An economist's perspective on the stability of locus of control

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Abstract

Non-cognitive skills are increasingly receiving attention in the applied economics literature as a stable and relatively fixed stock of human capital and that determine a series of adulthood labour market and health outcomes. Very little empirical evidence exists about the stability and the determinants of these traits and thus little can be said about their potential for endogeneity. Using high quality longitudinal data from Australia, we assess whether locus of control is a stable trait over the short- and medium-term, and, if not, whether its dynamics are economically meaningful. Our results show that radical changes in control tendencies are unlikely in adulthood and employment- and health-related life-events have little explanatory power in explaining changes in control tendencies. The standard criticism about the high degree of endogeneity of locus of control in adulthood appears to be exaggerated for shorter time intervals of 4 years. On the other hand, measurement error, when using lagged values of locus of control, may downward bias estimates up to 50%.

JEL classification:

Keywords: Non-cognitive skills, locus of control, stability, life events, measurement error, endogeneity

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1 Introduction

Non-cognitive skills, such as the Big-Five personality traits and locus of control, are increasingly receiving attention in the applied economics literature as an alternative source of productive capital. Understanding psychological capital as a stock of human capital similar to cognitive ability relies on the assumption that, once formed, it is relatively stable and has equal, if not higher, explanatory power than cognitive ability in explaining economically-relevant outcomes (See Borghans et al., 2008; Heckman et al., 2006, for an overview). For instance, locus of control, a belief about the degree to which an individual exerts control over one's life in contrast to fate or luck (Rotter, 1966), has been shown to have a sizeable influence on earnings (Heineck and Anger, 2010; Semykina and Linz, 2007; Osborne Groves, 2005; Goldsmith et al., 1997; Duncan and Dunifon, 1998; Andrisani, 1981, 1977), decisions in favor of educational (Baron and Cobb-Clark, 2010; Coleman and Deleire, 2003; Coleman, 1966) or health investments (Chiteji, 2010), and the ability to cope with unanticipated life-events such as health shocks (Schurer, 2008) or unemployment (Caliendo et al., 2010).

Some studies implicitly make the assumption that locus of control is a fixed personality trait (Goldsmith et al., 1997), especially so, if the personality data available for analysis is measured ex post (e.g. Heineck and Anger, 2010; Schurer, 2008) or years before the main outcomes of interest are measured (e.g. Osborne Groves, 2005; Cebi, 2007).

Assuming stability to justify the use of lead or lagged data of locus of control is not the result of weak study design, but has to do with the fact that measures of control tendencies, and personality traits in general, are rarely available at all and, if they are, they were usually measured late in the sequence of collected waves of longitudinal data. For instance, in the German-Socioeconomic Panel, locus of control and the Big Five personality traits were measured in 2005, more than 20 years after the first wave was collected. Similar arguments hold for the British Household Panel Survey, and the Panel Study of Income Dynamics, just to mention a few.

To be able to nevertheless work with the available, but scarce personality data, Heineck and Anger (2010), for instance, attach Big Five personality and locus of control data measured in 2005 to their working data-set starting from 1991 to explain hourly wages.

Their study concedes that locus of control and personality may change over the life-cycle, but they assume that changes are the same for people in the same age-group. Psychologists call these mean-level or normative changes in personality.[1] Heineck and Anger (2010) solve the problem by adjusting all personality measures by age and then implicitly assume that there are no individual-specific changes in personality.

Mean-level stability does not imply, however, that individual differences in change do not exist. For example, when there are no mean-level changes over time, there may still be robust individual differences in change. Subsets of individuals may be increasing and decreasing due to a series of experienced positive and negative life-events and thus offsetting each other's change, resulting in zero mean-level changes (Roberts et al., 2001; Roberts, 1997).

What psychologists call intra-individual changes is labelled by economists as endogeneity, i.e. personality traits are potentially determined by outcome variables of interest. For instance, if locus of control was jointly determined with contemporaneous and/or past values of wages, then standard assumptions of regression analysis would no longer hold and the bias of the estimates would be of unknown sign and dimension. In such a case, the wage effects of locus of control presented in, for instance, Andrisani (1977) or Semykina and Linz (2007), who use contemporaneous measures of locus of control to explain contemporaneous wages, would be biased.

Some researchers suggest to use lagged data of the personality trait of interest to avoid problems of simultaneity or reverse causality (Heckman et al. 2011). However, even if such data was available, one would encounter the problem of error-in-variables if personality traits change over the lagged time period. Osborne Groves (2005) uses in her study both adolescent and lagged adult values of locus of control to assess the effect of locus of control on hourly wages.[2] If there is a large change in locus of control over

[1] Mean-level changes in personality traits are often equated with normative changes in personality. Normative change occurs when most people change in the same way during a specific period within the life course. Normative changes are thought to result from maturational or historical processes shared by a population (E.g. McCrae et al., 2000). A third concept of stability refers to rank-order consistency, which is defined as the relative placement of an individual within one group over time. Rank-order consistency is assessed by test-retest stability coefficients. Roberts and DelVecchio (2000) have shown in a meta-analysis that rank-order consistency peaks at age 50 and remains stable from then on, suggesting that intra-individual changes in personality must have occurred over time.

[2] A similar approach is chosen by Cebi (2007).

time, and if assuming that contemporaneous locus of control is the true measure, then the degree of measurement error would be large, downward biasing the estimates of the wage effect towards zero (Bound et al., 2001).

The stability assumption of personality traits is not taken out of the blue, but based on the work of psychologists who suggest that a variety of personality traits form before or during adolescence, but then remain relatively stable across age-groups during adulthood from age 30 onwards (E.g. McCrae and Costa, 2006; Costa and McCrae, 1988, for Big Five personality traits). However, this mean-level stability is more contested today, suggesting that mean-level changes may occur up until the age of 50, depending on which personality trait is considered (e.g. Roberts et al., 2000, using a meta-analysis).

Much less has been written on the stability of locus of control in particular, but it has been argued that locus of control also develops in childhood and then stabilizes during the adolescents years (Sherman, 1984). During childhood, internal locus of control tendencies are more likely to develop if the the parents provide emotional support and a nurturing home environment, and if stressful, and disruptive life events can be avoided (Carton and Nowicki, 1994). A study by Stephens and Delys (1973) propose that by age four children from economically disadvantaged backgrounds already exhibit less internal control tendencies than children from more advantaged families.

Apart from this small number of studies on the evolution of control tendencies in childhood, and Schurer (2008) who has shown with German data that individual and mean-level changes in control tendencies are a rare empirical phenomenon for working age adults, there is little evidence on the stability of locus of control and the causal pathways between control tendencies and economic and social outcomes. It is not clear, for instance, whether locus of control determines future labour market outcomes or whether it is the consequence of a series of positive or negative employment-related life events which the individual experienced in the past. Seligman (1975) suggested that control tendencies can change through negative life-events, but the nature of the event matters: the more uncontrollable an event is perceived, the more likely it will lead to a sense of helplessness and loss of control. Goldsmith et al. (1996) investigated this latter question, testing whether episodes of unemployment can alter one's sense of control, although their study

finds no support for men and weak effects for women.

This paper tries to shed light on the question whether locus of control can be considered an exogenous construct and if not, to what degree does proxying locus of control with its past lead to downward biases. We use high quality longitudinal data from Australia which allow us to investigate mean-level, and the determinants of intra-individual, changes in control tendencies in the short-run (1 year) and the medium to long-run (4 years). Further, the availability of locus of control in three different waves allows us also to quantify the measurement error resulting from using various lagged values instead of contemporaneous values of locus of control and to assess whether simultaneity between locus of control and wages plays a role. The data-set is of particular help as it collected over eight years a battery of positive (e.g. promoted at work) and negative life-events (e.g. fired from job) that occurred in the past year to an individual and which can be considered determinants of non-normative changes in locus of control. Beyond, some of these events are outside the control of an individual (e.g. death of a spouse) and thus could be considered as good proxies for what Seligman declares relevant in causing feelings of helplessness.

The remainder of the paper is as follows: Section 2 outlines the statistical problems that follow when assuming locus of control to be a stable and/or exogenous personality trait. Section 3 describes the longitudinal data-set used and how locus of control and its changes over time are constructed. Section 4 presents descriptive statistics on the correlates of changes in locus of control (e.g. by age, gender and life-events). In Section 5 three sets of linear regression results on the determinants of locus of control are presented. In Section 6 an application is presented in which we estimate the wage-elasticity of sense of control and calculate the measurement error resulting from using locus of control data from past years to the time when wages are measured. Section 7 concludes.

2 The statistical problem

Modeling unobserved heterogeneity has a long tradition in the statistical analysis of casual effects. In particular, the econometrics of panel data analysis is concerned with methods that attempt to control for the various sources of heterogeneity (Wooldridge, 2002). The main unobserved, yet confounding factors are traditionally assumed to be constant over

time, and so this magnitude is often represented as an individual specific effect, let's say α_i., in a model that allows for cross-sectional and time-period variation. With the availability of longitudinal data-sets, that take repeat observations of individuals over time, the time-invariant unobserved heterogeneity could be accounted for through fixed effects estimation by either sweeping it out from the model by taking differences or by directly estimating an intercept for each individual. The general econometrics literature states that the unobserved, time-invariant heterogeneity could represent motivation, personality, or time-preferences (p. 248 Wooldridge, 2002), but does not elaborate any further on its concrete nature. A study by Boyce (2010) shows that up to 20% of the time-invariant fixed effect can be explained by personality traits.

The availability of individual-specific data on personality that become increasingly observable, simplifies statistical analysis significantly, as one can directly include the individual-specific information as additional right-hand side regressors in an OLS regression. However, even though personality has been considered to be time-invariant traits when justification is needed for the use of fixed effects estimation methods,[3] a series of criticisms is brought forward against this stability when the data is directly observed and included.

There is a good reason for this skepticism, as from a statistical point of view the erroneous assumption of stability and/or exogeneity of locus of control or any other personality trait could lead to biased and inconsistent parameter estimates. Endogeneity in locus of control can arise due to different causes. For the purpose of this study we illustrate these causes with an application. Let's assume we are interested in the effects of time-invariant locus of control (L_i) on wages (Y_{it}):

$$Y_{it} = X'_{it}\beta + \gamma L_i + \varepsilon_{it}, \tag{1}$$

where $\mathbf{X}$ is a vector of observable characteristics, β a vector of parameters to be estimated (including an intercept) and ε_{it} are idiosyncratic, time-varying shocks. For simplicity, let's assume that L_i picks up all relevant individual-specific heterogeneity. To obtain unbiased

[3] Fixed effects models work only in sofar, as the person-specific, unobserved heterogeneity is fixed over time. Some studies have questioned this assumption (e.g. Frijters et al., 2010). Jones and Schurer (2009) have shown that the individual specific effect does vary by age-groups.

and consistent parameter estimates of γ using OLS, the correlation between L_i and ε_{it} needs to be zero.

We distinguish three cases in which the assumption of locus of control being a stable trait could lead to biased estimates of the effect of locus of control on an outcome of interest. Cases 1. and 2. will be addressed in due course of this paper.

Case 1: Simultaneity. This case refers to the possibility that the current level of locus of control is (partially) the outcome of current (and past) wages. In its simplest form, allow locus of control L_{it} to be a function of current wages and a vector of other time-varying factors W'_{it}:

$$L_{it} = \eta Y_{it} + W'\delta + \nu_{it}. \tag{2}$$

Estimating Eq. 1 would imply that we cannot identify γ, because L_{it} would be correlated with ε_{it}. To show this, insert Eq. 2 into Eq. 1 (and vice versa) and solve for Y_{it} and L_{it}, so we get:

$$\begin{aligned} Y_{it} &= (1-\gamma\eta)^{-1}X'_{it}\beta + (1-\gamma\eta)^{-1}\gamma W'\delta + (1-\gamma\eta)^{-1}\gamma\nu_{it} + (1-\gamma\eta)^{-1}\varepsilon_{it}, & (3)\\ L_{it} &= (1-\gamma\eta)^{-1}W'\delta + (1-\gamma\eta)^{-1}\eta X'_{it}\beta + (1-\gamma\eta)^{-1}\eta\varepsilon_{it} + (1-\gamma\eta)^{-1}\nu_{it}. & (4) \end{aligned}$$

From Eq. 4 it follows then that the covariance between L_{it} and ε_{it} in Eq. 1 is non-zero and thus the orthogonality assumption, required for obtaining unbiased parameter estimates, is violated:

$$\begin{aligned} cov(L_{it}, \varepsilon_{it}) &= (1-\gamma\eta)^{-1}\ cov(W'\delta + \eta X'_{it}\beta + \nu_{it}, \varepsilon_{it}) + (1-\gamma\eta)^{-1}\eta\ V(\varepsilon_{it}),\\ &= (1-\gamma\eta)^{-1}\eta\ \sigma^2 \neq 0. \end{aligned} \tag{5}$$

A special case of the simultaneity problem is reverse causality, which would state that contemporaneous locus of control is a function of (contemporaneous and) past wages. In such a scenario the orthogonality condition between error term and locus of control is also not satisfied.

Both cases can be addressed by finding suitable instrumental variables for locus of con-

trol that shift locus of control but do not influence wages. Such an instrument is difficult to find, but if repeated observations of both locus of control and wages were available, then past values of locus of control could be a good candidate. This choice, however, introduces yet another complication that can lead to endogeneity in locus of control. If locus of control is not a stable trait, then past locus of control proxies contemporaneous locus of control with measurement error.

Case 2: Errors-in-variables. Let's assume that locus of control L_{it} is not observed, but a proxy is available that is locus of control measured in time period $t-k$. Alternatively, assume that contemporaneous locus of control is intentionally proxied by a past value L_{it-k} to avoid the simultaneity problem. Then the true value of locus of control is measured with error υ_{it} if locus of control is not stable over time:

$$L_{it-k} = L_{it} + \upsilon_{it}, \tag{6}$$

where k is any positive integer and υ_{it} is a mean-zero error process. In this case, Eq. 1 can be re-written as:

$$Y_{it} = \alpha_i + X'_{it}\beta + \gamma L_{it-k} + (\varepsilon_{it} - \gamma\upsilon_{it}), \tag{7}$$

If the measurement error is uncorrelated with the true measure of locus of control L_{it}, i.e. Cov(L_{it},υ_{it})=0, then by construction the correlation between the measurement error and the observed measure of locus of control must be non-zero, i.e. Cov(L_{it-k},υ_{it}) $\neq 0$. As a consequence, the Cov(L_{it-k}, $\varepsilon_{it} - \gamma\upsilon_{it}$) = - γ Cov(L_{it-k}, ε_{it}) $\neq 0$ in Eq. 7. This is causing the OLS regression of Y_{it} on L_{it-k} to be biased and inconsistent. In the simple case of a single explanatory variable measured with error, we can determine the nature of the bias as:

$$plim(\gamma) = \gamma \frac{\sigma^2_{L_{it}}}{\sigma^2_{L_{it}} + \sigma^2_{\upsilon}}, \tag{8}$$

which states that in the limit (plim), the estimate of γ is biased towards zero, depending on the variance of the measurement error σ^2_{υ}. The greater the variation in the measurement error, relative to variation in the signal ($\sigma^2_{L_{it}}$) the greater the bias (p. 437 Greene, 2002). Note that this simple and clear result about the form of the bias only works in the case of a

univariate regression. With multiple regressors where only one of the variables is measured with error, the bias will also depend (in a not so straightforward way) on the correlation between the x variable measured with error and the other explanatory variables.

Measurement error cannot easily be quantified if not several measures of locus of control are available. In an application presented in Section 6 we quantify this measurement error, as our data-sets has locus of control available in three different time periods.

Case 3: Omitted variable bias. This case refers to the possibility that current locus of control is correlated with period-specific, but unobserved shocks (e.g. ε_{it} represents sudden health deteriorations or being laid off during a recession) or with time-invariant, but unobserved other factors (e.g. α_i represents cognitive ability).

For the former case, we have the violation:

$$E[L_i, \varepsilon_{it}] \neq 0$$

For the latter case, we have the violation:

$$E[L_i, \alpha_i] \neq 0$$

The bias in $\hat{\gamma}$ depends on the correlation between the omitted variables and locus of control plus the effect of the omitted variables. Note, if variables were observed that capture the effect of these omitted variables, we would simply include them into the regression. Conditional on these variables, the effect of locus of control would then be identified.

3 Locus of control: The survey instrument

To test the hypothesis of stability on locus of control, we make use of five waves of the Household, Income, and Labour Dynamics Survey of Australia (HILDA) (2003-2007). HILDA is a broad, general purpose longitudinal survey designed to obtain detailed information about household structure and formation, income and economic well-being, and employment and labour force participation. The data consist of a large nationally

representative sample of Australian households, and are collected both in face-to-face interviews and self-completion questionnaires covering all household members aged 15 years and older. In Wave 1 of the HILDA survey, 7,682 households were interviewed and a sample of 13,969 successful interviews were obtained. These individuals were followed in subsequent waves.[4]

3.1 Locus of control

The explanatory variable of main interest is an index of locus of control. In 2003, 2004, and 2007 survey respondents were asked to answer a personality questionnaire, which contained, among others, all seven original questions of the Mastery Module taken from the factor items measuring Psychological Coping Resources developed in Pearlin and Schooler (1978). Mastery refers to a personal belief about the extent to which one regards one's life chances as being under one's own control (internal) in contrast to being fatalistically ruled (external). Self-efficacy has been linked to a variety of aspects of human development, such as cognitive, health, clinical, athletic and organizational functioning (See Bandura, 1997, for an overview).

Respondents of the survey were asked whether a particular personality trait refers to them. They may answer any number between 1 and 7, where 1 stands for *Does not apply* and 7 stands for *Fully applies*. Table 1 describes the seven questions referring to locus of control. A principal component analysis reveals that questions (a) to (e) unambiguously load on one factor, while questions (f) and (g) load on another one (see Appendix Fig. A). These two factors can be interpreted as external and internal control tendencies, as suggested in Pearlin and Schooler (1978), who use data from a representative sample of the city of Chicago.

[Insert Table 1 here]

We create a Combined Index (Eq. 9) by adding to the External Index (Qa + Qb +

[4] A more detailed description of HILDA can be found in Wooden and Watson (2002) and various issues of HILDA Annual Reports, which are available on line from `www.melbourneinstitute.com/hilda/areport.html`.

Qc + Qd + Qe) the number 16 and subtracting the Internal Index (Qf + Qg) (reverse scores). This index is therefore increasing in external control tendencies and is bounded between 7 (internal) and 49 (external).

$$LOC_i = \sum_{j=a}^{e} Q_{i,j} + 16 - \sum_{j=f}^{g} Q_{i,j}, \tag{9}$$

3.2 Changes in locus of control over time

Changes between two time-periods are calculated between the years 2003-2004 (short-run) and the years 2003-2007 (long-run) for each individual, for whom data on locus of control is available either in both 2003 and 2004 (4,554 men and 5,174 women) or in both 2003 and 2007 (3,883 men and 4,467 women).

Table 2 reports the average differences, their standard deviations and ranges, and the number of changes by percentiles (1%, 25%, 50%, 75%, 99%) in locus of control in the short-run and in the long-run. A positive number is interpreted as an increase in external control tendencies (become more fatalistic), whereas a negative number as an increase in internal control tendencies (become more convinced of one's own control).

[Insert Table 2 here]

Theoretically, the difference in the index ranges between -42 and $+42$, which would imply that an individual is internally controlled in one year ($LOC_{i,t} = 7$) and externally controlled in another year ($LOC_{i,-t} = 49$). Empirically, this does not appear to happen. On average, the mean and median change in the sample is 0 for women and almost 0 for men, and the standard deviation of this change is approximately 7 points in the long-run. A change of 7 implies that, on average, individuals change their answer on each of the seven questions (a) to (g) by one point. The top and bottom 1% changes in the distribution change their locus of control score in the long-run by 19-20 points, which translates into an average deviation on each item of the questionnaire by almost three points (see Table 1, right columns). Therefore, rank reversals in the locus of control score are no real empirical phenomenon, at least not within a time period of one to four years.

In terms of sample proportions, about 9.3% of men and 8.3% women did not change their report of locus of control between 2003 and 2007, about 12% of men and 14.5% of women reported an increase in external control tendencies by more than one standard deviation, and almost 13% reported an increase of internal control tendencies beyond one standard deviation. These numbers imply that 75% (72%) of men (women) either did not change at all, or changed within a very small degree their control tendency.

The distributions of changes in the short- and long-run are graphically depicted in Figures 1(a) and 1(b) by gender. Distributions do not differ between men and women in the short-run ($p=0.386$), but differ in the long-run ($p<0.001$).

[Insert Figures 1(a) and 1(b) here]

One of the main concepts to describe stability in the psychology literature is the one of mean-level or normative changes, which refer to changes in personality common to all individuals within a particular (age) group (McCrae et al., 2000). In Figures 2(a) and 2(b) we therefore separate out the observed changes by age-groups and it turns out that only the older age-groups (70-79 and 80 +) experience on average notable changes in control tendencies. Both men and women in the oldest age-groups experience an average increase in external control tendencies of up to 2 points. The younger age-groups, on average, develop internal control tendencies, whereas the older develop external control tendencies. This holds particularly true for men, whereas for women the middle-aged develop some external control tendencies in the long-run (30-49). Overall, the short-run changes across all age-groups cannot be distinguished from 0 in a statistical sense, and in the long-run they are jointly significant only at the 5% (men) and 10% level for women.[5] These descriptive results suggest that mean-level stability may exist within the various age-groups.

[Insert Figures 2(a) and 2(b) here]

[5]Figures 1(a) and 1(b) also show that short-and long-run changes within each age-group are not different, only for men aged 40-49 (5% level) and for women aged 70 to 79 (10% level).

In terms of period-to-period correlations of locus of control, we observe from Table 3 that they resemble those of health (self-reported health status), especially for the younger and middle-aged groups (up to age 50). They are larger than the period-to-period correlations of life satisfaction, but they are smaller than those of household income and substantially smaller than the correlations of religious affiliation (Here: Catholic, but similar results are obtained for Islam and Hebrew). They also vary significantly across age-groups over longer time-periods of 4 years (p=0.001), whereby correlations are the smallest for the very young (younger than 20) and the elderly (80+) and the largest for individuals between 50 and 79 years. Particularly high correlations across four time-periods are obtained for the Big-Five personality traits of Extraversion, Conscientiousness, and Openness to Experience, which suggests that these traits could be more fixed over time than locus of control.

[Insert Table 3 here]

4 Descriptive analysis of correlates of changes in locus of control

In the next sections we show how changes in locus of control systematically differ over the life-cycle (normative changes) and by a series of life-events (Intra-individual changes). These results are obtained from bivariate kernel regression models to allow for possible non-linearities and graphed with a 95% confidence interval.

4.1 Normative changes: By age-groups

Figures 3(a) and 3(b) show the evolution of changes of locus of control over the life-cycle. For men and women changes in locus of control differ significantly across the life-cycle, whereby at older age men tend to develop more external control tendencies (p=.053). Once the youngest (<25) and the oldest individuals of the sample are dropped, the differences in changes across age-groups are no longer statistically significant (p=.359) (Figure 3(c)).

[Insert Figures 3(a), 3(b), and 3(c) here]

4.2 Intra-individual changes: By experiences of life events

It is hypothesized that individuals who are constantly shocked in life by (unanticipated) life events are more likely to adjust their beliefs on how much control they exert over their own life (e.g. Goldsmith et al., 1996). We can test this hypothesis by directly using life-event data available in HILDA from Wave 2 (2002) onwards. Table 4 lists all questions available that could be used to construct an index of positive and negative life-events which our sample members experience between 2004, after locus of control was measured in 2003, and 2007, when it is measured again.

[Insert Table 4 here]

The cumulative sum of negative life-events is calculated as the total number of times an individual is observed to experience any of the 11 items listed in the upper panel of Table 4 between 2004 and 2007. A similar sum is created for all positive life-events, which is the sum of the eight events listed in the lower panel. The total sum of negative events experienced within four years is bounded between 0 and 17, with a mean of 2.2. Positive life-events are bounded between 0 and 11, with a mean of 1.4 (Table 8 in the Appendix). Over 60% of our sample did not experience any of the positive events, whereas only 25% did not experience any negative event. Even though the means differ, the whole distributions do not vary by gender.[6]

Figures 4(a) and 4(b) show bivariate kernel density estimates (and their 95% confidence interval) of changes in locus of control as a function of the number of negative life-events experienced separately by gender. Only for women, average changes are significantly different across the total number of negative life events experienced between 2004 and 2007 (p=0.011). However, the relationship is almost flat up until 9 life events, and then fans out for both men and women, while the increase is more pronounced for women. The

[6] The p-values of a Kolmogorov-Smirnov test of equal distributions are p=0.96 for positive life-events and 0.160 for negative life-events. These results are provided upon request.

slight increase in external control tendencies of individuals who experience more than 9 negative events is driven by a small number of individuals (25 men, 45 women).

[Insert Figures 4 here]

Figures 4(c) to 4(h) depict the bivariate kernel density estimates for each age-group (Less than 25 years, 25 to 59, and 60 years and plus) restricting the sample to individuals who experienced 9 or less negative life events. Changes in control tendencies appear to be associated with the negative life-event for young men only (p=.055). For women, the association is significant for older women only (p=.047).

Figures 5(a) and 5(b) show that the cumulative experience of positive life-events is associated with an increase in internal control tendencies for both men (p=.020) and women (p=.011). These are mainly driven by the sample of working individuals (25 to 59 year old). This is the group which is most likely to experience such events as marriage, child-birth, or promotions at the work-place (see Figs. 5(c) to 5(f)).

[Insert Figures 5 here]

We performed a similar descriptive analysis for changes in the Big Five personality traits that take place between 2005 and 2009 and obtained similar results. Figure 10 in the Appendix shows that the distribution of changes in each dimension of the Big Five is comparable to the changes obtained for locus of control.

5 Regression results

The descriptive analysis shows that only small changes in control tendencies occur in the data and that an accumulation of any life event does not changes control tendencies in dramatic ways. In the following sections we move on to a more systematic approach to identify particular (sequence of) life-events that dramatically change a sense of control.

5.1 Models and results

In the regression analysis, three different hypothesis are tested on what type of events could change beliefs about control tendencies. On the one hand, it is possible that the experience of a single negative life-event, such as the death of a partner or being fired from the job, is enough to tilt an individual towards external control tendencies. On the other hand, it is more likely that a sequence of events is required to hit an individual until he or she changes beliefs about control, hence it is the intensity of events independent of their nature. Last, it may be the persistence of a particular event that matters, e.g. recurring health shocks, or consecutive years of unemployment. To test these different hypothesis, we estimate variations of the following equation:

$$\triangle LOC_{i,07/03} = X'_{i,03}\beta + S'_{i,07/04}\gamma + \varepsilon_i, \tag{10}$$

In Eq. 10 $\triangle LOC_{i,07/03}$ is the change in locus of control between the years 2003 and 2007. A positive change indicates an increase in external control tendencies. The measure is standardized to mean 0 and a standard deviation of 1. The vector $X_{i,03}$ comprises control variables measured in 2003 (age-group indicators, marital status, foreigner, employment status, household income (ln), educational qualification).[7] In a robustness check, we included also the Big-Five personality traits that were measured in 2005, but the results remain stable (Provided upon request).

The vector $S_{i,07/04}$ includes all binary variables that indicate the experience of a life event (see Table 10 in the Appendix for a full list) during 2004 and 2007. We tested whether it makes a difference to our parameter estimates if we include each life-event separately or to include all of them jointly into Eq. 10. The estimates of the effect of each life-event obtained from both specifications are statistically not different from each other as it can be seen from the high p-values of a t-test of equality of coefficients reported in column 1 of Table 9 in the Appendix. The model fit according to the likelihood ratio test would be better if we included all life-evens simultaneously for almost all life-events, while the model fit is better according to the BIC, which punishes more for every additional

[7] Omitted categories: Finished Year 11 or less, Less than 30 years of age, single.

regressor included, for the restricted model.[8] We decided against including all life-events jointly, as some life-events measure similar phenomenon (e.g. fired from job and worsening of finances).

Figures 6(a) and 6(b) graphically display the estimated effects of individual life-events on changes in external control tendencies between 2003 and 2007 obtained from an OLS regression (Box-plot: coefficients with 95% confidence intervals). The dependent variable is bounded between -34 and 34 (30 for women), but we standardize it to mean 0 and a standard deviation of 1. The magnitude of the effect of an individual life event is therefore interpreted in standard deviation increase (positive coefficient) or decrease (negative coefficient) in external control tendencies. Life-events are added one at a time. (Full estimation results are provided upon request).

[Insert Figure 6 here]

For both men and women it is clear that none of the individual life-events exerts a statistically significant effect except for men pregnancy (of their partner) or child birth (Models 4 and 5), changing jobs (Model 17), and experiencing a worsening of finances (Model 20) and for women a serious illness/injury (Model 6) and being promoted at work or improvement of finances (Models 18 and 19). The magnitudes of the effects, though, are relatively small. Women who experienced a severe illness or injury between 2004 and 2007 increase their external control tendencies by 0.1 of a standard deviation of changes in locus of control, which represents less than one unit on a scale ranging from -34 to 30. For men, a worsening of finances represents a change of 0.22 of a standard deviation or 1.5 units on a -34 to 34 scale.

A next step is to ask whether life-events matter substantially only if they occur cumulatively and therefore it could be the intensity of this accumulation that has an effect on the perception of control tendencies. We construct three different domain-specific shock indicators that take the value 1 if the total sum of domain specific shocks is greater than a

[8] See p-values of likelihood ratio test in column 2 of Table 9, which refers to the likelihood ration test of a full model that includes all life-events simultaneously against a restricted model that includes only each life-event individually. BIC for the unrestricted and restricted model are reported in column 3 and 4, respectively, of the same table.

particular threshold (See Table 10 in the Appendix for definitions). The domains comprise (1) Family related life-events (Death of a spouse, child, relative, friend, victim of property crime), (2) Employment/Income related life-events (Worsening of finances, retired, fired, or episodes of unemployment), and (3) Health-related life-events (Serious illness or injury, victim of physical violence, new health conditions that were not yet present in 2003).

In Eq. 11, we include three dummy variables that take the value 1 if the sum of life-events in each life domain, i.e. family-related ($DF_{i,07/04}$), employment- or income-related ($DE_{i,07/04}$), and health-related ($DH_{i,07/04}$), that occurred between 2004 and 2007 is greater than 3 standard deviations.[9]

$$\triangle LOC_{i,07/03} = X'_{i,03}\beta + \gamma_F \; DF_{i,07/04} + \gamma_E \; DE_{i,07/04} + \gamma_H \; DH_{i,07/04} + \varepsilon_i, \qquad (11)$$

Full estimation results are reported in Table 11 in the Appendix, but the main results are graphically displayed in Figure 7. For both men and women, intensity in family-related negative life-events is not associated with changes in control tendencies. It is only the higher intensity ($>$ 3 SD) in health- or employment-related negative events that are significantly associated with changes in control tendencies. For men, experiencing more than 8 health-related events within four years increases external control tendencies by 2.4 points on a scale ranging from -34 and 34. This is the case for 130 individuals or around 3% of our estimation sample of men. For women, experiencing more than 4.8 employment-related events within four years is associated with an increase of almost 4 points on a scale of -34 to 30. This is the largest increase we find in all models. Note, however, that this high intensity is a rare phenomenon in our data: only 21 women or less than 0.5% of our estimation sample experience such a sequence of events.

[Insert Figure 7 here]

In a last set of results, we present the associations of persistence of the same event or a particular sequence of different events with changes in control tendencies. Thus, we

[9] In a sensitivity analysis we investigate smaller magnitudes of 1 and 2 standard deviations. Table 8 provides descriptive statistics of the indicator variables constructed from the three thresholds.

include in our estimation model dummy variables that take the value 1 if the following sequence of events happened to an individual (and zero otherwise): (1) Unemployed for at least three out of four years, (2) Reporting a long-term chronic health condition in at least three out of four years, (3) Reporting chronic pain in four consecutive years, (4) Experiencing a serious illness or injury in at least two years, (5) Experiencing the death of at least two very close family members (spouse or child) within four years, (6) Was fired from job, lost a spouse, child or close family member, and experienced a health shock, (7) Was promoted at least three out of four years, (8) Experienced at least twice an improvement in finances within four years. Individuals described in (7) and (8) experience positive life-events and thus we test their effect on a decrease in external control tendencies. Definitions of all shock variables used in the analysis are provided in Table 10 in the Appendix.

Figure 8 graphically presents these results for both men and women. For women, the largest effects are for a sequence of health shocks and a combination of employment-, family- and health-related shocks. Women who lost their job, lost a spouse or child, and experienced a serious illness/injury, increase external control tendencies by 2.5 points, whereas women, who experienced at least two health shocks within four years increase their external tendencies by 1.6 points. For men, several deaths experienced in the family surprisingly increase internal control tendencies by about 3 points. Note, again, that the number of individuals who experience such an event is relatively small (33 men or less than 1% of the sample). Men who were promoted at least three times within four years increase their internal control tendencies by 1.5 points.

[Insert Figure 8 here]

A similar analysis of the potential changes in all dimensions of the Big-Five personality traits yielded a similar results. These are provided upon request.

All estimated models as described above were tested for normality, heteroskedasticity, omitted variable bias (RESET test) and functional form tests (Hosmer-Lemeshow-Test). Each model passed all tests except for a test for homoskedasticity. Thus, we used White

robust standard errors in the analysis. Since the dependent variable has a normal distribution, linear regression analysis should be adequate. We tried alternative models taking account for the count nature and the potentially large number of zeros (zero-inflated negative binomial models). The main results do not change.

5.2 Are these changes economically meaningful?

To get a better understanding of whether these changes have any economic meaning, we express them in monetary terms calculated from the estimates of wage-effects of locus of control provided in the empirical literature.

Table 5 shows the estimated wage effects obtained from the five most often cited studies that estimate the effect of locus of control on hourly wages. The largest effects, on average, are obtained in Heineck and Anger (2010) for both men (7%) and women (average 7%, maximum estimate 10%). Hence, for a one standard deviation increase in external locus of control, the hourly wage decreases by 7% for both men and women.

[Insert Table 5 here]

In Table 6 we quantify the magnitude of changes in external control tendencies in terms of loss or gain in hourly wages for a series of life-events, that turned out to have the strongest effect on changes in locus of control. The calculations are based on the wage effects presented in Heineck and Anger (2010).

[Insert Table 6 here]

Men, who experienced a series of employment-related shocks between 2004 and 2007 ($>$ 3 SD) change their locus of control tendencies that is equivalent to a 2.8% decrease in average hourly wages, while for women the decrease is equivalent to a 5% decrease in average hourly wages. These are the largest changes we can find in our sample. It is important to note also that these maximum losses are a rare phenomenon in our sample as only 11 men and 21 women are observed to experience so many employment-related

shocks.

In contrast, the experience of more common life-events, e.g. such as being promoted within 2004 and 2007, by women (N=496), decreases external control tendencies that is equivalent to an increase in average hourly wages of 1.8%. Men who experienced a worsening of their finances (N=230) in the same time period increase external control tendencies that is equivalent to a decrease in average hourly wages of 1.5%.

This interval of maximum changes in locus of control can be considered to be fairly small.

6 Application: Measurement error and the effect of individuals' sense of control on wages

Our data-set allows us to quantify the measurement error when using lagged values of locus of control to assess the effect of locus of control on wages and salaries.

For simplicity, we estimate the following univariate model explaining wages (logarithm) as outlined in Eq. 12.

$$Y_{it} = \alpha + \gamma L_{it} + \varepsilon_{it}, \tag{12}$$

In this formulation we assume that the true measure of locus of control is the one measured contemporaneously, but we allow locus of control to vary over time. We ask, whether using lagged proxies of locus of control downward biases the wage effect of locus of control. As we have the same measures of locus of control available in the years 2003, 2004, and 2007, we can proxy contemporaneous locus of control by three different lag structures as outlined in Eq. 13.

$$L_{it-k} = L_{it} + \upsilon_{it}, \tag{13}$$

In our case, $k \in 1, 3, 4$, so we estimate three different wage equations:

$$Y_{i2007} = \alpha + \gamma L_{i2003} + \varepsilon_{i2007}, \tag{14}$$

$$Y_{i2007} = \alpha + \gamma L_{i2004} + \varepsilon_{i2007}, \tag{15}$$

$$Y_{i2004} = \alpha + \gamma L_{i2003} + \varepsilon_{i2004}, \tag{16}$$

Each Eq. 14-16 is estimated separately for men and women aged between 30 and 54 years of age, hence we concentrate on the prime working age population. Individuals in top 1% and bottom 5% of hourly wages, which are unreasonable reports of wages, are discarded.

From these estimates we then calculate the biased estimate and its proportion of the true estimate (which is obtained by estimating Eq. 12 for $t \in \{2003, 2007, 2007\}$).

Table 7 reports the results of the wage effects of locus of control. Regarding hourly wages (lower panel), the true wage effect for a one standard deviation change in locus of control is 3.7 to 4.7% for women and 3.5 to 6.6% for men. These effects are comparable to the estimates presented in Heineck and Anger (2010), Semykina and Linz (2007), Osborne Groves (2005), and Andrisani (1977), but they are larger than those presented in Cebi (2007).[10]

More interesting is the degree of the bias induced by the measurement error. All estimates are almost 50% downward biased. The bias is the largest the longer the lag between contemporaneous and past values of locus of control. For instance, for women using a measure of locus of control from four time periods in the past reduces the true estimate by 48.2%, whereas this estimate is reduced by 43.9% if locus of control is measured one period in the past. A similar conclusion holds for men.

Thus, using lagged values of locus of control as panacea to potential endogeneity problems in locus of control is not advisable, unless one makes clear that these estimates are conservative estimates of an effect of interest.

[10]Note that our results are unadjusted for education and sample selection as all the other studies did. We refrained from estimating multivariate models since the calculation of the measurement error bias is far from straight forward in a multivariate setting. We control for gender and implicitly for age by restricting our sample to a narrow age-group.

7 Conclusions

Locus of control is a personality trait that is receiving increasingly attention in the applied labor and health economics literature. Due to its availability in selected waves of larger longitudinal data sets, applied economists adopt the assumption of stability of this trait to be able to either use it as a exogenous variable for samples of adult individuals or to attach the measure to future or past waves of a longitudinal survey.

To our knowledge, this is the first study that investigates whether the assumption of stability of locus of control has an empirical grounding at least for shorter time periods of four years. Using Australian longitudinal data, we show that locus of control measures between two time periods do vary, but these changes are almost negligible and cannot be systematically linked to single positive or negative life-events. A greater intensity of life-events, such as a series of employment or heath-related life-events experienced between four years, can be systematically linked to changes in control tendencies, however, these changes are also almost negligible. These broader results are in line with Goldsmith et al. (1996) who found no effect of unemployment on changes in locus of control.

Also, we find that using lagged values of locus of control to avoid the endogeneity problem in locus of control, may be problematic as it entails a downward bias of the true effect of locus of control by almost 50%. Estimates obtained from lagged values of locus of control should be understood as conservative figures of the true effect.

We suggest that the expected bias in e.g. estimated wage effects of locus of control as presented in the applied literature should be relatively small if contemporaneous measures of locus of control are used to assess contemporaneous wages and salaries (e.g Semykina and Linz, 2007; Andrisani, 1977) and could be considered larger if lead or lagged values of locus of control are used (e.g Heineck and Anger, 2010; Osborne Groves, 2005; Cebi, 2007).

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Table 1: Dimensions of locus of control: Number of observations (Proportions)

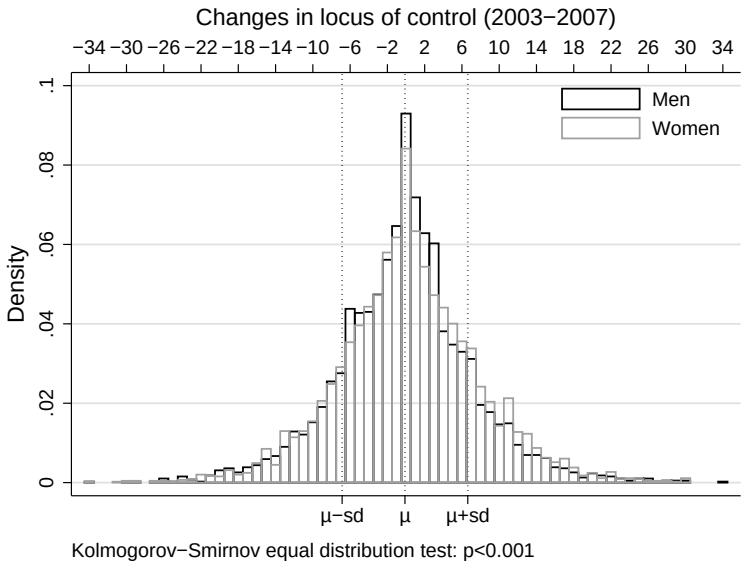
	Categories							
Question N=33,749	**Strongly disagree**	**2**	**3**	**4**	**5**	**6**	**Strongly agree**	**Mean (SD)**
(a) I have little control over the things that happen to me	7701 (22.82)	10204 (30.23)	5423 (16.07)	4765 (14.12)	2958 (8.76)	1679 (4.97)	1019 (3.02)	2.83 (1.61)
(b) There is really no way I can solve some of the problems I have	9214 (27.30)	11343 (33.61)	4718 (13.98)	3297 (9.77)	2359 (6.99)	1649 (4.89)	1169 (3.46)	2.64 (1.63)
(c) There is little I can do to change many of the important things in my life	8876 (26.30)	11139 (33.01)	4922 (14.58)	3684 (10.92)	2439 (7.23)	1633 (4.84)	1056 (3.13	2.67 (1.61)
(d) I often feel helpless in dealing with the problems of life	9662 (28.63)	10897 (32.29)	4704 (13.94)	3629 (10.75)	2397 (7.10)	1585 (4.70)	875 (2.59)	2.60 (1.59)
(e) Sometimes I feel that I'm being pushed around in life	9777 (28.97)	9992 (29.61)	4768 (14.13)	3840 (11.38)	2812 (8.33)	1640 (4.86)	920 (2.73)	2.66 (1.63)
(f) What happens to me in the future mostly depends on me	1229 (3.64)	1313 (3.89)	1447 (4.29)	2895 (8.58)	4903 (14.53)	11111 (32.92)	10851 (32.15)	5.54 (1.59)
(g) I can do just about anything I really set my mind to do	925 (2.74)	1238 (3.67)	1934 (5.73)	4508 (13.36)	7012 (20.78)	10026 (29.71)	8106 (24.02)	5.31 (1.51)

Data Source: HILDA 2003, 2004, 2007. Self-completion Questionnaire (SCQ), Question B10.

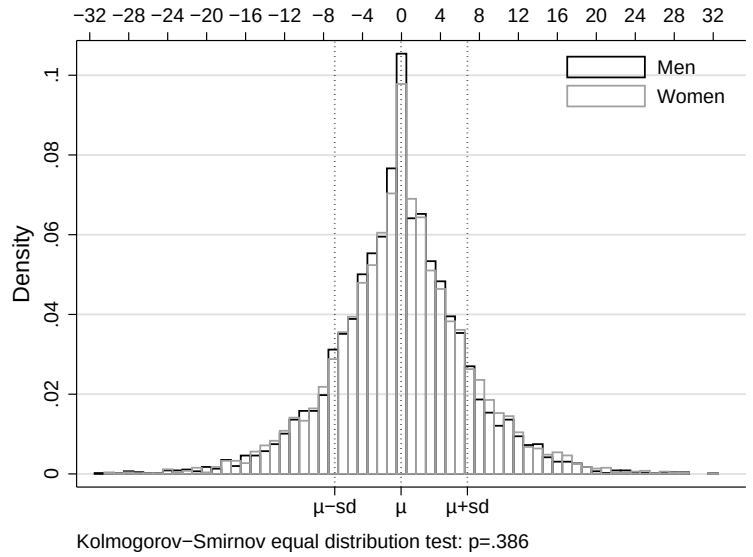
Table 2: Summary statistics of changes in locus of control over time

Changes (Δ) between	N	Mean	SD	Min	Max	Δ by percentiles 1%	25%	50%	75%	99%
Men										
2003-2004	4554	-0.159	6.71	-31	32	-18	-4	0	4	17
2003-2007	3883	-0.146	7.30	-34	34	-19	-4	0	4	20
Women										
2003-2004	5174	0.060	6.90	-30	32	-18	-4	0	4	18
2003-2007	4467	0.263	7.63	-34	30	-19	-4	0	5	20

Note: Sample comprises individuals for whom LOC data is available in years 2003 or 2004, and 2007. Data Source: HILDA 2003, 2004, 2007.

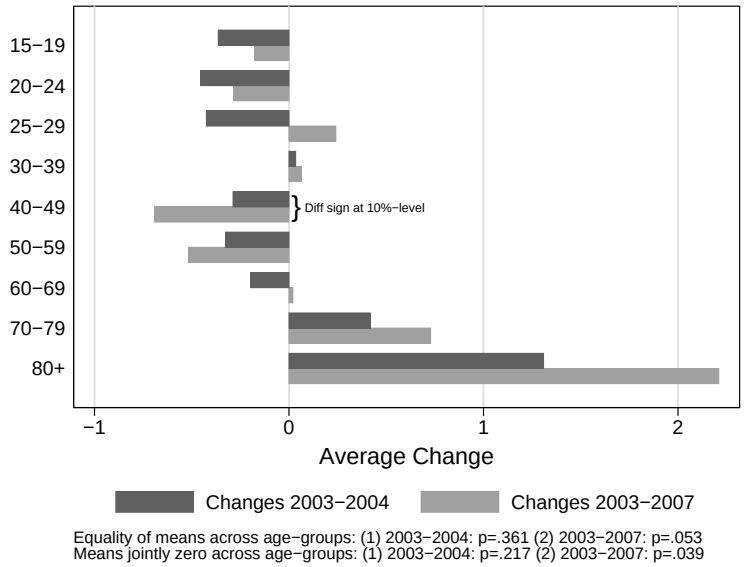


(a) Long-run (2003-2007)

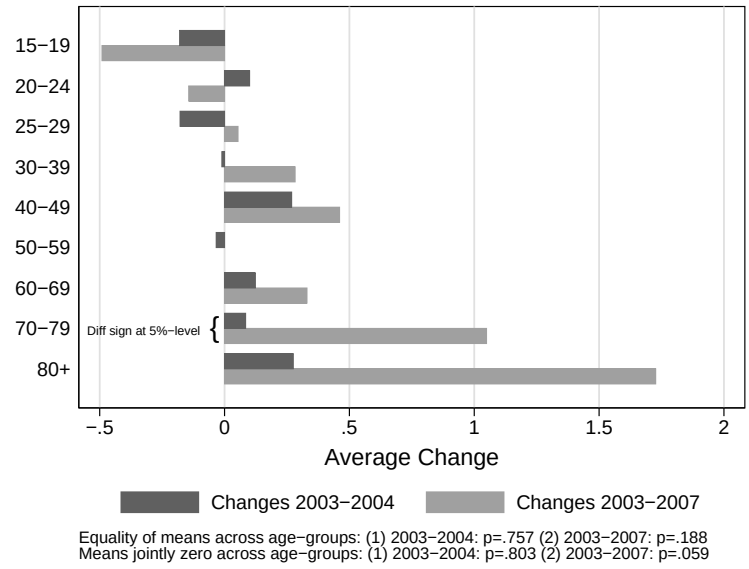


(b) Short-run (2003-2004)

Figure 1: Distribution of changes in locus of control by gender (HILDA 2003, 2004,2007)



(a) Men



(b) Women

Figure 2: Changes in control tendencies in the short- and long-run, by gender and age

Table 3: Correlation coefficients by age-groups

Short-run (2003-2004)

	LOC	Extrav	Agree	Consc	Emote	Open	Income	Life sat	Health	Cath[a]
Average	0.605						0.815	0.548	0.708	
15 to 19	0.524						0.414	0.493	0.029	
20 to 24	0.631						0.729	0.499	0.578	
25 to 29	0.622						0.667	0.493	0.608	
30 to 39	0.614						0.708	0.544	0.659	
40 to 49	0.647						0.758	0.565	0.703	
50 to 59	0.640						0.864	0.593	0.750	
60 to 69	0.570						0.981	0.560	0.745	
70 to 79	0.531						0.814	0.536	0.759	
80 +	0.508						0.852	0.492	0.717	
p-value	0.000						0.000	0.000	0.000	

Long-run (2003-2007 locus of control, 2005-2009 Big Five personality, 2004-2007 Catholic

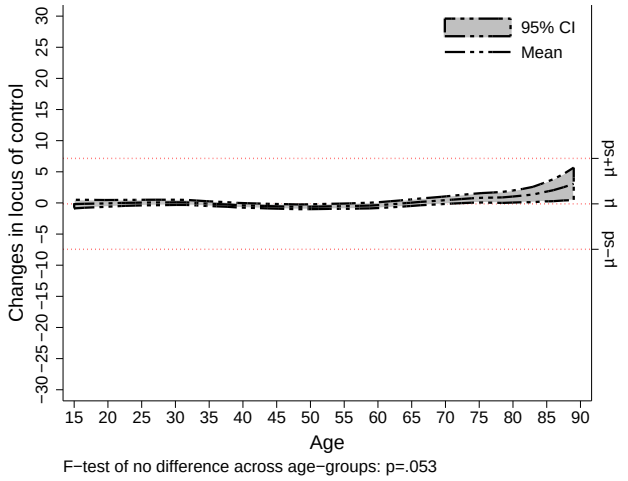
	LOC	Extrav	Agree	Consc	Emote	Open	Income	Life sat	Health	Cath[a]
Average	0.517	0.735	0.573	0.671	0.600	0.708	0.876	0.431	0.625	0.911
15 to 19	0.371	0.595	0.466	0.494	0.515	0.600	0.450	0.304		0.741
20 to 24	0.536	0.647	0.511	0.535	0.508	0.638	0.537	0.381	0.202	0.847
25 to 29	0.496	0.715	0.580	0.628	0.559	0.675	0.375	0.355	0.468	0.890
30 to 39	0.515	0.794	0.602	0.676	0.567	0.712	0.805	0.407	0.557	0.907
40 to 49	0.545	0.778	0.616	0.727	0.641	0.756	0.933	0.446	0.609	0.906
50 to 59	0.562	0.745	0.607	0.713	0.630	0.757	0.856	0.491	0.663	0.944
60 to 69	0.507	0.733	0.559	0.706	0.649	0.708	1.200	0.434	0.643	0.961
70 to 79	0.521	0.667	0.520	0.661	0.610	0.623	0.718	0.420	0.723	0.956
80 +	0.343	0.593	0.515	0.567	0.499	0.668	0.885	0.404	0.631	0.956
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: a: Data on Catholic religion affiliation are taken from Waves 4 and 7.
Similar correlations are obtained for Muslim and Jewish religions. All models control for gender.

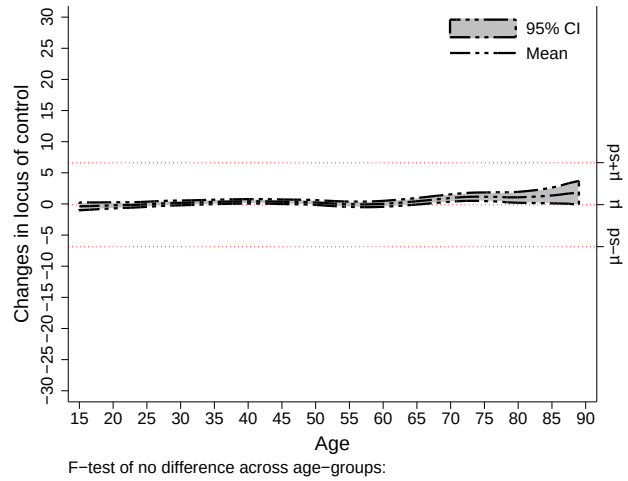
Table 4: Negative and positive life events

	Questions
Negative life events	
	Serious personal illness or injury
	Serious personal illness to family member
	Death of spouse or child
	Death of close family member or relative
	Death of a close friend
	Victim of physical violence
	Victim of property crime
	Detained in jail
	Family member detained in jail
	Fired or made redundant
	Major worsening of finances
Positive life events	
	Got married
	Got back together with spouse
	Pregnancy
	Birth or adoption of new child
	Promoted at work
	Major improvement of finances
	Retired from the workforce
	Changed jobs

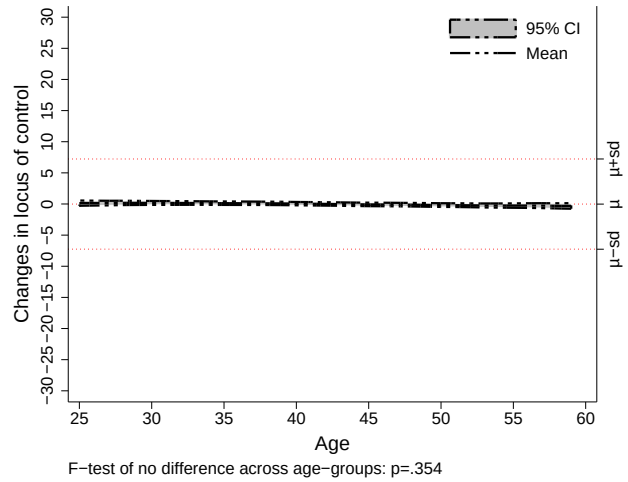
Note: Life-events are part of a self-completion questionnaire of HILDA Life-event data is available from Wave 2 (2002) onwards. Omitted: separation of spouse due to ambiguity whether it is a negative or positive event.



(a) Men

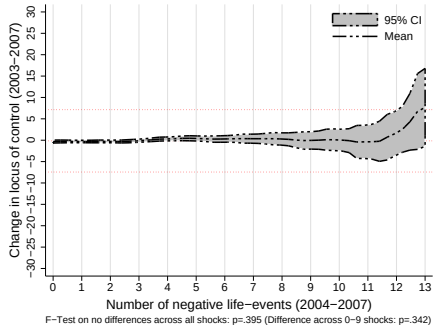


(b) Women

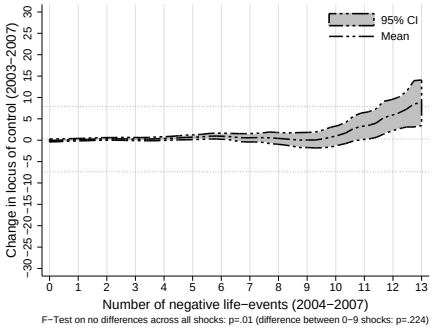


(c) Age 25-60 (Men and women)

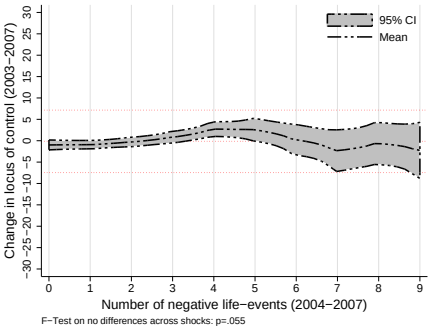
Figure 3: Changes in locus of control over the life-cycle (HILDA 2003-2007)



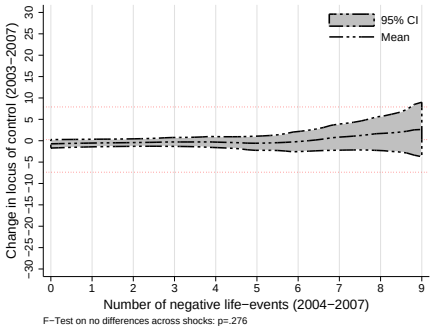
(a) Men



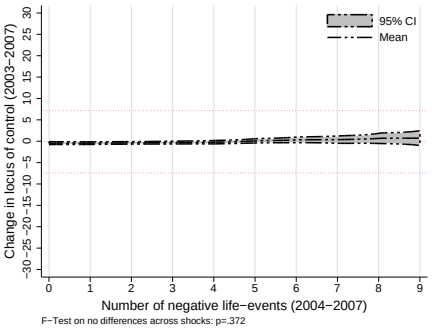
(b) Women



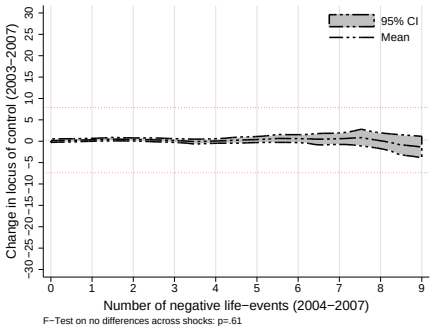
(c) Men 15 to 24



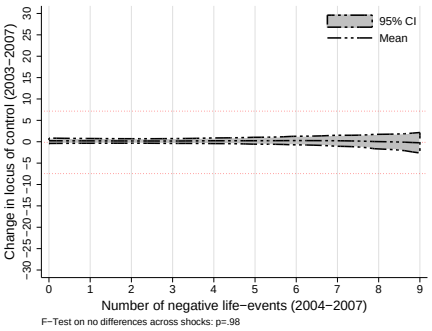
(d) Women 15 to 24



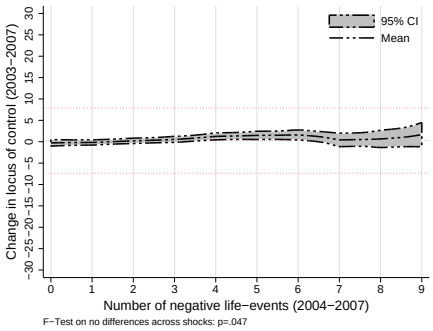
(e) Men 25 to 59



(f) Women 25 to 59

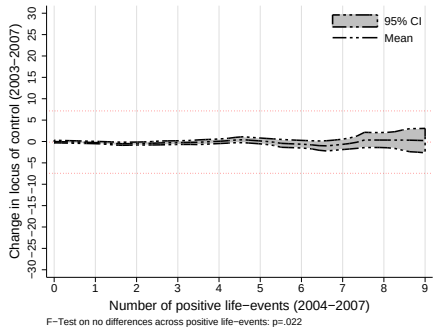


(g) Men 60 +

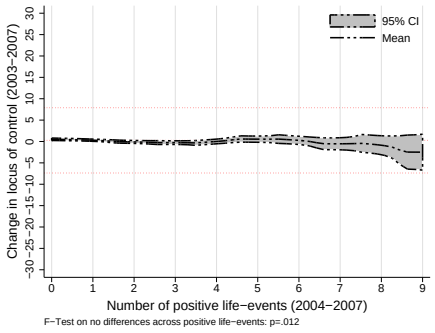


(h) Women 60 +

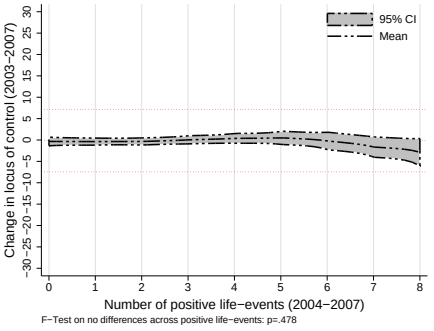
Figure 4: Association between negative life events and changes in locus of control, by gender (HILDA 2003-2007)



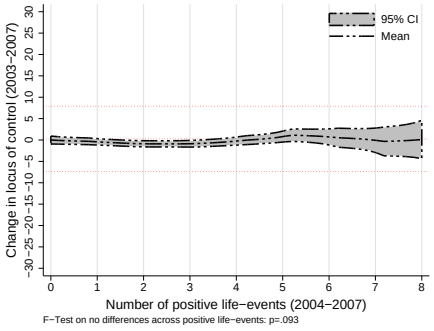
(a) Men



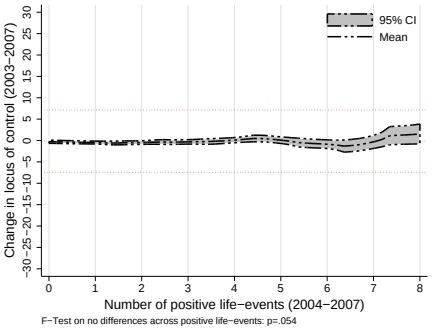
(b) Women



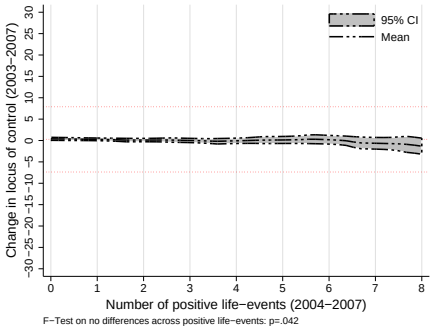
(c) Men 15 to 24



(d) Women 15 to 24

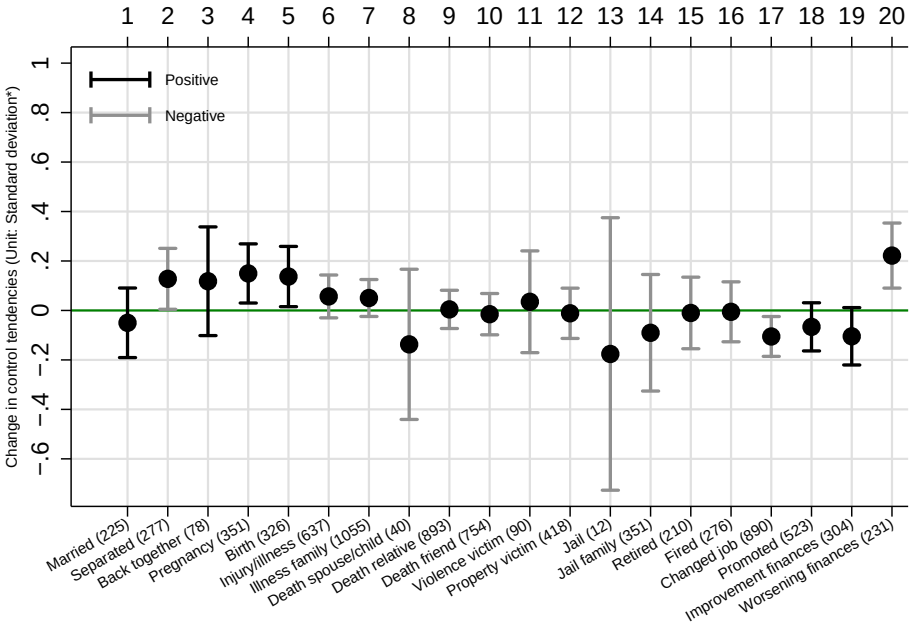


(e) Men 25 to 59



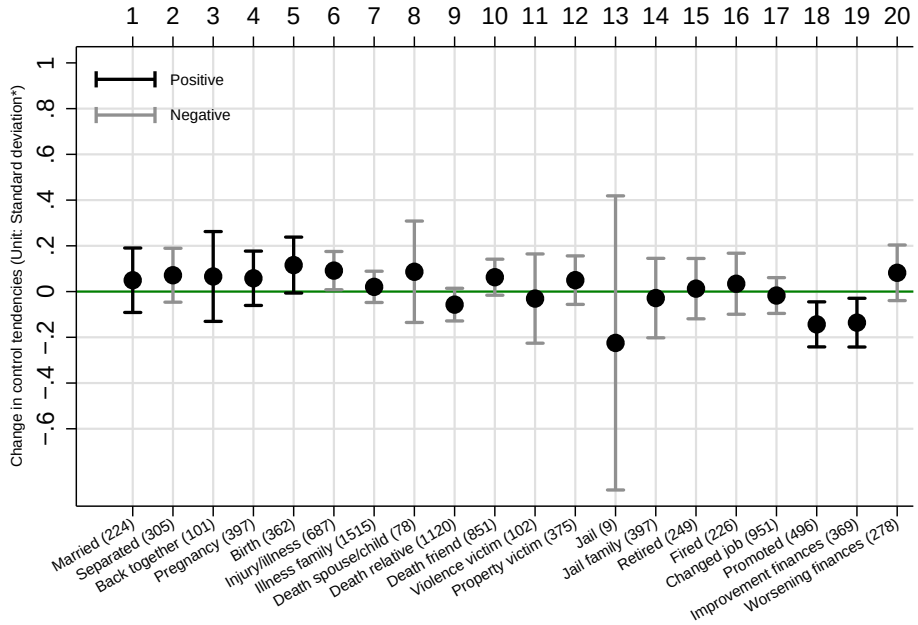
(f) Women 25 to 59

Figure 5: Association between positive life events and changes in locus of control, by gender and age (HILDA 2003-2007)



Estimated coefficients from OLS models; Average R−sqr: .004; N = 2781; Number of obs for life−event in parentheses
* 1 SD change in locus of control is equal to 7.3 units on a scale ranging from −34 to 34.

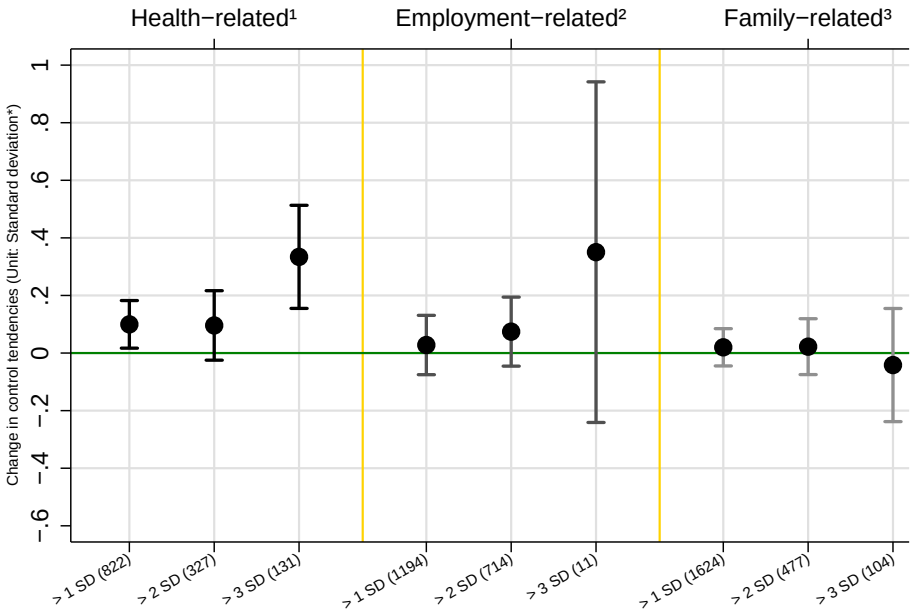
(a) Men



Estimated coefficients from OLS models; Average R−sqr: .001; N = 3235; Number of obs for life−event in parentheses
* 1 SD change in locus of control is equal to 7.6 units on a scale ranging from −34 to 30.

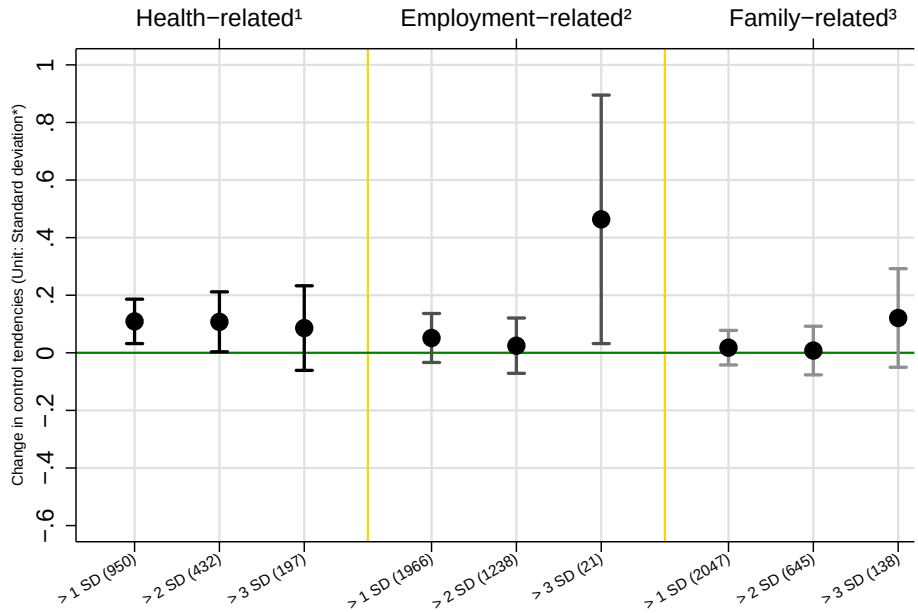
(b) Women

Figure 6: Effect of individual life-events on changes on external control tendencies (OLS)



Estimated coefficients from OLS models; Average R−sqr: .006; N = 3859, * 1 SD = 7.2 (scale −34 to 34).
¹ health−related = 1 if number of health shocks > 1−3 SD;²: employment−related = 1 if num of employment events > 1−3 SD
³: family−related shock = 1 if num of family events > 1, 2, or 3 SD.

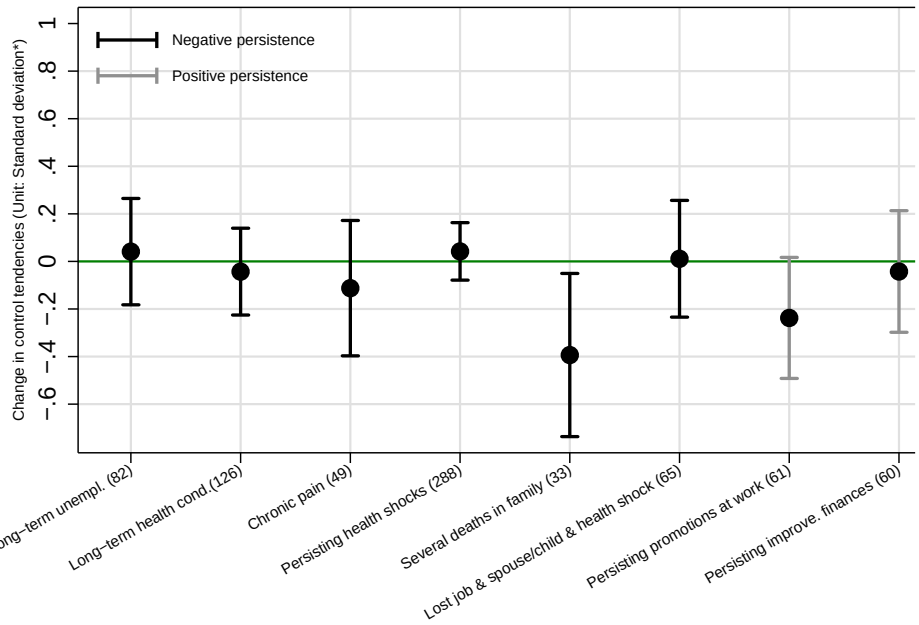
(a) Men



Estimated coefficients from OLS models; Average R−sqr: .003; N = 4437, * 1 SD = 7.6 (scale −34 to 30).
¹ health−related = 1 if number of health shocks > 1−3 SD;²: employment−related = 1 if num of employment events > 1−3 SD
³: family−related shock = 1 if num of family events > 1, 2, or 3 SD.

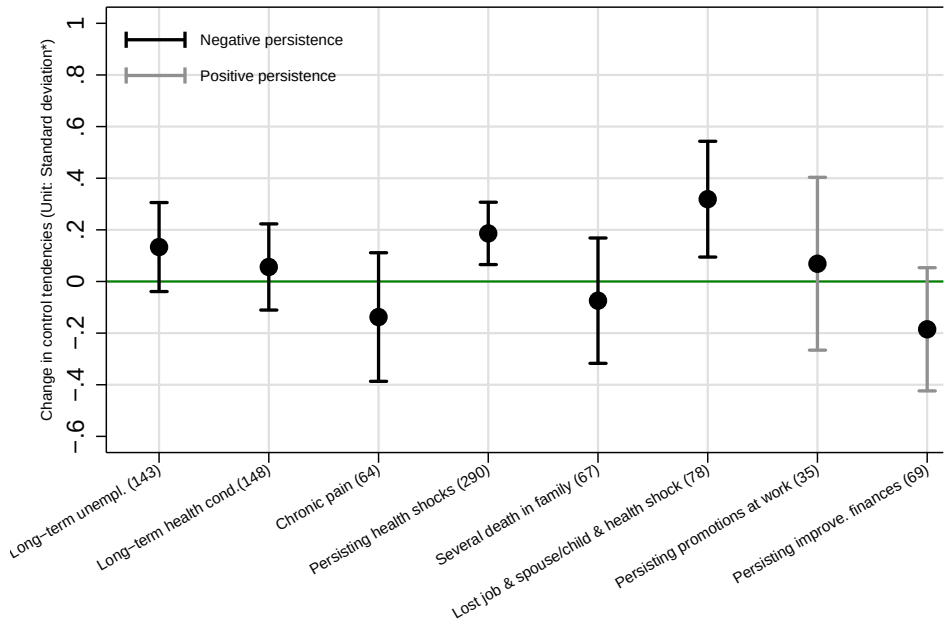
(b) Women

Figure 7: Effect of domain of life-events on changes on external control tendencies (OLS)



Estimated coefficients from OLS models; Average R−sqr: .005; N = 3859, * 1 SD = 7.3 (scale −34 to 34).
Number of observations for particular sequence of events in parentheses.

(a) Men



Estimated coefficients from OLS models; Average R−sqr: .002; N = 4437, * 1 SD = 7.6 (scale −34 to 30).
Number of observations for particular sequence of events in parentheses.

(b) Women

Figure 8: Effect of persistence of life-events on external control tendencies (OLS)

Table 5: Estimated wage effects of locus of control

Study	**Data**	**Effects**[e]	**Locus of control measured**
Heineck and Anger (2010)	GSOEP[a]	Men: 7% Women: 4-10%	in 2005, earnings in 1991-2005
Cebi (2007)	NLSY[b]	2.1%	in 1979, earnings in 1979-82
Osborne Groves (2005)	NLSYW[c]	Women: 5-7%	in 1970/1988, earnings in 1991-93
Andrisani (1977)	NLS[d]	Young men: 7.5% Middle-aged men: 5%	in same year as earnings
Semykina and Linz (2007)	3 surveys on Russian employees	Women: 6.4% Men: 4.6%	in same year as earnings

Note: a German Socio-Economic Panel, b National Longitudinal Survey of Youth,
c National Longitudinal Survey of Youth Women sample, d National Longitudinal Survey
e Percentage change in hourly wage due to a 1 standard deviation change in locus of control.

Table 6: Wage equivalent of changes in locus of control

Men	**Worsening Finances**	**Health Shocks** > 3 SD	**Employment Shocks** > 3 SD	**Several Deaths** (in family)
Changes in LOC (Prop of 1 SD)	0.22	0.38	0.4	-0.4
% change[a] avg hourly wage	1.54	2.66	2.8	-2.8
N	230	130	11	33
Women	**Promoted At work**	**Persisting Shocks** ≥ 2	**Employment Health** > 3 SD	**Accumulation of Shocks**
Changes in LOC (Prop of 1 SD)	-0.18	0.195	0.5	0.35
% change[b] avg hourly wage	-1.8	1.95	5	3.5
N	496	290	21	78

a Avg hourly wage in GSOEP: 38.5 Euro, wage elasticity from Heineck and Anger (2010) is 7%
b Avg hourly wage in GSOEP: 30.1 Euro, wage elasticity from Heineck and Anger (2010) is 10%

A Principal component analysis

Table 7: Estimated wage effects[a] of locus of control and its measurement error

Model	$\hat{\gamma}$	σ_γ	Bias[b]	Prop[c]	N
Gross annual wages and salaries					
Women aged 30 to 54					
Wage in 2007 using LOC from 2003	-0.094	0.023	-0.049	52.1	1714
Wage in 2007 using LOC from 2004	-0.116	0.024	-0.061	53.1	1613
Wage in 2004 using LOC from 2003	-0.045	0.024	-0.025	56.0	1839
Men aged 30 to 54					
Wage in 2007 using LOC from 2003	-0.119	0.019	-0.062	51.9	1604
Wage in 2007 using LOC from 2004	-0.119	0.020	-0.065	54.6	1491
Wage in 2004 using LOC from 2003	-0.095	0.019	-0.053	55.7	1853
Hourly Wages					
Women aged 30 to 54					
Wage in 2007 using LOC from 2003	-0.047	0.012	-0.024	51.8	1519
Wage in 2007 using LOC from 2004	-0.036	0.013	-0.019	52.9	1431
Wage in 2004 using LOC from 2003	-0.037	0.012	-0.021	56.1	1597
Men aged 30 to 54					
Wage in 2007 using LOC from 2003	-0.066	0.013	-0.034	51.6	1502
Wage in 2007 using LOC from 2004	-0.043	0.013	-0.024	55.1	1395
Wage in 2004 using LOC from 2003	-0.035	0.012	-0.019	55.3	1724

Models are estimated on sample of 30 to 54 year old, top 1% and bottom 5% of wages are discarded.

a wage effects are measured in percentage changes due to a 1 SD change in locus of control.

b Biased estimate is calculated as: $\hat{\gamma} * \frac{\sigma^2_{L_{it}}}{\sigma^2_{L_{it}} + \sigma^2_v}$. Prop is the proportion of true estimate $\hat{\gamma}$.

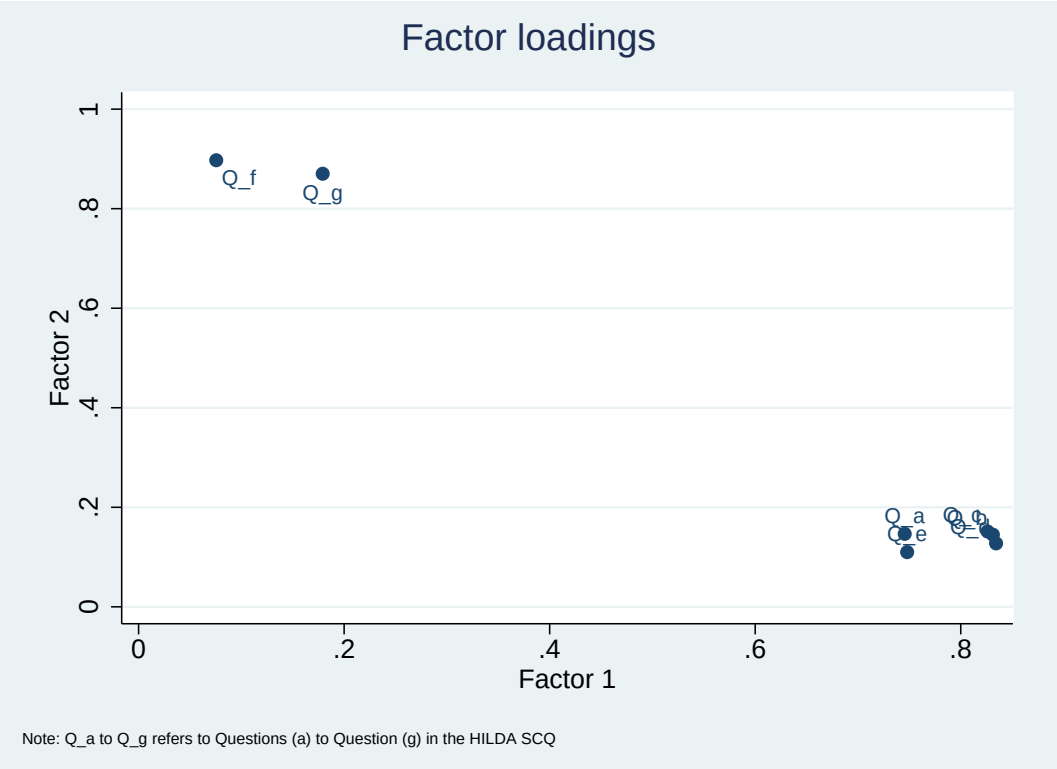


Figure 9: Plot of factor loadings for each sub-dimension of locus of control

Table 8: Descriptive statistics of variables used in analysis

	Sample of men					Sample of women					Diff
Variable	mean	SD	min	max	N	mean	SD	min	max	N	p-val[a]
Full index locus of control	18.29	7.55	7	49	3859	18.53	7.76	7	49	4440	0.148
External locus of control	13.21	6.29	5	35	3859	13.42	6.55	5	35	4440	0.138
Internal locus of control	10.92	2.68	2	14	3859	10.89	2.75	2	14	4440	0.571
Change in locus of control between 2003 and 2007	-0.14	7.3	-34	34	3859	0.25	7.64	-34	30	4440	0.017
Change in locus of control between 2003 and 2004	-0.27	6.61	-30	32	3586	0.02	6.86	-30	29	4156	0.065
Got married	0.03	0.16	0	1	3827	0.02	0.15	0	1	4411	0.319
Separated from spouse	0.04	0.19	0	1	3820	0.04	0.2	0	1	4393	0.235
Got back together with spouse	0.01	0.1	0	1	3823	0.01	0.11	0	1	4396	0.523
Pregnancy	0.05	0.22	0	1	3826	0.06	0.23	0	1	4403	0.182
Birth/adoption of new child	0.04	0.19	0	1	3822	0.04	0.19	0	1	4399	0.890
Serious personal injury/illness	0.09	0.28	0	1	3827	0.08	0.27	0	1	4400	0.065
Serious injury/illness to family member	0.16	0.37	0	1	3822	0.2	0.4	0	1	4400	0.000
Death of spouse or child	0.01	0.08	0	1	3824	0.01	0.1	0	1	4398	0.024
Death of close relative/family member	0.1	0.31	0	1	3825	0.11	0.31	0	1	4398	0.857
Death of a close friend	0.1	0.3	0	1	3824	0.11	0.31	0	1	4397	0.250
Victim of physical violence	0.02	0.13	0	1	3821	0.02	0.13	0	1	4400	0.447
Victim of a property crime	0.07	0.25	0	1	3826	0.06	0.23	0	1	4406	0.063
Detained in jail	0	0.04	0	1	3827	0	0.02	0	1	4404	0.060
Close family member detained in jail	0.01	0.09	0	1	3826	0.02	0.12	0	1	4406	0.001
Retired from the workforce	0.03	0.17	0	1	3825	0.02	0.15	0	1	4408	0.181
Fired or made redundant	0.04	0.19	0	1	3823	0.02	0.15	0	1	4404	0.000
Changed jobs	0.15	0.35	0	1	3822	0.12	0.32	0	1	4402	0.000
Promoted at work	0.07	0.26	0	1	3819	0.05	0.22	0	1	4391	0.000
Major improvement in finances	0.04	0.19	0	1	3827	0.04	0.19	0	1	4402	0.938
Major worsening in finances	0.03	0.17	0	1	3826	0.03	0.18	0	1	4406	0.816
Sum negative life-events	2.19	2.09	0	17	3859	2.32	2.19	0	16	4440	0.006
Sum positive life-events	1.4	1.77	0	11	3859	1.31	1.65	0	10	4440	0.014
Total number of new health conditions or health	1.57	2.75	0	30	3859	1.69	3.05	0	26	4440	0.062
Total number of income related shocks e	1.2	1.62	0	7	3859	1.68	1.75	0	7	4440	0.000
Total number of shocks regarding family life	1.55	1.62	0	12	3859	1.73	1.71	0	12	4440	0.000
Total number of health shocks $>$ 3 SD	0.03	0.18	0	1	3859	0.04	0.2	0	1	4440	0.017
Total number of employment shocks $>$ 3 SD	0.001	0.05	0	1	3859	0	0.07	0	1	4440	0.168
Total number of family-related shocks $>$ 3 SD	0.03	0.16	0	1	3859	0.03	0.17	0	1	4440	0.235
Total number of health shocks $>$ 2 SD	0.08	0.28	0	1	3859	0.1	0.3	0	1	4440	0.047
Total number of employment shocks $>$ 2 SD	0.19	0.39	0	1	3859	0.28	0.45	0	1	4440	0.000
Total number of family-related shocks $>$ 2 SD	0.12	0.33	0	1	3859	0.14	0.35	0	1	4440	0.004
Total number of health shocks $>$ 1 SD	0.21	0.41	0	1	3859	0.21	0.41	0	1	4440	0.913
Total number of employment shocks $>$ 1 SD	0.31	0.46	0	1	3859	0.44	0.5	0	1	4440	0.000
Total number of family-related shocks $>$ 1 SD	0.42	0.49	0	1	3859	0.46	0.5	0	1	4440	0.000
Long-term unemployed	0.02	0.14	0	1	3859	0.03	0.18	0	1	4440	0.002
Chronic health condition	0.03	0.18	0	1	3859	0.03	0.18	0	1	4440	0.907
Chronic pain	0.01	0.11	0	1	3859	0.01	0.12	0	1	4440	0.557
Persistent health shocks	0.07	0.26	0	1	3859	0.07	0.25	0	1	4440	0.106
Persistent deaths in family	0.01	0.09	0	1	3859	0.01	0.12	0	1	4440	0.008
Lost job, partner/spouse, health shock	0.02	0.13	0	1	3859	0.02	0.13	0	1	4440	0.731
Persistent promotion at job	0.02	0.12	0	1	3859	0.01	0.09	0	1	4440	0.001
Persistent improvement finances	0.02	0.12	0	1	3859	0.02	0.12	0	1	4440	0.998
Age-group 15 to 19	0.08	0.26	0	1	3859	0.07	0.26	0	1	4440	0.385
Age-group 20 to 24	0.06	0.24	0	1	3859	0.06	0.23	0	1	4440	0.380
Age-group 25 to 29	0.07	0.25	0	1	3859	0.08	0.27	0	1	4440	0.067
Age-group 30 to 39	0.19	0.4	0	1	3859	0.2	0.4	0	1	4440	0.562
Age-group 40 to 49	0.22	0.41	0	1	3859	0.22	0.42	0	1	4440	0.792
Age-group 50 to 59	0.17	0.38	0	1	3859	0.17	0.37	0	1	4440	0.393
Age-group 60 to 69	0.12	0.33	0	1	3859	0.11	0.32	0	1	4440	0.200
Age-group 70 to 79	0.07	0.26	0	1	3859	0.07	0.26	0	1	4440	0.978
Age-group 80 and older	0.01	0.1	0	1	3859	0.02	0.14	0	1	4440	0.005
Married or de facto in 2003	0.57	0.49	0	1	3859	0.54	0.5	0	1	4440	0.001
Separated or divorced in 2003	0.03	0.16	0	1	3859	0.03	0.18	0	1	4440	0.058
Foreigner	0.22	0.41	0	1	3859	0.2	0.4	0	1	4440	0.235
Full or part-time employed in 2003	0.72	0.45	0	1	3859	0.58	0.49	0	1	4440	0.000
Household income (ln) in 2003	10.76	0.68	5.3	13.96	3859	10.68	0.70	5.23	13.96	4440	0.000
Masters or doctorate	0.04	0.19	0	1	3859	0.03	0.16	0	1	4440	0.002
Grad diploma, grad certificate	0.05	0.21	0	1	3859	0.06	0.23	0	1	4440	0.017
Bachelor or honours	0.12	0.32	0	1	3859	0.13	0.34	0	1	4440	0.041
Advanced diploma, diploma	0.09	0.29	0	1	3859	0.09	0.28	0	1	4440	0.155
Any certificate	0.28	0.45	0	1	3859	0.14	0.34	0	1	4440	0.000
Year 12	0.13	0.33	0	1	3859	0.15	0.36	0	1	4440	0.001
Year 11 and below	0.3	0.46	0	1	3859	0.41	0.49	0	1	4440	0.000

Note: a p-val refers to a t-test of differences in mean between men and women.

Table 9: Test statistics restricted[a] versus unrestricted[b] model

	t-test[c]	LR-Test[c]	BIC	
	p-val	p-val	unres[b]	res[a]
Got married	0.333	0.032	9296.0	9174.3
Separated from spouse	0.929	0.041	9296.0	9173.4
Got back together with spouse	0.537	0.032	9296.0	9174.4
Pregnancy	0.023	0.036	9296.0	9173.9
Birth/adoption of new child	0.283	0.067	9296.0	9171.3
Serious personal injury/illness	0.559	0.088	9296.0	9170.1
Serious injury/illness to family member	0.803	0.031	9296.0	9174.4
Death of spouse or child	0.780	0.033	9296.0	9174.2
Death of close relative/family member	0.482	0.053	9296.0	9172.3
Death of a close friend	0.255	0.052	9296.0	9172.3
Victim of physical violence	0.154	0.029	9296.0	9174.7
Victim of a property crime	0.924	0.035	9296.0	9173.9
Detained in jail	0.931	0.032	9296.0	9174.3
Close family member detained in jail	0.768	0.029	9296.0	9174.7
Retired from the workforce	0.255	0.028	9296.0	9174.8
Fired or made redundant	0.847	0.030	9296.0	9174.5
Changed jobs	0.547	0.030	9296.0	9174.6
Promoted at work	0.119	0.188	9296.0	9166.6
Major improvement in finances	0.794	0.127	9296.0	9168.5
Major worsening in finances	0.226	0.044	9296.0	9173.0

Note: a Restricted model includes each life event separately.
b Unrestricted model includes all life events jointly.
c t-test of equality of coefficients between restricted and unrestricted model.
b LR-test compares model fit between restricted and unrestricted model.

Table 10: Definition of indicators of negative and positive life-events between 2004-2007

Variables	Definition
Figure 6: Individual life events	
Married	Life events in past year: Got married
Separated	Life events in past year: Separated from spouse
Back together	Life events in past year: Got back together with spouse
Pregnancy	Life events in past year: Pregnancy
Birth	Life events in past year: Birth/adoption of new child
Injury/illness	Life events in past year: Serious personal injury/illness
Illness family	Life events in past year: Serious injury/illness to family member
Death spouse/child	Life events in past year: Death of spouse or child
Death relative	Life events in past year: Death of close relative/family member
Death friend	Life events in past year: Death of a close friend
Violence victim	Life events in past year: Victim of physical violence
Property victim	Life events in past year: Victim of a property crime
Jail	Life events in past year: Detained in jail
Jail family	Life events in past year: Close family member detained in jail
Retired	Life events in past year: Retired from the workforce
Fired	Life events in past year: Fired or made redundant
Changed jobs	Life events in past year: Changed jobs
Promoted	Life events in past year: Promoted at work
Improvement finances	Life events in past year: Major improvement in finances
Worsening finances	Life events in past year: Major worsening in finances
Figure 7: indicator for a high number of domain-specific negative events	
Health related	Sum of: (1) Serious illness/injury, (2) victim of physical violence, New episodes of: (3) Other long-term condition, (4) Long-term condition or ailment, (5) Long-term effects head injury, 6) Disfigurement or disformity, ((7) Chronic or recurring pain, (8) Shortness of breath, (9) Mental illness, (10) Condition that restricts physical activity, (11) Nervous or emotional condition, (12) Limited use of feet or legs, (13) Difficulty of gripping things, (14) Limited use of arms and fingers, (15) Blackout, fits, or loss of consciousness.
= 1 if > 1 SD	Number of health-related (new) events/conditions > 2.7
= 1 if > 2 SD	Number of health-related (new) events/conditions > 5.4
= 1 if > 3 SD	Number of health-related (new) events/conditions > 8.1
Employment related	Sum of (1) Worsening finances, (2) being fired, (3) unemployed looking for full- or part-time work, (4) marginally out of the labour force
= 1 if > 1 SD	Number of employment related events > 1.6
= 1 if > 2 SD	Number of employment related events > 3.2
= 1 if > 3 SD	Number of employment related events > 4.8
Family related	Sum of: (1) Serious injury/illness to family member, (2) Death of spouse or child, (3) Death of close relative/family member, (4) Death of a close friend, (5) Victim of a property crime
= 1 if > 1 SD	Number of family-related events > 1.6
= 1 if > 2 SD	Number of family-related events > 3.2
= 1 if > 3 SD	Number of family-related events > 4.8
Figure 8: indicator identifying individuals with persisting positive and negative events	
Long-term unemployed	Being fired, unemployed, or marginally out of the labour force at least in three out of four consecutive years
Long-term health condition	Reporting any long-term health condition in at least three out of four consecutive years
Chronic pain	Reporting chronic pain in all four consecutive years
Persisting health shocks	Experience of at least two health shocks within a period of four consecutive years
Several death in family	Lost at least two very close family members (spouse or child) within a period of four consecutive years
Lost job, lost spouse or child, had a health shock	Fired from job or worsening of finances, lost a spouse/child or a close family member, and experienced a health shock within a period of four consecutive years
Persistent promotions at work	Was promoted at least three out of four times within four consecutive years
Persisting improvement in finances	Experienced at least twice an improvement of finances within period of four consecutive years

Table 11: Determinants of changes in external control tendencies between 2003 and 2007 (OLS)

DV: Determinants of external control tendencies 2007 and 2003 ($LOC_{i,t=07} - LOC^{1}_{i,t=03} \geq 0$), Mean 0, St Dev 1								
Variables	**Women**				**Men**			
	Health	Employment	Family	All shocks	Health	Employment	Family	All shocks
Domains of negative life-events experienced between 2004 and 2007								
Health-related life event[1]	0.327***			0.331***	0.109			0.094
	(0.113)			(0.113)	(0.090)			(0.090)
Employment-related event[2]		0.352		0.351		0.497*		0.468*
		(0.458)		(0.448)		(0.278)		(0.277)
Family-related event[3]			-0.000	-0.043			0.143	0.123
			(0.107)	(0.108)			(0.093)	(0.093)
Age-groups (Omitted category: Less than 30 years of age)								
Age-group 30 to 39	-0.040	-0.037	-0.034	-0.042	0.006	0.008	0.007	0.006
	(0.053)	(0.053)	(0.053)	(0.053)	(0.049)	(0.049)	(0.049)	(0.049)
Age-group 40 to 49	-0.144***	-0.139**	-0.137**	-0.145***	0.059	0.060	0.062	0.055
	(0.055)	(0.055)	(0.055)	(0.055)	(0.049)	(0.049)	(0.049)	(0.049)
Age-group 50 to 59	-0.139**	-0.125**	-0.123**	-0.139**	-0.024	-0.018	-0.020	-0.027
	(0.060)	(0.060)	(0.060)	(0.060)	(0.054)	(0.054)	(0.054)	(0.054)
Age-group 60 to 69	-0.067	-0.060	-0.059	-0.067	0.011	0.015	0.014	0.007
	(0.074)	(0.074)	(0.074)	(0.074)	(0.065)	(0.064)	(0.064)	(0.065)
Age-group 70 to 79	-0.019	-0.004	-0.003	-0.019	0.063	0.077	0.071	0.062
	(0.090)	(0.090)	(0.090)	(0.090)	(0.075)	(0.074)	(0.074)	(0.075)
Age-group 80 and older	0.211	0.230	0.228	0.215	0.144	0.158	0.146	0.143
	(0.201)	(0.201)	(0.202)	(0.201)	(0.135)	(0.135)	(0.136)	(0.136)
Marital status in 2003 (Omitted category: Single								
Married or de facto in 2003	0.059	0.059	0.058	0.060	0.056	0.057	0.055	0.059
	(0.040)	(0.040)	(0.040)	(0.040)	(0.036)	(0.036)	(0.036)	(0.036)
Separated or divorced in 2003	-0.079	-0.086	-0.088	-0.076	-0.045	-0.040	-0.043	-0.039
	(0.109)	(0.108)	(0.109)	(0.109)	(0.093)	(0.093)	(0.093)	(0.093)

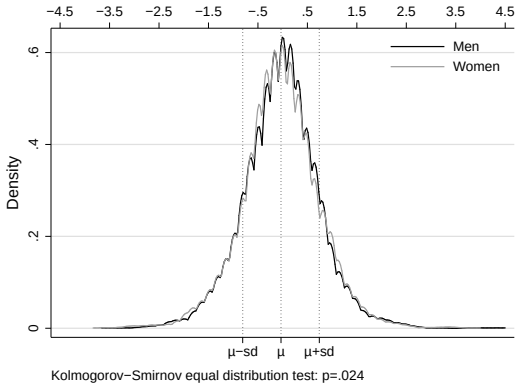
Foreigner	-0.045	-0.049	-0.049	-0.046	-0.033	-0.033	-0.032	-0.031
	(0.042)	(0.042)	(0.042)	(0.042)	(0.039)	(0.039)	(0.038)	(0.039)
Full or part-time employed in 2003	0.002	-0.017	-0.020	0.005	-0.053	-0.050	-0.053	-0.046
	(0.051)	(0.051)	(0.051)	(0.051)	(0.036)	(0.037)	(0.036)	(0.037)
Household income (ln) in 2003	-0.060**	-0.062**	-0.062**	-0.060**	-0.035	-0.037	-0.037	-0.035
	(0.028)	(0.028)	(0.028)	(0.028)	(0.026)	(0.026)	(0.026)	(0.026)
Educational attainment in 2003 (Omitted category: Finished Year 11 or drop-out								
Postgraduate - masters or doctorate	0.165**	0.164**	0.164**	0.165**	0.045	0.046	0.044	0.044
	(0.076)	(0.076)	(0.076)	(0.076)	(0.091)	(0.091)	(0.091)	(0.091)
Graduate diploma, graduate certificate	0.149**	0.143**	0.143**	0.149**	0.080	0.080	0.080	0.080
	(0.073)	(0.073)	(0.073)	(0.073)	(0.059)	(0.059)	(0.059)	(0.059)
Bachelor or honours degree	0.086	0.086	0.086	0.086	0.080*	0.079*	0.080*	0.078
	(0.053)	(0.053)	(0.053)	(0.053)	(0.048)	(0.048)	(0.048)	(0.048)
Advanced diploma, diploma	0.163***	0.165***	0.165***	0.164***	0.060	0.056	0.058	0.056
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Any certificate	0.070	0.072	0.073	0.069	0.035	0.032	0.034	0.031
	(0.045)	(0.045)	(0.045)	(0.045)	(0.050)	(0.050)	(0.050)	(0.050)
Finished Year 12	0.056	0.056	0.059	0.053	-0.045	-0.046	-0.046	-0.047
	(0.056)	(0.056)	(0.056)	(0.056)	(0.046)	(0.046)	(0.047)	(0.046)
Constant	0.615**	0.658**	0.661**	0.613**	0.341	0.360	0.358	0.326
	(0.300)	(0.299)	(0.299)	(0.300)	(0.278)	(0.278)	(0.278)	(0.278)
Observations	3859	3859	3859	3859	4440	4440	4440	4440
Number of observations for which domain event = 1	130	11	103		195	21	138	
R-squared	0.012	0.009	0.009	0.012	0.006	0.007	0.006	0.007
Omitted variable test (p-value)	0.879	0.466	0.471	0.722	0.962	0.772	0.982	
Test of equality of effects (p-value)				0.0598				0.458
Test of jointly not significant (p-value)				0.0253				0.0851

Note: Each domain of negative life events sums all life-events experienced in this domains between 2004-2007.

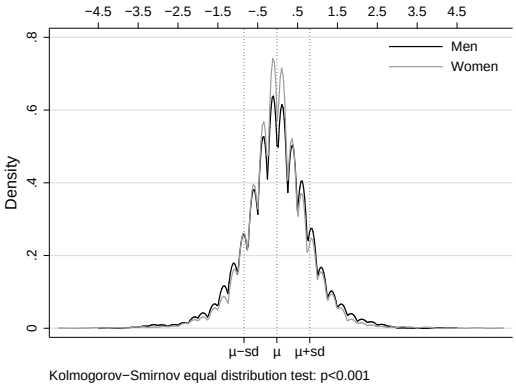
1 Health-related shock = 1 if total number of health-related shocks between 2004-2007 is greater than 3 SD.

2 Employment/income-related shock = 1 if total number of employment-related shocks between 2004-2007 is greater than 3 SD.

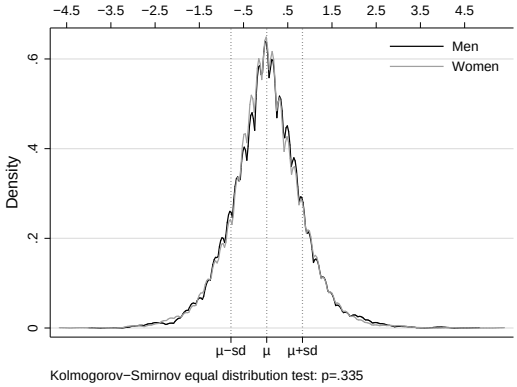
3 Family-related shock = 1 if total number of family-related shocks between 2004-2007 is greater than 3 SD.



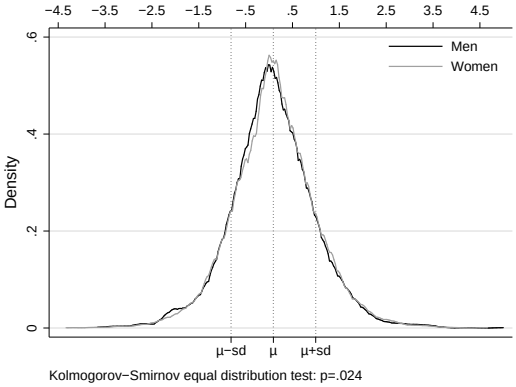
(a) Extraversion



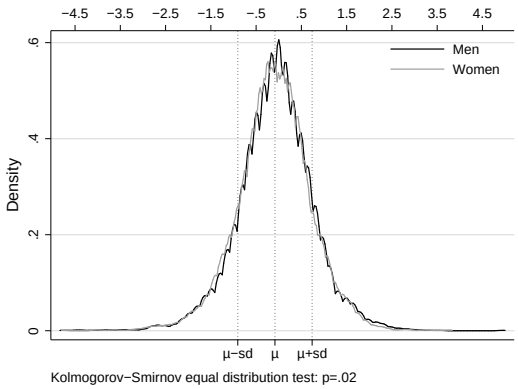
(b) Agreeableness



(c) Conscientiousness



(d) Emotional Stability



(e) Openness to Experience

Figure 10: Distribution of changes in Big Five personality by gender (HILDA 2005 and 2009)