

Number of Events Experienced in Last 12 Months	Counts of Person-Year Observations
Experienced 3 or More Positive Events	178
Experienced 2 Positive Events	2,760
Experienced 1 Positive Event	27,135
Experienced 1 Negative Event	50,025
Experienced 2 Negative Events	18,380
Experienced 3 Negative Events	5,260
Experienced 4 Negative Events	1,335
Experienced 5 Negative Events	421
Experienced 6 or More Negative Events	178
	178,965

Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table A2a: Anticipation and Adaptation to Positive Life Events

Dependent Variable: Life Satisfaction (0-10)

Variables of Interest	**Birth or Adoption of New Child (1)**	**Major Improvements in Finance (2)**	**Got Promoted (3)**	**Got Married (4)**	**Retired (5)**	**Got Back Together With Spouse (6)**
< -24 Months	-0.060***	0.059***	0.076**	0.013	0.091***	0.034
	(0.017)	*(0.017)*	*(0.028)*	*(0.011)*	*(0.023)*	*(0.041)*
-24 to -18 Months	-0.05	0.123***	0.090*	-0.012	0.142***	0.123
	(0.026)	*(0.030)*	*(0.035)*	*(0.020)*	*(0.037)*	*(0.090)*
-18 to -12 Months	-0.025	0.067*	0.106**	0.021	0.149***	0.029
	(0.026)	*(0.027)*	*(0.039)*	*(0.018)*	*(0.044)*	*(0.069)*
-12 to -6 Months	0.091***	0.145***	0.156***	0.001	0.083*	0.206**
	(0.027)	*(0.031)*	*(0.035)*	*(0.022)*	*(0.040)*	*(0.077)*
-6 to 0 Months	0.141***	0.187***	0.224***	0.063***	0.07	0.038
	(0.026)	*(0.026)*	*(0.040)*	*(0.018)*	*(0.043)*	*(0.066)*
0 to 6 Months	0.124***	-0.049	0.141***	0.008	-0.044	0.022
	(0.028)	*(0.028)*	*(0.042)*	*(0.019)*	*(0.042)*	*(0.070)*
6 to 12 Months	0.156***	-0.031	0.212***	0.008	0.045	-0.019
	(0.026)	*(0.033)*	*(0.036)*	*(0.023)*	*(0.039)*	*(0.097)*
12 to 18 Months	0.061*	-0.016	0.102*	0.054**	0.004	-0.091
	(0.027)	*(0.028)*	*(0.045)*	*(0.020)*	*(0.039)*	*(0.076)*
18 to 24 Months	0.04	-0.032	0.119**	-0.031	0.017	0.049
	(0.028)	*(0.033)*	*(0.037)*	*(0.024)*	*(0.040)*	*(0.094)*
Controls	Yes					
Individual Fixed Effects	Yes					
R-Squared	0.0726					
N	116,959					

Robust standard errors clustered at individual level in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table A2b: Anticipation and Adaptation to Negative Life Events

Dependent Variable: Life Satisfaction (0-10)

Panel A: Negative Life Events 1 to 6	**Death of a Close Friend (1)**	**Death of an Extended Family Member or Relative (2)**	**Death of a Spouse or a Child (3)**	**Major Worsening of Finances (4)**	**Made Redundant (5)**	**Serious Illness or Injury to a Family Member (6)**
< -24 Months	-0.01	0.006	-0.097*	-0.059**	0.009	0.004
	(0.008)	*(0.010)*	*(0.048)*	*(0.021)*	*(0.022)*	*(0.008)*
-24 to -18 Months	-0.016	0.009	-0.161*	-0.190***	-0.057	-0.022
	(0.020)	*(0.017)*	*(0.081)*	*(0.044)*	*(0.037)*	*(0.015)*
-18 to -12 Months	-0.004	-0.002	-0.144	-0.136**	-0.003	0.008
	(0.015)	*(0.016)*	*(0.080)*	*(0.042)*	*(0.034)*	*(0.013)*
-12 to -6 Months	-0.054**	-0.018	-0.498***	-0.580***	-0.064	-0.028
	(0.020)	*(0.016)*	*(0.110)*	*(0.050)*	*(0.040)*	*(0.015)*
-6 to 0 Months	-0.017	-0.011	-0.381***	-0.487***	-0.082*	-0.030*
	(0.015)	*(0.015)*	*(0.095)*	*(0.044)*	*(0.033)*	*(0.013)*
0 to 6 Months	0.013	-0.021	-0.139	-0.125**	0.036	0.024
	(0.015)	*(0.015)*	*(0.077)*	*(0.047)*	*(0.032)*	*(0.013)*
6 to 12 Months	0.001	-0.01	-0.246*	-0.235***	-0.056	-0.006
	(0.021)	*(0.017)*	*(0.100)*	*(0.049)*	*(0.038)*	*(0.016)*
12 to 18 Months	0.028	-0.001	-0.118	-0.105*	0.036	-0.009
	(0.015)	*(0.016)*	*(0.078)*	*(0.046)*	*(0.034)*	*(0.013)*
18 to 24 Months	-0.017	-0.007	0.035	-0.149**	-0.038	0.037*
	(0.021)	*(0.018)*	*(0.098)*	*(0.049)*	*(0.040)*	*(0.017)*

Panel B: Negative Life Events 7 to 12	**Serious Personal Illness or Injury (7)**	**Family Member Detained in Jail (8)**	**Detained in Jail (9)**	**Victim of Property Crime (10)**	**Victim of Physical Vio-lence (11)**	**Separated or Divorced from Spouse (12)**
< -24 Months	-0.059***	-0.03	-0.025	0.006	-0.087*	0.025

	(0.012)	*(0.025)*	*(0.112)*	*(0.018)*	*(0.037)*	*(0.023)*
-24 to -18 Months	-0.102***	-0.027	-0.175	-0.042	-0.103	-0.142***
	(0.023)	*(0.072)*	*(0.293)*	*(0.033)*	*(0.073)*	*(0.037)*
-18 to -12 Months	-0.063**	-0.037	0.071	0.006	-0.165**	-0.087*
	(0.020)	*(0.050)*	*(0.191)*	*(0.026)*	*(0.059)*	*(0.040)*
-12 to -6 Months	-0.236***	-0.062	-0.134	-0.084*	-0.272***	-0.298***
	(0.024)	*(0.066)*	*(0.254)*	*(0.033)*	*(0.073)*	*(0.038)*
-6 to 0 Months	-0.192***	-0.075	-0.188	-0.065*	-0.339***	-0.355***
	(0.020)	*(0.050)*	*(0.195)*	*(0.026)*	*(0.062)*	*(0.044)*
0 to 6 Months	-0.005	-0.028	-0.294	0.008	-0.233***	-0.041
	(0.020)	*(0.056)*	*(0.205)*	*(0.028)*	*(0.070)*	*(0.041)*
6 to 12 Months	-0.074**	0.049	0.146	0.016	-0.105	-0.272***
	(0.024)	*(0.069)*	*(0.265)*	*(0.037)*	*(0.080)*	*(0.040)*
12 to 18 Months	0.024	-0.088	0.059	-0.022	-0.02	-0.004
	(0.020)	*(0.058)*	*(0.196)*	*(0.029)*	*(0.067)*	*(0.044)*
18 to 24 Months	-0.004	-0.049	0.295	0.034	-0.115	-0.056
	(0.023)	*(0.066)*	*(0.175)*	*(0.040)*	*(0.093)*	*(0.037)*
Controls			Yes			
Individual Fixed Effects			Yes			
R-Squared			0.0726			
N			116,959			

Robust standard errors clustered at individual level in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table A3: Heterogeneous Effects – Non-Linear Model, Indices

Dependent Variable: Life Satisfaction (0-10)	**Male** (1)	**Female** (2)	**< High School** (3)	**>= High School** (4)	**< 40 Years** (5)	**>= 40 Years** (6)	**Extro-verted** (7)	**Intro-verted** (8)
Positive Life Events Index	0.276	0.242	0.321	0.127	0.332	0.208	0.181	0.188
	(0.307)	*(0.248)*	*(0.282)*	*(0.236)*	*(0.249)*	*(0.233)*	*(0.232)*	*(0.276)*
Positive Life Events Index / (1 + Coefficient *|Positive Life Events Index|)	0.586	0.672	0.812	0.221	0.666	0.043	0.257	0.573
	(1.307)	*(1.180)*	*(1.368)*	*(0.859)*	*(1.037)*	*(0.613)*	*(0.952)*	*(1.146)*
Negative Life Events Index	-0.259^{***}	-0.144	-0.104	-0.302^{***}	-0.218^{**}	-0.164^{**}	-0.221^{***}	-0.241^{**}
	(0.075)	*(0.095)*	*(0.086)*	*(0.092)*	*(0.091)*	*(0.084)*	*(0.083)*	*(0.114)*
Negative Life Events Index / (1 + Coefficient *|Negative Life Events Index|)	-0.199^{***}	-0.134^{***}	-0.132^{***}	-0.176^{***}	-0.166^{***}	-0.130^{***}	-0.161^{***}	-0.172^{***}
	(0.015)	*(0.044)*	*(0.050)*	*(0.020)*	*(0.053)*	*(0.013)*	*(0.032)*	*(0.056)*
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.0381	0.0314	0.0303	0.0431	0.0383	0.0336	0.0339	0.0322
N	55,036	61,923	79,919	37,040	63,287	53,672	62,318	45,359

Robust standard errors clustered at individual level in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Table A4: Robustness Checks – Non-Linear Model, Indices

Dependent Variable: Life Satisfaction (0-10)	**Exogenous Events Only**	**Events Without Significant Anticipation**	**Balanced Panel**	**Including Interviewer Observation Controls**
Variables of Interest	**(1)**	**(2)**	**(3)**	**(4)**
Positive Life Events Index	-0.170	0.196	0.434	0.348***
	(0.231)	*(0.365)*	*(0.603)*	*(0.138)*
Positive Life Events Index / (1 + Coefficient *|Positive Life Events Index|)	-0.621	1.041	2.372	1.086
	(0.448)	*(2.378)*	*(6.369)*	*(1.416)*
Negative Life Events Index	-0.260***	-0.480***	-0.152	-0.228***
	(0.069)	*(0.134)*	*(0.111)*	*(0.062)*
Negative Life Events Index / (1 + Coefficient *|Negative Life Events Index|)	-0.205***	-0.454***	-0.189***	-0.176***
	(0.027)	*(0.003)*	*(0.071)*	*(0.027)*
Controls	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.0204	0.0113	0.0414	0.0327
N	116,959	116,959	41,074	116,931

Robust standard errors clustered at individual level in parentheses.

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

Appendix B

1. Meta-Survey Measures of Respondent's Engagement with Questions

Yet another worry is the fidelity of respondents when answering questions about their life satisfaction, and retrospectively, about experiences of positive or negative life events during the past twelve months. Such non-fidelity in answering behaviour could bias our results in both directions.

To study the extent to which fidelity matters to our findings, we exploit two items that are routinely answered by interviewers after the interview of individual respondents. The first asks interviewers: "In general, how would you describe the respondent's co-operation during the interview?" The second asks: "In general, how would you describe the respondent's understanding of the questions?" For both meta-survey measures, answer possibilities range from one ("excellent") to five ("very poor"). We dichotomise both items such that one equals categories two and above (i.e. "good" and above), and zero equals categories three and less (i.e. "fair" and below). We then include both items as additional controls in our preferred specification. Table B1 Column 1 shows the result of this exercise.

We find little evidence that non-fidelity affects our findings: signs, sizes, and significance levels of coefficient estimates closely mimic those in our preferred specification.

Table B1: Robustness Check – Linear Model, Index

Dependent Variable: Life Satisfaction (0-10) *Variables of Interest*	**Including Interviewer Observation Controls** **(1)**
Positive Events Index	1.121***
	(0.085)
Positive Events Index Squared	-0.400
	(0.258)
Negative Events Index	0.812***
	(0.056)
Negative Events Index Squared	-0.196***
	(0.057)
Controls	Yes
Individual Fixed Effects	Yes
R-Squared	0.0734
N	116,931

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include age, age squared (divided by 100), years of education, and log household income. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

2. Interactions of Successive Life Events Over Time

A concern with our empirical strategy may be interaction effects between successive life events over time: if one life event (for example, a divorce) triggers another, subsequent life event (for example, moving house), there is collinearity between one life event at time t and the anticipated shock of another life event at time $t+1$, which are not cleanly statistically separable. As a result, one may pick up the effect of moving house in the future when estimating the effect of divorce in the present. In other words, what we may be picking up are interaction effects between successive negative life events over time, rather than differential effects due to differences in the number of positive and negative life events occurring in a given period.

We counter this concern in several ways: first, we note that, by including individual fixed effects and thereby looking at within-person variation, we account for (time-invariant) differences between individuals in their ability to cope with successive shocks. Second, our positive and negative life events indices in Equation 3a implicitly take into account that events may not be symmetric and may differ from each other in terms of nature and magnitude of impact. Third, as has been shown, following the literature and focusing on exogenous and unanticipated life events leaves our results qualitatively unchanged. Finally, we re-estimate Equation 3a using our two-step procedure by including lags of our negative and positive life events indices plus their interactions with current indices. If our results are driven by interaction effects over time, we would expect these interactions to turn out significant. Table B2 in the Appendix shows that this is not the case. We therefore cautiously conclude that interaction effects between successive life events over time are unlikely to drive our results.

Table B2: Robustness Check – Linear Model, Estimates With Lags of Dynamic Life Events Indices and Their Interactions

Dependent Variable: Life Satisfaction (0-10)	
	Anticipation/Adaptation
	Two-Step
	Linear Model
	Index
Variables of Interest	**(1)**
Positive Life Events Index	0.981***
	(0.072)
Lag of Positive Life Events Index	0.101
	(0.075)
Positive Life Events Index *x* Lag of Positive Life Events Index	-0.442
	(0.338)
Negative Life Events Index	0.957***
	(0.048)
Lag of Negative Life Events Index	0.007
	(0.047)
Negative Life Events Index *x* Lag of Negative Life Events Index	-0.052
	(0.081)
Controls	Yes
Individual Fixed Effects	Yes
R-Squared	0.0672
N	85,656

Robust standard errors clustered at individual level in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Life satisfaction is measured on a zero-to-ten scale. Controls include dummies for age bins (in five-year brackets), years of education, log household income, and the lags of positive and negative life events indices. See Section 2 for a description of the data and Section 3 for the procedure to create positive and negative life events indices.
Source: HILDA, 2002 to 2017, individuals aged 15 and above; own calculations.

3. Alternative, Non-Linear Estimation Procedure

As a final robustness check, we test whether our results remain qualitatively the same when using an alternative, non-linear estimation procedure instead of our conventional linear model. In particular, we re-estimate our main specifications – our model using life events indices accounting for anticipation and adaptation, our model using dummies for the number of positive and negative life events, and our model using counts – using *panel-data ordered logit models with individual fixed effects* (cf. Baetschmann, 2012; Baetschmann et al., 2015). The results are shown in Table B3 Columns 1 (indices), 2 (dummies), and 3 (counts).

As can be seen, the results using this alternative, non-linear estimation procedure remain qualitatively the same, pointing towards a globally concave life-satisfaction function.

Table B3: Robustness Check – Alternative, Non-Linear Estimation Procedure

	Robustness (FE Ord. Logit) (1)	Robustness (FE Ord. Logit) (2)	Robustness (FE Ord. Logit) (3)
Positive Life Events Index	2.831***		
	(0.211)		
Positive Life Events Index Squared	-1.284**		
	(0.605)		
Negative Life Events Index	2.003***		
	(0.099)		
Negative Life Events Index Squared	-0.147***		
	(0.059)		
Experienced 3 or More Positive Events		0.524**	
		(0.234)	
Experienced 2 Positive Events		0.472***	
		(0.048)	
Experienced 1 Positive Event		0.210***	
		(0.017)	
Experienced 1 Negative Event		-0.193***	
		(0.013)	
Experienced 2 Negative Events		-0.414***	
		(0.021)	
Experienced 3 Negative Events		-0.699***	
		(0.038)	
Experienced 4 Negative Events		-0.795***	
		(0.071)	
Experienced 5 Negative Events		-1.386***	
		(0.125)	
Experienced 6 or more Negative Events		-1.660***	

		(0.211)	
Number of Positive Events			0.199***
			(0.033)
Number of Positive Events Squared			0.013
			(0.021)
Number of Negative Events			-0.190***
			(0.013)
Number of Negative Events Squared			-0.010**
			(0.004)
Time-Varying Co-Variates	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
R^2	0.0243	0.0117	0.0116
N	116,959	176,280	176,280

Appendix C

There may be some residual selection into positive or negative life events even after controlling for time-varying observables and individual fixed effects (i.e. time-invariant observables and unobservables). This may lead us to estimating group-level heterogeneity rather than the true shape of the life-satisfaction function. To look into this, we conduct three additional robustness checks.

First, we calculate cross-tabulations of the mean number of total positive and negative life events experienced by each individual in the panel during our observation period, by quartile. The results can be seen in Table C1a.

Table C1a: Cross-Tabulation of Positive and Negative Life Events, by Quartile

Panel A. All Individuals

Quartile of Negative Life Events	**(1) Mean Number of Total Negative Life Events**	**(2) Mean Number of Total Positive Life Events**
1st Quartile	0.2	0.4
2nd Quartile	1.7	0.9
3rd Quartile	4.2	1.4
4th Quartile	10.7	2.3
Quartile of Positive Life Events	**Mean Number of Total Positive Life Events**	**Mean Number of Total Negative Life Events**
1st Quartile	0.0	3.0
2nd Quartile	0.1	2.5
3rd Quartile	1.2	4.6
4th Quartile	3.7	6.6

Panel B. Individuals in Panel for >= 10 Years

Quartile of Negative Life Events	**(3) Mean Number of Total Negative Life Events**	**(4) Mean Number of Total Positive Life Events**
1st Quartile	2.4	1.9
2nd Quartile	5.4	2.4
3rd Quartile	8.4	2.6
4th Quartile	15.6	2.6
Quartile of Positive Life Events	**Mean Number of Total Positive Life Events**	**Mean Number of Total Negative Life Events**
1st Quartile	0.1	7.5
2nd Quartile	1.2	7.8
3rd Quartile	2.5	8.1
4th Quartile	5.5	8.6

As can be seen in Table C1a Panel A Column 2, we find some evidence that the mean number of total positive life events depends somewhat on the quartile of negative life events the individual is in, whereas the mean number of total negative life events depends somewhat on the quartile of positive life events.

However, this may be an artefact of sampling: those who have been in the sample for, say, two years will have lower numbers of life events in either direction, while those who have been in the sample for more years will have higher numbers of both. In Table C1a Panel B, we test this, by restricting our sample to individuals who have been in the sample for longer, namely ten years. As can be seen in Column 4, the mean number of total positive life events does *not* vary much depending on the quartile of negative life events the individual is in, and similarly, the mean number of total negative life events does *not* vary much depending on the quarter of positive life events. There is thus little difference in positive or negative life events, respectively, depending on the number of the others.

To check whether our results remain unchanged under this sample restriction, we re-estimate our baseline specification (i.e. the quadratic specification with dynamic life events indices) for those individuals who have been in the sample for 10 years or more. We find that our results remain the same. This can be seen in Table C1b Column 3, where they can be compared to our previous results (Columns 1 and 2).

Table C1b: Baseline Specification Restricted to Individuals in Panel for >= 10 Years

	Life Satisfaction (0-10)		
	(1)	**(2)**	**(3)**
Positive Life Events Index	1.141***	1.026***	1.081***
	(0.085)	*(0.076)*	*(0.088)*
Positive Life Events Index Squared	-0.415	-0.099	-0.295
	(0.259)	*(0.278)*	*(0.313)*
Negative Life Events Index	0.816***	0.808***	0.780***
	(0.058)	*(0.067)*	*(0.063)*
Negative Life Events Index Squared	-0.201***	-0.212***	-0.221***
	(0.060)	*(0.072)*	*(0.063)*
Time-Varying Controls	Yes	Yes	Yes
Leads and Lags of Time Varying Controls	No	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
R Squared	0.071	0.080	0.074
N	116,959	116,959	85,593

Robust standard errors clustered at the individual level in parentheses. The time varying controls include age, age^2 /100, log household income, and years of education.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As a second additional robustness check, we estimate linear probability models, using key observables to predict the likelihood to experience *(i)* at least one positive life event, *(ii)* at least one negative life event, and *(iii)* at least one positive and negative life event together, in any given year. The results can be seen in Table C2.

Table C2: Linear Probability Models to Predict Experience of Life Events

	FE Linear Probability Model Life Events		
	At Least One Positive	**At Least One Negative**	**At Least One Positive and One Negative Together**
	(1)	**(2)**	**(3)**
Age	-0.014***	-0.007***	-0.008***
	(0.001)	*(0.001)*	*(0.001)*
Age^2 / 100	0.008***	0.008***	0.005***
	(0.001)	*(0.001)*	*(0.001)*
Married	0.135***	-0.092***	0.033***
	(0.005)	*(0.006)*	*(0.004)*
Log Income	0.004***	-0.008***	0.001
	(0.001)	*(0.002)*	*(0.001)*
Years Education	0.031***	0.006**	0.011***
	(0.002)	*(0.002)*	*(0.001)*
R Squared	0.032	0.001	0.004
N	176,280	176,280	176,280

Robust standard errors clustered at the individual level in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

There is evidence that some observables have differential predictive power in explaining the likelihood of experiencing at least one positive (Column 1) or one negative life event (Column 2), or at least one positive and one negative life event together (Column 3). However, effect sizes tend to be very low, typically changing the likelihood of experiencing any life event by no more than three percentage points. Hence, observables tend to have little explanatory power for predicting life events. A notable exception is being married, which has a very strong predictive power in explaining at least one positive life event, and a similar yet somewhat lower predictive power (in the opposite direction) in explaining at least one negative life event. Note, however, that we routinely control for being married (as well as other observables) throughout our regressions.

Finally, as a third additional robustness check, we re-estimate our baseline specification (i.e. the quadratic specification with dynamic life events indices) for those individuals who have experienced at least one positive life event and at least one negative life event during our observation period. The results can be seen in Table C3 Column 3, where they can again be compared to our previous results (Columns 1 and 2).

Table C3: Baseline Specification Restricted to Individuals

Experiencing at Least One Positive and at Least One Negative Life Event

	Life Satisfaction (0-10)		
	(1)	**(2)**	**(3)**
Positive Life Events Index	1.141***	1.026***	1.017***
	(0.085)	*(0.076)*	*(0.077)*
Positive Life Events Index Squared	-0.415	-0.099	-0.051
	(0.259)	*(0.278)*	*(0.266)*
Negative Life Events Index	0.816***	0.808***	0.815***
	(0.058)	*(0.067)*	*(0.060)*
Negative Life Events Index Squared	-0.201***	-0.212***	-0.182***
	(0.060)	*(0.072)*	*(0.057)*
Time-Varying Controls	Yes	Yes	Yes
Leads and Lags of Time Varying Controls	No	Yes	No
Individual Fixed Effects	Yes	Yes	Yes
R Squared	0.071	0.080	0.086
N	116,959	116,959	81,776

Robust standard errors clustered at the individual level in parentheses. The time varying controls include age, age^2 /100, log household income, and years of education.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As can be seen in Column 3, our results remain the same when restricting our sample to those individuals who have experienced at least one positive life event and at least one negative life event during our observation period.

Taken together, although we cannot fully exclude that there may be some residual selection into positive or negative life events, it is rather unlikely that this remaining selection is a key driver behind our results. We continue to confirm our key finding of a globally concave life-satisfaction function.