Harsh times:
Do stressors lead to labor market losses?

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Abstract

This paper examines the links between stressful life events and labor market outcomes. We use twin data for Finnish men and women combined with register-based individual information on earnings, employment and social income transfers. The twin data allow us to account for shared environmental and genetic confounders. We measure the exposure to stressful life events in 1990. The labor market outcomes are measured during a 20-year follow-up over the period 1990-2009. Four findings stand out. First, stressors lead to worse labor market outcomes. Second, both men and women are distressed by labor market shocks, but they respond differently to marital problems and health shocks within the family. For example, women respond to marital problems by working more, whereas men respond similarly after facing a random health shock within the family. Third, the relationship between health shocks and labor market outcomes diminishes as time passes, whereas the consequences of labor market shocks are more permanent. Fourth, the links between stressors and labor market outcomes are not primarily driven by health behaviors, such as smoking and alcohol use, or worse mental stability.

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I. Introduction

Life events come in many forms. The economic literature has focused on the relationships between specific adverse events and labor market outcomes. Employment interruptions, such as mass lay-offs, negatively affect subsequent wages and labor market attachment [1]-[3]. The onset of disability and health shocks have substantial negative effects on wages and employment [4]-[6]. Additionally, there is a negative relationship between household disruptions – such as divorce, widowhood or sickness in the family – and labor market outcomes [7]-[9]. Recently, Van den Berg et al. [10] examined the effect of an (exogenous) death of a child on parents' subsequent labor market outcomes, marital status and health.[1]

There are several mechanisms through which adverse events may lead to negative labor market outcomes. Adverse life events affect health behaviors such as the misuse of alcohol and smoking [14]-[15], subjective wellbeing [16], and eroding mental health [17]-[18]. These may weaken an individual's ability to participate in the labor market and reduce work performance. In addition to reducing work capacity, individuals might also decrease the hours of work and stay home to take care of ill family members.

We examine how adverse life events are related to labor market success later in life. As outcome variables, we use register-based information on earnings and employment. Because we analyze the effects in the context of a Nordic welfare state (Finland), we also examine the effects of adverse life events on receiving social income transfers and total income.

[1] Persson and Rossin-Slater [11] find that the death of a relative during pregnancy has negative consequences on birth outcomes and mental health during childhood. Carlson [12] reports that layoffs occurring during pregnancy are associated with a decrease in birth weight. The adverse effects lead to spillover effects. For example, an involuntary job loss of a husband decreases significantly the mental well-being of his wife [13].

We contribute to the literature in three important ways. First, the intersection between psychology and other social sciences is increasingly fruitful ground for new economic insights into policy-relevant issues. Our novel contribution is to use the Stressful Life Events (SLE) index, which systematically accounts for a broad set of adverse events. The shocks described by the SLE index have been a locus of empirical research in the psychiatric epidemiology literature. Adverse life events are stressors that lead to onset of a major depression in life [19]-[20].

Second, the true effects of adverse events are challenging to identify, because the exposure to stressful life events may be influenced by unobserved environmental and genetic confounders, and these factors may also be significantly correlated with labor market success later in life. There is evidence that the exposure to events that are likely influenced by an individual's own behavior, such as problems with a spouse or criminal behavior, are partially explained by genetic factors [21]. By contrast, familial events, such as financial difficulties in the family, death of a parent and parental separation are to a large extent explained by shared environmental factors [21]. Thus, we estimate the relationship between adverse events and labor market outcomes using a large and representative data set on Finnish twins.

By using data on identical twins, we can account for shared environmental factors and inherited traits and preferences that are potential determinants of shocks that people face in their lives. Additionally, there are psychological traits that help individuals to mitigate and overcome the stress caused by adverse life events. These sources of resiliency include self-confidence and autonomy. Genetic factors play a significant role in explaining human resilience to stress and adversity [22]-[23], and these mediators are potentially accounted for in a twin-design. Only one empirical study has used twin data to examine the relationship between adverse life events and labor market outcomes [24]. In their study using twin data

for Swedish men, Lundborg et al. [24] found that poor adolescent mental health is negatively associated with long-term earnings and employment.[2]

The literature shows that primary shocks, such as lay-offs, may predispose an individual to a series of secondary shocks, such as marital problems and risky health behaviors [28]-[29]. Individuals with poor health are more likely to become unemployed [30]-[31], and stress levels are positively associated with extreme outcomes such as premature death [32]. The cumulative exposure to adversities may have substantial effects on labor market outcomes in the long run. Under this scenario, it is difficult to disentangle the separate effects of a specific event on subsequent labor market losses when the total effects are partly influenced by other factors. A solution is to use the SLE index because this index captures the total burden of multiple types of adverse events in the long run. In a regression setting, it is in principle possible to simultaneously control for a variety of different events and estimate the statistical significance of the individual effects. However, the interpretation of the estimated effects easily becomes cumbersome if the regression is overloaded with many variables that have significant interaction effects. Thus, the use of the SLE index mitigates the residual confounding caused by other shocks. Hence, the key advantage of the SLE index is that it compactly summarizes information about several negative aspects, which implies that we manage to combine different adverse events into one index (or three different indexes as we do in our paper) to create a single variable that provides an overall account of the underlying structure of stressful life events.

Third, to obtain a more complete picture, we distinguish labor market shocks, family shocks and health shocks and analyze the adaptation to these shocks over a 20-year follow-

[2] Previous studies utilizing twin data have mainly focused on the effects of birth weight on labor market outcomes [25]-[26] and the impact of children on female labor supply and earnings [27].

up period. Gaining deeper knowledge regarding the adaptation to shocks is particularly useful for public policy purposes. There is an apparent need for policy intervention if the effects of a shock on subsequent labor market attachment and earnings are permanent.

This paper is organized as follows. The next section describes the Finnish twin cohort study, which has been matched to register-based data on labor market outcomes. The third section briefly discusses our empirical approach. The fourth section presents the baseline results of our analysis and various extensions. The final section concludes the paper by putting our findings into the larger context of the literature.

II. Data

Twin survey and register data on labor market outcomes

The analysis is based on the extensive use of the Finnish twin survey matched to the Finnish Longitudinal Employer-Employee Data (FLEED). The linked data were created for research purposes by Statistics Finland. The twin survey sample is based on the Older Finnish Twin Cohort Study by the Department of Public Health in the University of Helsinki, which was compiled from the Central Population Registry of Finland [33]-[34]. Initial candidates for the survey were all Finnish twins born before 1958 identified using information on birth date, place of birth, sex, and surname at birth. The twin data contain only same-sex twin pairs. A questionnaire was mailed to these candidates in 1975 to collect baseline data and to determine their zygosity. The response rate for the 1975 survey was 89% (N = 12,502 twin pairs with responses from both twins, age $\geq$ 18). Two follow-up surveys were conducted in 1981 (the response rate 84%) and 1990 (the response rate 77%). The 1990 survey was mailed only to twins who were born between the years 1930 and 1957, and thus the number of twin

pairs in the 1990 survey was approximately one-half of that in the 1981 survey. The twins were at least 33 years old in 1990.

The twin study contains information on smoking, alcohol use, symptoms of illnesses and reported diseases, medication use, physical characteristics, psychosocial factors and multi-faceted information on experiences at work and in one's personal life. The twin data are a representative sample of the general population in Finland [33], [35]-[36]. The linked data also remain representative for the smaller sample of MZ (monozygotic, genetically identical) twins [37].

The twin study was linked to the FLEED using personal identifiers. The FLEED consists of annual panel data over the period 1990-2009. Using the linked data, we comprehensively tracked the labor market behavior of those twins who participated in the original twin surveys. FLEED is based on administrative registers of individuals and firms collected and/or maintained by Statistics Finland. The data include information on an individual's exact labor market status and income derived directly from tax and other administrative registers. Thus, the income and employment information do not suffer from the characteristic shortcomings of survey data (e.g., underreporting, recall errors or top-coding).

The analysis was performed by using adverse shock variables from the 1990 survey (N = 5,787 twin pairs). We restricted the sample to non-retired working-age persons, which decreased the sample size to 5,311 twin pairs. The analysis focused on individuals for whom we had data on stressful life events, relevant covariates, and labor market outcomes. After excluding missing information, the sample size was further decreased to 4,506 twin pairs. Observations for which information was not available for the individual's twin were also excluded from the final estimation sample, resulting in 2,956 twin pairs (i.e., 5,912 individuals). Of these individuals, ~57% were females, and ~37% were MZ twins. In total,

the data included 75,304 yearly observations for the 1990-2009 period. On average, we observed individuals in the data for 16 years.

Outcome measures

As the main outcome variables, we used annual employment months, the logarithm of annual earnings (added with self-employed income) and the logarithm of social income transfers. The data contain information on total annual taxable income obtained from the Finnish tax authorities. Total income is a broader concept than earnings because total income also includes income transfers and social security benefits, such as parental leave and unemployment benefits. Thus, annual social income transfers were calculated by subtracting annual wage and salary earnings and self-employment income from total annual taxable income. Earnings and social income transfers measures were then replaced with their initial values plus one before logarithmic transformation. The income measures were deflated to 2009 euros using the consumer price index provided by Statistics Finland.

Assessment of stressful life events

The 1990 twin survey contained a 16-item Holmes and Rahe life event inventory [38]-[39]. Of these items, 10 were initially rated as negative [39]. These negative events were death of a spouse, loss of a job, divorce or separation, increased difficulties with a boss or colleagues, financial difficulties, increase in difficulties with a spouse, difficulties of a sexual nature, change in the health of a family member, death of a close family member or friend, and a

disease or injury causing a work disability longer than three weeks.[3] The twins were requested to indicate which SLEs they had experienced and to specify the timing of the events as follows: 1 = never, 2 = during the last six months, 3 = during the last five years (excluding the events during the last 6 months), and 4 = happened to me earlier.

The retrospective information on adverse life events going back many years may suffer from recall bias. Consequently, we used information on adverse events that happened to individuals recently, i.e., during the past 6 months. Because the 1990 twin survey was conducted in autumn, the most recent negative shocks had happened to the respondents in the early 1990s or later. Thus, the measure for SLEs was positive for those individuals who in 1990 reported experiencing a specific event recently *and* also reported never experiencing such an event in 1981. Those subjects who had more than two items missing were excluded (239 individuals). Analogous to a previous study, if the subjects had one or two missing SLE items, then they were coded as 'never experiencing' [39]. We measured the SLE index by using the sum of these 10 items.

Two relevant empirical facts have been established in the literature. First, non-random events, which are likely influenced by an individual's own behavior are explained by genetic factors for the most part, whereas shared and unshared environmental factors are larger contributors to the variance in family shocks that are more random [21]. Second, men and women are distressed by distinctly different types of adverse events. Men are more influenced by labor market shocks, whereas women are more likely than men to be distressed by (social) network events and family shocks [40]-[42]. This pattern is consistent with the "cost-of-caring" hypothesis according to which the greater vulnerability of women is

[3] Earlier studies used twin data from the 1981 survey, which contained 17 stressful life events instead of 16. The additional event in the 1981 survey was "Marked increase in work load", which was regarded as either a positive or a negative event by the experts [39].

explained by their higher emotional engagement in others' lives. Using these empirical insights from earlier studies, we further categorized adverse shocks into three non-overlapping classes. These categories constitute a useful approach to understand the long-run effects of various aspects of stress. Specifically, the events were measured by using the sum of exposure to negative life events as follows:

1 – *Labor market shocks:* Loss of a job, difficulties with a boss or colleagues at work and financial difficulties.

2 – *Family shocks*: Divorce or separation, difficulties with a spouse and sexual difficulties.

3 – *Health shocks*: Death of a spouse, death of a close relative or friend, change in the health of a family member and disease or injury leading to more than three weeks of work disability.

Using the twin data we examined the contributions of genetic and shared environmental factors to the variation in ever experiencing different types of SLEs. The results are reported in Appendix A and suggest that potentially non-random labor market shocks and family shocks are explained by genetic factors for the most part, whereas shared environmental factors are larger contributors to the variance in health and death shocks within the family, which are more random.

Control variables

We controlled for age, the number of diseases and prior earnings level in all specifications. The number of chronic diseases (1981) was used to account for the pre-existing health

endowment. Chronic diseases include, among others, emphysema, chronic obstructive pulmonary disease, high blood pressure, angina pectoris, peptic ulcer, diabetes, and gout.

We accounted for the possibility that the relationship between adverse life events and labor market outcomes is driven by reverse causality. Early income is a strong predictor of labor market success later in life. If early labor market success or failure influences the exposure to adverse events, then the estimates might reflect reverse or two-way causality, at least in part. Our main measure for early labor market success was the individual's annual taxable earnings in 1980.[4] Earnings in 1980 also served as a proxy for unobserved within-twin heterogeneity e.g. in ability. This information was obtained from the comprehensive Longitudinal Population Census by Statistics Finland to which the twin data were linked using personal IDs. We acknowledge that reverse causality may still be induced during the time period of 1981-1989.

Many potential mechanisms can underlie the relationship between adverse life events and subsequent labor market outcomes. We explore these mechanisms by incorporating additional covariates for the central aspects of risky health behaviors, as well as measures for mental stability. For example, adverse life events have been found to affect risky health behaviors, such as excessive alcohol consumption and smoking [14]-[15], which lead to substantial losses in the labor market [43]-[44]. To capture smoking, we used a binary indicator for current smoking status in 1990 (i.e., whether the person reported smoking at the time of the survey). To measure heavy alcohol consumption, we used an indicator variable for binge drinking. Our measure was equal to one for those who in 1990 reported

[4] The data also include the self-reported categorical income level measured in 1975, as well as employment status. Importantly, the twins were on a parallel path already in 1975, before the negative events occurred. These parallel paths were examined by testing the differences in the mean levels of income and employment in 1975 based on experiencing different types of stressful life events.

consuming an amount of alcohol corresponding to at least one bottle of wine (i.e., at least six alcohol units) on the same occasion at least once a month.

Mental stability was measured using the indicators of neuroticism and extraversion originating from the 1981 survey. We added neuroticism as an additional control due to the established link between experiencing adverse shocks and neuroticism [45], [39] and between neuroticism and labor market success [46]. In turn, extraversion may predispose individuals to experience negative life events more positively [47]. Personality characteristics are also highly correlated with individual resilience [48].[5] Neuroticism (extraversion) was assessed by 10 (9) items in the short form of the Eysenck Personality Inventory. We also added the use of tranquilizers from the 1990 survey as a covariate capturing an aspect of mental health. Tranquilizer use had a value of one if the twin reported using a positive quantity of tranquilizers in 1990.

III. Empirical method and statistics

Empirical method

The main econometric analysis is based on the following model:

$$Y_{ijt} = \alpha + \beta SLE_{ij,1990} + f_j + g_{ij} + \varepsilon_{ijt} \quad (1)$$

[5] Individuals may report differently less severe events (e.g. an illness in the family, if the mother has a bad case of flu, or difficulties with a spouse or colleagues), depending on how traumatic they feel the events are. A more resilient person might not report such an event in the SLE, whereas a more sensitive person might.

where Y_{ijt} is the labor market outcome of twin *i* in twin-pair *j* in year *t*, $SLE_{ij,1990}$ is the stressful life event index measured in 1990, f_j is the unobserved shared environmental effect common to both twins of pair *j*, g_{ij} is the unobserved genetic effect specific to twin *i* of pair *j*, and ε_{ijt} is a random shock to twin *i* of pair *j*.

The equation is first estimated by OLS using cross-sectional variation between individuals. This model provides an estimate for SLE that is denoted by β_{OLS}. For β_{OLS} to be a consistent estimator of the coefficient of β, the moment condition $E[f_j + g_{ij} + \varepsilon_{ij}|SLE_{ij}] = 0$ should hold. This condition does not hold if f_j or g_{ij} is correlated with the SLE index. Because f_j and g_{ij} are typically not accounted for in observational data, the omission of these confounders yields biased estimates for the association between SLE and labor market outcomes. For example, a positive correlation between risk-loving behavior and the exposure to some family shock – such as divorce – will lead β_{OLS} to overestimate the true value of β.

We used the within-twins variation among the DZ (dizygotic, genetically full siblings) twins to difference out the shared environmental effects, f_j. In the twin-differenced DZ sample, the estimator is consistent if $E[(g_{2j} - g_{1j}) + (\varepsilon_{2j} - \varepsilon_{1j})|(SLE_{2j} - SLE_{1j})] = 0$, where the terms inside the brackets refer to the within-sibling differences of the variables. The condition does not hold if $(g_{2j} - g_{1j})$ is correlated with $(SLE_{2j} - SLE_{1j})$. Furthermore, if the twins are identical, $(g_{2j} - g_{1j}) = 0$. Thus, the genetic effects can also be differenced out. Using within-twins variation among the MZ twins yields an estimator that is denoted by β_{MZ}. If adverse events are random conditional on genetic endowment, then β_{MZ} is a consistent estimate of β.

There are three challenges with the twin-based design. First, although identical twins share 100% of their genes, there is still a potential endogeneity problem caused by omitted

variables if there are unaccounted variables that affect both adverse life events and subsequent labor market outcomes. For example, identical twins can differ in their initial endowments, such as birth weight [49]. Low birth weight has been linked to adult outcomes, such as lower cognitive ability, lower mental stability (i.e., neuroticism), deficits in social skills (introversion), weaker autonomy, lower probability of mating, and poorer labor market outcomes (e.g., [24], [50]-[52]). If low birth weight is positively related to experiencing adverse life events, then the within-MZ twin-pair results would be upward biased because we have no information on birth weight. However, lower mental stability (such as neuroticism) may capture, at least partly, the potential negative effects of low birth weight on both experiencing adverse life events and labor market success.

The second problem is that twin-differencing may exacerbate the measurement error problem compared to conventional cross-sectional analysis [49], [53]. If the life event measures were subject to classical measurement error, then our results would be downward biased and lead to conservative estimates for adverse life events.

The third potential problem is that there might be spillover effects within pairs of twins. If the adverse experiences of one twin also have negative effects for the other twin, the within-twin design would underestimate the effects of adverse life events on labor market outcomes.[6]

[6] Accordingly, twins may report differently negative events in the family, such as the mother's/father's illness, depending how traumatic they feel the events are. The data have information on family closeness, i.e., whether the individual has reported being close with his/her father and mother, on a five-point scale. We examined whether twins reported differently events regarding the death of a close family member and sickness in the family, depending on how close they were with their parents. These results suggested that family closeness was not associated with the way twins reported experiencing these extreme events.

Descriptive statistics

Table 1 documents the mean values of the variables by gender. We also report t-test statistics for the null hypothesis of equal group means in Column 3. The means of the variables are consistent with the well-known empirical facts. Women have higher scores in the SLE index. Women have weaker labor market success in terms of earnings and employment compared with men; however, they receive less social income transfers over time. Although women drink and smoke less, they have more chronic diseases, and they also use more tranquilizers. Women have higher scores in neuroticism [54], whereas men have higher scores in extraversion.

We have confirmed that there is a sufficient amount of within-twin pair variation in the SLE index among MZ twins, which is a necessary condition for model identification. Approximately 40% of the MZ twins differ in their SLE indexes. Therefore, the within-twin estimates do not rely on an idiosyncratic subset of the sample of twins with unusual differences.

Figures 1-3 depict earnings, employment months and social income transfers, conditional on experiencing stressful life events (1990), over the follow-up period of 1990-2009. The year 1990 was the peak of the economic upswing in Finland, with exceptionally high employment. In 1991-1994, Finland experienced a severe economic crisis, during which unemployment increased to a historically high level and GDP dropped sharply. After 1995, the Finnish economy started to recover. As Figures 1-3 show, earnings and employment were generally notably higher for those men who had not reported experiencing stressful life events in 1990. By contrast, we do not find similar aggregate results for women. For men, the differences in earnings and employment became detectable during the depression of the early 1990s, and the gaps persisted even when the economy started to

recover after 1995. Social income transfers were consistently higher for both men and women with a history of stressful life events.

Finally, we report how different types of stressful life event indexes and individual's 'baseline' characteristics are correlated by gender. The individual characteristics were measured in 1980/1981. Therefore, they were pre-determined for our stress measures. The correlations are reported in Table B1 of Appendix. The within-MZ differences in initial labor market status (employment) and skill-level (earnings in 1980 and education level) were not correlated with the differences in experiencing SLE for men. For women, we find, for example, that the prior earnings level and employment were negatively related to experiencing adverse life events. Neuroticism is also important in explaining differences in experiencing labor market shocks for both genders. Additionally, the number of chronic diseases and excess alcohol use in 1981 were positively related to experiencing labor market shocks among women.[7]

[Table 1 and Figures 1-3 in here]

IV. Results

Main results

The estimates of the effects of stressful life events on earnings, employment months and social income transfers are reported in Table 2 for men and in Table 3 for women. The

[7] Labor market shocks and family shocks could be triggered by e.g. health-related behaviors thus inducing endogeneity in the estimated model. To address this possibility, we estimated our main regressions by including smoking status and alcohol consumption in 1975 and 1981 to the models. The baseline findings remained intact with respect to our main findings.

specifications marked with 'A' report the estimates for the SLE index, whereas the specifications marked with 'B' report the estimates for three non-overlapping classes of SLEs: Labor market shocks, Family shocks, and Health shocks. The controls include the initial number of chronic diseases (1981) and the prior earnings level (1980). The OLS specification (Column 1) also controls for age to be comparable with the specifications (Columns 2-4) estimated using the within-twin pair regressions, which automatically account for such an invariant within-twin variable.

We first discuss the results for men. The baseline estimates using the standard OLS specification reveal that stressful life events are negatively correlated with both earnings and labor market attachment. Negative life shocks are also positively linked to receiving social income transfers over the estimation window. These results are fully consistent with Figures 1-3. The estimates are economically significant. The point estimates show that one additional SLE is associated with a reduction in employment months of ~0.64 per year. This decrease amounts to approximately one year over our 20-year observation period. A similar increase in the SLE index is associated with a decrease in average earnings of 34% and an increase in social income transfers of 75%.

The overall pattern of the estimation results remains the same when we focus on the twin-differenced DZ-MZ model (Column 2) and the DZ model (Column 3), which both control for shared environment. The results for the MZ sample (Column 4) confirm our earlier findings for employment and social income transfers when both shared environmental and genetic factors are accounted for. These preferred estimates reveal that one additional SLE is associated with a decrease in employment of 10 months and an increase in receiving social income transfers of 20% over a 20-year period.

Table 3 reports the corresponding estimates for women. The baseline OLS estimates (Column 1) are comparable with those in Figures 1-3: the SLE index is not statistically

significantly linked to subsequent earnings or employment but is positively linked to receiving social income transfers. In essence, the results remain unchanged when we focus on our preferred twin-differenced MZ model (Column 4), which accounts for both shared environmental and genetic factors. The estimate for social income transfers in the MZ sample remains large and statistically significant at 0.20. This point estimate implies that one additional SLE is associated with an increase in receiving social income transfers of 22%. The magnitude of the estimate is highly economically significant.

The estimates for the three classes of the SLE index are reported in the specifications marked with 'B' in Tables 2-3. Our preferred results for the MZ sample show that the total SLE index masks substantial heterogeneity of the effects by the type of shocks. The model that uses earnings as the outcome variable shows that women are adversely influenced by labor market shocks but are positively influenced by health shocks. The estimates reveal that one additional labor market shock (such as losing a job) is associated with a decrease in earnings by 18% for women. A similar increase in health shocks is associated with an increase in earnings by 20%. This link is driven by the death of a close family member or a friend rather than sickness in the family. The estimates are economically significant, and the magnitudes correspond roughly to a decrease in schooling by two years. For men, none of the three types of shocks yield statistically significant point estimates on earnings. The point estimate for labor market shocks is, however, marginally statistically significant ($p = 0.103$).

Using employment as the outcome variable the quantitative magnitude of a labor market shock is large for both men and women (~10 months for men and 6 months for women over a 20-year period). When we use social income transfers as the outcome variable, the results show that experiencing labor market shocks is highly positively related to receiving more income transfers for both genders, and the effect is substantially larger for men than for women (cf. Figure 3). The negative effect of labor market shocks on subsequent

labor market outcomes may seem mechanical at first glance. However, these relationships are not exclusively driven by unemployment shocks but also by difficulties with a boss or colleagues for both men and women.

Interestingly, experiencing health shocks, such as the death of a spouse or sickness in the family, is associated with receiving more social income transfers for women (but not for men) and an increase in employment months for men (but not for women). A plausible explanation for this pattern is that work-oriented men may seek support from social networks from their workplaces, which leads them to work more and implies a lower need for social income transfers. Husbands may also substitute for the lost earnings of the disabled spouse/relative by working more. Health shocks may also lead to a notable increase in social income transfers for women to compensate for the lost income if men are the primary family breadwinners (cf. [55]). Thus, our results establish that men and women respond differently to negative shocks. Another interesting result is that women respond to marital problems by working more, whereas family shocks are associated with receiving *less* social income transfers for men. This result for women is driven by problems of a sexual nature and difficulties with a spouse rather than the final divorce.

We also took into account that individuals in the sample can only experience the death of a spouse, divorce and marital discord if they are married. For this reason, we restricted our sample to married individuals only. There may also be a correlation between age and the type of shock, e.g., losing a spouse after the age of 45, when there are meaningful differences in the marriage market. Both of these additional tests provided fairly comparable results for both men and women. The most notable exceptions are that health shocks were associated with a decrease in employment for single women and women over 45 years old and that health shocks were positively associated with men's employment only for the younger cohorts.

[Tables 2-3 in here]

Robustness checks

To examine the sensitivity of the main results, we estimated additional specifications. We briefly discuss the most important checks. First, the main estimation results are based on the sum of experiencing stressful live events, where each event is given the same weight. As a robustness test, we used the weighted sum of experiencing negative life events based on the weighting method used in Riese et al. [39]. The prior findings suggest that the impact of life events at a low frequency is larger compared with those at a high frequency [56]. The weights for the SLEs were calculated as the inverse of the lifetime prevalence (1 minus prevalence) of each negative SLE within our sample. The prevalence was defined as ever having experienced the specific SLE. The results showed larger negative effects of health shocks on men's earnings and women's labor market attachment. These differences are most likely driven by the fact that extreme negative shocks – such as widowhood – are given more weight in the estimation. Labor market shocks – such as the loss of a job – were also negatively related to men's earnings in the long run.

Second, we set the threshold to zero for missing items. The number of yearly observations decreased from 75,304 to 65,574. The results remained intact with respect to our main findings, except that for men, the health shock was no longer statistically significantly related to employment, whereas the health shock was positively related to receiving more social income transfers.

Additional aspects

We used an alternative measure for (weak) labor market attachment, namely the average number of unemployment months. Our preferred within-MZ results are presented in Column 1 of Table 4. The results show that stressors are positively related to unemployment months. Therefore, these results are comparable with those for employment. The estimates reveal that one labor market shock is associated with an increase in unemployment by 8 months (men) and 4 months (women) over a 20-year period. Accordingly, a similar increase in health shocks among men and family shocks among women is related to a decrease in unemployment by 4 months over a 20-year estimation period.

Because we analyze data from a Nordic welfare state, we used an alternative measure for earnings, namely the total taxable income. These include earnings, self-employed income, and social income transfers. The results are presented in Column 2 of Table 4. Our preferred within-MZ regression results show that adverse family shocks are negatively associated with total income for men (7%), whereas health shocks are positively related to total income for both men (10%) and women (28%).

[Table 4 in here]

Adaption to stressful life events

Hedonic adaptation refers to the psychological process in which individuals return to their earlier baseline level of subjective well-being following a change in external life circumstances. Misheva [16] found that more recent traumatic events, such as an assault or rape, have a much greater impact on various aspects of emotional well-being. Another interesting study is that by Clark et al. [57], who found evidence supporting the adaptation

hypothesis for experiencing life events such as divorce, widowhood and layoff. Using German panel data that allowed individuals to be followed over time, Clark et al. [57] also reported incomplete adaption to unemployment for men.

We analyzed the adaptation to stressful life events using labor market success as the outcome variable. We tracked the effects of adverse life events on the outcomes over time, by splitting the sample into three-year intervals.[8] The preferred within-MZ results are reported in Table 5 (men) and Table 6 (women).

The results are closely in accordance with those presented in Table 2 for men and Table 3 for women. One notable exception is that health shocks affect men's earnings and the amount of social income transfers in the short run. The results indicate that the adaption to adverse events is different for labor market shocks and health shocks. It appears that plausibly exogenous health shocks within a family have an immediate effect on labor market outcomes but this effect diminishes as time passes. For men, the estimates are statistically significant mostly for the 1990-1992 period. The relationship between labor market shocks and labor market outcomes is more permanent, especially when we use social income transfers as the outcome variable for men. For women, we find that the relationship between labor market shocks and subsequent labor market outcomes is statistically significant mainly during the years 1996-2007, which was the period of relatively strong economic activity. We do not find similar associations during the recession years in the early 1990s, which suggests that the estimated effects depend on the macroeconomic context.

[8] The sample is not sufficiently large to examine the effects of adverse life events for each year separately (or by adding interaction terms between the year dummies and SLEs in the model). However, the year-specific coefficients were of the same magnitude as the ones reported in Table 4, although not always statistically significant due to the smaller sample size.

[Tables 5-6 in here]

Potential mechanisms

Adverse shocks weaken an individual's ability to participate in the labor market and reduce work performance. At one extreme, there may be adjustment at the extensive margin of labor supply. Thus, adverse life events may lead to a permanent withdrawal from the labor force. In a follow-up study, Lassemo and Sandanger [59] showed that traumatic events significantly predicted subsequent work disability. For this reason, we examined whether various types of adverse life events are related to the incidence of disability pension in our twin data. The results show that labor market shocks predict the incidence of work disability for men, and family health shocks predict work disability for women.[9]

Health and health behaviors are prominent mechanisms for the relationship between adverse life events and subsequent labor market outcomes. The effect of SLEs on labor market outcomes may operate through both physical and mental illness [17-18, 58] triggered by, e.g., increased risky health behaviors, such as misuse of alcohol [14-15]. To analyze this mechanism more closely, we examined the potential role of risky health behaviors (alcohol consumption and smoking) and mental stability (neuroticism, extroversion and the use of tranquilizers) as determinants of the relationship between stressful life events and subsequent labor market outcomes. This is an important extension of the earlier literature because perceived stress may trigger substantial changes in risky health behaviors, such as excessive alcohol consumption [13]-[14] leading to substantial employment and earnings losses in the labor market [44]. We used the within-twin pair variation of these variables to explore the robustness of our within-twin results for three classes of the SLE index estimated in the

[9] The results are not reported but are available from the authors.

model that presents the results for various time periods.[10] We do not report these results because there would be a large number of specifications to show (three outcomes for both women and men for seven different time periods). The most important finding is that the (negative) effect of labor market shocks on earnings and employment becomes both statistically and economically less significant for men. Therefore, the negative effects stemming from labor market shocks may be partially related to the changes in risky health behaviors such as abusive use of alcohol. However, when we use social income transfers as the outcome variable, the baseline results for the SLE indexes remain intact for both men and women, showing that the associations between adverse shocks and receiving social income transfers are not primarily driven by the changes in risky health behaviors or personality traits. Consistent with the earlier literature, we find that neuroticism, heavy alcohol use and the use of tranquilizers are *per se* negatively related to long-term labor market outcomes for both men and women.

Our dynamic analysis shows that the effects of labor market shocks tend to be smaller in the long run especially among men. This pattern is in line with the study by Stier and Endweld [60], who showed that men are more likely to find a new job after a job loss than are women. The finding could be explained by a larger labor supply elasticity among women at the extensive margin of labor supply. To this end, we examined the heterogeneity of the estimates between married and nonmarried individuals. These results revealed that the negative effect of labor market shocks on women's employment was less prominent for

[10] We do not include the measures of risky health behaviors as controls in the baseline models because alcohol consumption and smoking were measured in 1990 based on recall (with some measurement error) and the behaviors are also likely to change over the 20-year time period used to measure the labor market outcomes. Additionally, the changes in health behaviors between 1990 and 2009 could be endogenously related to unobserved SLEs during this time period.

nonmarried individuals. Consequently, a potential explanation for the relationship between adverse events and labor market outcomes could be financial support from the spouse.

Adverse events may also improve employment, as we have reported. Women tend to respond to marital problems by working more and men respond similarly to health shocks. Our result for women is in accordance with that of the study by Bargain *et al*. [61], who showed that divorce increases female labor supply. Stronger attachment to the labor market may improve women's outside options in the event of separation.

There are other plausible mechanisms that may explain the observed dynamic pattern over time. First, the effects of (individual) health shocks are mitigated over time because adversely affected persons tend to recover from illness, at least to some degree. Second, people may not make fully rational and consistent decisions regarding their health and health behavior. Therefore, a possible reason for adaptation may be misperceptions of people regarding their actual health status after the diagnosis of a disease. This is supported by the study by Baji and Bíró [62], who compared the effects of health shocks on subjective and objective survival probabilities. They found that some people are overly optimistic about their actual health condition and are not always fully aware of the negative long-term consequences of health shocks. This implies that some people may return to work earlier than they should, given their health status.

5. Conclusions

Life is replete with stressors. Negative shocks include events such as job loss, divorce and the onset of major illness. Adverse life events may have long-lasting effects on an individual's ability to earn and be employed. We explored the relationship between past stressful life events and long-term labor market success using a twin design. The earlier

literature in economics focused on the effects of specific shocks, such as mass lay-offs or the onset of divorce, on subsequent labor market outcomes. Our main contribution is that we used comprehensive measures of stressful life events that capture the full spectrum of negative shocks that individuals are forced to cope with during their lives. Focusing on single separate shocks does not account for this spectrum.

We used data on Finnish twins linked to comprehensive register-based, individual-level information on earnings and employment status. The long-term labor market outcomes were measured in adulthood. To identify the effects, we used twin data because the literature has shown that family environment and genetics have profound roles in predisposing individuals to experience stressful life events. Thus, we exploited the within-twin dimension of the linked data to fully account for both unobservable family and genetic confounders.

Our main finding was that stressful life events are an important but neglected determinants of long-term labor market outcomes. Using within-twin pair estimations for monozygotic twins, we found that those who had previously experienced stressful life events have significantly weaker long-term labor market attachment. We also established two other important empirical patterns. First, both men and women are negatively affected by labor market shocks. This finding is reasonable given that women in Finland are strongly attached to the labor market. In turn, men and women respond differently to marital problems and health shocks within the family. For example, women respond to marital problems by working more, whereas men respond similarly after facing a random health shock within the family. Second, people adapt differently to different types of shocks. People appear to adapt faster to health shocks, such as sickness in the family, whereas the relationship between labor market shocks and labor market outcomes is more permanent, especially among women.

Our results regarding the effects of labor market shocks on long-term earnings complement the findings of Jacobson et al. [1] and Korkeamäki and Kyyrä [3], who found

that people who are displaced from their workplaces earn ~20% less several years after the job loss. Our findings contribute to the literature by showing that difficulties with a boss or colleagues also affect labor market outcomes in the long run. We found that women respond to marital problems by working more, in accordance with Haurin [7] and Bargain et al. [60]. Garcia-Gómez et al. [9] and Haurin [7] found that a spouse's illness has no significant impact on the employment probability of a female spouse. Our estimated effect of family health shocks on women's employment was also not statistically significant. Garcia-Gómez et al. [9] utilized Dutch data and reported a sizeable decrease in men's employment after a sickness in the family, whereas our results showed the opposite. Whereas the reduction in men's employment in the Netherlands was mostly attributed to an increase in the retirement probability, our results reflected the added-worker effect in which men compensate for lost income within a family by working more. This increase in employment is also reflected in higher earnings for men in the short run.

Limitations

We acknowledge that there are limitations that are relevant for the interpretation of our results. First, our analysis of twin data did not completely rule out noncausal explanations for the associations between adverse life events and labor market outcomes. For example, birth weight, a confounding psychological factor, or unmeasured health-related behavior may lead one twin to experience more adverse life events, such as hardships in the job market or family life. However, our measure of family health shocks is not explained by genetic factors (Appendix A). The DF-analysis showed that family health shocks can be regarded as

plausibly exogenous and their occurrence is unlikely to be influenced by the individual's own behavior.[11]

The second limitation is that SLEs could also have occurred during the period 1991-2009. These post-1990 SLEs that are omitted from the linked data potentially confound estimates. It is not unreasonable to believe that someone who is in his/her mid-thirties in 1990 would have such an event (divorce, the death of a parent, spouse or child) over the subsequent 20 years and that this event would affect his or her labor market experience. Nevertheless, in the earlier literature examining the effects of specific shocks on labor market outcomes, it has been standard to exclude additional shocks later in life, and, importantly, some of these later shocks may be endogenous with respect to labor market status.

Third, the SLE index accounts exclusively for negative shocks. It is possible that there were also positive shocks that countered negative ones, thus buffering the effects on labor market outcomes during the 1990-2009 period. Such buffering would imply that our estimates for the effects of negative shocks are conservative.

The fourth limitation is that we could not completely rule out reverse causality in our estimation results, although we controlled for a set of initial characteristics in the regression models (such as prior earnings level and health status). Importantly, we found that prior earnings levels (measured in 1980) and employment (measured in 1981) were not related to experiencing adverse events later in life. The twin data also included the self-reported categorical income level measured in 1975, as well as employment status. Our analyses support the contention that the twins were on a parallel path already in 1975, before the negative events occurred.

[11] A study by Böckerman and Maczulskij [63] examines the effect of exogenous health shocks on long-term labor market prospects.

Fifth, we were not able to identify the exact mechanisms underlying the relationship between experiencing adverse life events and labor market outcomes later in life. The negative effects of health shocks may be mitigated over time because adversely affected persons tend to recover from illness. Because of data limitations we were unable to account for the effect of changes in health behaviors or lifestyles as consequence of experiencing a shock after 1990.

Sixth, there may be time-varying, unobserved confounders that are potentially correlated with adverse life shocks for which we cannot account. These may have generated some bias in the estimates.

Seventh, adverse experiences of one twin may also have negative spillover effects for the other twin. Nevertheless, by using twin design, we can conclude that the relationships between adverse life events and labor market outcomes are not driven by shared environmental or genetic factors.

Finally, our results were obtained in a Finnish setting. Finland is a much smaller, more culturally homogenous country with a more robust welfare state than some other EU countries or the US. We clearly need more evidence on the impact of stressful life events in other cultural and institutional settings.

Policy implications

We showed that adverse life events have profound negative impacts on long-term labor market outcomes. Therefore, adverse life events have indirect negative impacts along with their direct emotional and psychological effects. Individuals may find it difficult to insure themselves against idiosyncratic adverse life events, because they have incomplete information regarding the frequency of shocks and/or they are not able to make fully rational

choices. This provides support for social insurance schemes and other public policies that accommodate the economic effects of adverse life events on individual well-being.

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Figures and tables

Figure 1. The effect of stressful life events in 1990 on the trajectory of earnings over the period 1990-2010.

Figure 2. The effect of stressful life events in 1990 on the trajectory of employment months over the period 1990-2010.

Figure 3. The effect of stressful life events in 1990 on the trajectory of social income transfers over the period 1990-2010.

Table 1. Summary statistics by gender

	Men	Women	t-test
SLE			
SLE index	0.31	0.39	15.07 ***
Labor market shocks	0.11	0.13	7.42 ***
Family shocks	0.10	0.12	8.10 ***
Health shocks	0.10	0.14	12.06 ***
Outcomes			
Earnings, euros	26 566	17 915	77.59 ***
Social income transfers, euros	1 918	1 754	4.83 ***
Employment, months	10.3	9.7	18.05 ***
Basic controls			
Age	48.4	47.9	8.58 ***
No. of diseases in 1981	0.55	0.67	19.01 ***
Earnings in 1980, euros	20 168	11 753	119.55 ***
Mediators			
Smoking in 1990, dummy	0.32	0.23	28.60 ***
Binge drinker in 1990, dummy	0.47	0.14	107.55 ***
Tranquilizer use, dummy	0.04	0.08	17.11 ***
Extraversion	0.06	-0.04	13.84 ***
Neuroticism	-0.12	0.08	26.67 ***
Number of twin pairs	1 281	1 675	
Number of individuals	2 562	3 350	
Number of yearly-observations	29 940	45 094	

Notes: The table reports t-test statistics for the null hypothesis of equal group means. *** ($p < 0.010$).

Table 2. Regressions of long-term earnings, income transfers and employment for men.

	All twins (1)	DZ – MZ sample (2)	DZ sample (3)	MZ sample (4)
	OLS regressions	Twin-differences	Twin-differences	Twin-differences
Log(earnings)				
A. SLE index	-0.415 (0.029) ***	-0.302 (0.034) ***	-0.442 (0.042) ***	-0.015 (0.056)
B. SLE 3 classes:				
Labor market shock	-0.834 (0.058) ***	-0.692 (0.066) ***	-0.911 (0.078) ***	-0.194 (0.119)
Family shock	-0.057 (0.049)	0.029 (0.060)	0.063 (0.080)	0.040 (0.091)
Health shock	-0.315 (0.051) ***	-0.218 (0.057) ***	-0.405 (0.070) ***	0.126 (0.098)
Log(income transfers)				
A. SLE index	0.562 (0.037) ***	0.453 (0.051) ***	0.596 (0.062) ***	0.180 (0.085) **
B. SLE 3 classes:				
Labor market shock	1.051 (0.068) ***	1.116 (0.090) ***	1.186 (0.106) ***	0.930 (0.169) ***
Family shock	0.223 (0.066) ***	-0.108 (0.089)	0.080 (0.118)	-0.360 (0.134) ***
Health shock	0.350 (0.069) ***	0.314 (0.095) ***	0.418 (0.119) ***	0.070 (0.158)
Employment months				
A. SLE index	-0.643 (0.042) ***	-0.451 (0.052) ***	-0.677 (0.066) ***	0.005 (0.081)
B. SLE 3 classes:				
Labor market shock	-1.375 (0.080) ***	-1.169 (0.096) ***	-1.454 (0.114) ***	-0.494 (0.172) ***
Family shock	-0.084 (0.069)	0.118 (0.092)	0.140 (0.130)	0.154 (0.126)
Health shock	-0.389 (0.073) ***	-0.248 (0.090) ***	-0.594 (0.110) ***	0.400 (0.151) ***
Number of obs.	29,940	14,970	9,671	5,299

Notes: Standard errors are robust to within-twin variation. *** ($p < 0.010$), ** ($p < 0.050$), * ($p < 0.100$). Additional controls include the number of chronic diseases, and the prior earnings level (1980). OLS specification in Column 1 also controls for age and age squared.

Table 3. Regressions of long-term earnings, income transfers and employment for women.

	All twins (1)	DZ – MZ sample (2)	DZ sample (3)	MZ sample (4)
	OLS regressions	Twin-differences	Twin-differences	Twin-differences
Log(earnings)				
A. SLE index	-0.029 (0.020)	0.045 (0.027) *	0.064 (0.036) *	0.015 (0.040)
B. SLE 3 classes:				
Labor market shock	-0.079 (0.038) **	-0.039 (0.046)	0.052 (0.059)	-0.198 (0.074) ***
Family shock	-0.017 (0.034)	0.066 (0.044)	0.075 (0.061)	0.056 (0.063)
Health shock	0.005 (0.035)	0.116 (0.050) **	0.063 (0.064)	0.187 (0.081) **
Log(income transfers)				
A. SLE index	0.240 (0.027) ***	0.143 (0.036) ***	0.108 (0.046) ***	0.202 (0.057) ***
B. SLE 3 classes:				
Labor market shock	0.343 (0.051) ***	0.343 (0.065) ***	0.344 (0.087) ***	0.391 (0.099) ***
Family shock	-0.001 (0.047)	-0.217 (0.062) ***	-0.288 (0.083) ***	-0.132 (0.094)
Health shock	0.388 (0.050) ***	0.340 (0.071) ***	0.285 (0.093) ***	0.415 (0.111) ***
Empoyment months				
A. SLE index	-0.048 (0.030)	-0.064 (0.040)	-0.108 (0.053) ***	0.010 (0.061)
B. SLE 3 classes:				
Labor market shock	-0.225 (0.058) ***	-0.325 (0.070) ***	-0.333 (0.094) ***	-0.319 (0.106) ***
Family shock	-0.016 (0.053)	0.177 (0.071) **	0.108 (0.100)	0.303 (0.098) ***
Health shock	0.086 (0.054)	-0.051 (0.076)	-0.090 (0.098)	-0.008 (0.121)
Number of obs.	45,094	22,547	13,893	8,654

Notes: Standard errors are robust to within-twin variation. *** ($p < 0.010$), ** ($p < 0.050$), * ($p < 0.100$). Additional controls include the number of chronic diseases and the prior earnings level (1980). OLS specification in Column 1 also controls for age and age squared.

Table 4. Within-MZ regressions of long-term unemployment and total income

	Unemployment months	*Log (Total income)*
Men		
Labor market shock	0.417 (0.136) ***	0.080 (0.062)
Family shock	-0.074 (0.097)	-0.071 (0.040) *
Health shock	-0.238 (0.128) *	0.091 (0.053) *
Number of obs.		
Women		
Labor market shock	0.228 (0.080) ***	-0.032 (0.033)
Family shock	-0.253 (0.066) ***	0.005 (0.033)
Health shock	0.139 (0.087)	0.257 (0.039) ***
Number of obs.		

Notes: Standard errors are robust to within-twin variation. *** ($p < 0.010$), * ($p < 0.100$). Additional controls include the number of chronic diseases and the prior earnings level (1980).

Table 5. Within-MZ regressions of long-term earnings, income transfers and employment for men

	1990-92	1993-95	1996-98	1999-01	2002-04	2005-07	2008-09
Log(earnings)							
Labor market shock	-0.084	-0.432 *	-0.336	-0.223	-0.331	0.407	-0.257
	(0.208)	(0.248)	(0.319)	(0.363)	(0.392)	(0.329)	(0.645)
Family shock	-0.064	0.003	-0.222	-0.115	0.257	0.197	0.838 *
	(0.170)	(0.186)	(0.212)	(0.257)	(0.280)	(0.291)	(0.447)
Health shock	0.290 **	0.104	0.316	0.208	-0.778 **	0.272	-0.335
	(0.121)	(0.220)	(0.260)	(0.345)	(0.369)	(0.556)	(0.375)
Log(income transfers)							
Labor market shock	1.034 ***	0.840 **	1.260 ***	0.907 **	1.323 ***	0.379	-0.218
	(0.323)	(0.387)	(0.421)	(0.441)	(0.488)	(0.602)	(0.813)
Family shock	-0.219	-0.305	0.009	-0.466	-0.438	-0.744 *	-0.697
	(0.257)	(0.336)	(0.341)	(0.363)	(0.353)	(0.421)	(0.521)
Health shock	0.532 **	-0.450	-0.623 *	-0.207	1.260 **	-0.255	0.662
	(0.250)	(0.324)	(0.339)	(0.519)	(0.608)	(0.805)	(0.939)
Employment months							
Labor market shock	-0.864 **	-0.703 *	-0.590	0.109	-0.652	0.116	-0.097
	(0.344)	(0.422)	(0.430)	(0.516)	(0.458)	(0.469)	(0.723)
Family shock	-0.228	-0.092	-0.296	0.159	0.494	0.992 **	0.955 **
	(0.196)	(0.331)	(0.335)	(0.348)	(0.362)	(0.407)	(0.448)
Health shock	0.639 ***	0.457	0.508	0.177	-0.248	0.248	0.222
	(0.225)	(0.340)	(0.388)	(0.482)	(0.481)	(0.801)	(0.470)
Number of obs.	1318	929	847	735	656	513	301

Notes: Standard errors are robust to within-twin variation. *** ($p < 0.010$), ** ($p < 0.050$), * ($p < 0.100$). Additional controls include the number of chronic diseases and the prior earnings level (1980).

Table 6. Within-MZ regressions of long-term earnings, income transfers and employment for women

	1990-92	1993-95	1996-98	1999-01	2002-04	2005-07	2008-09
Log(earnings)							
Labor market shock	0.103	0.176	-0.337 (*)	-0.521 ***	-0.318	-0.594 ***	-0.010
	(0.127)	(0.194)	(0.208)	(0.178)	(0.213)	(0.225)	(0.258)
Family shock	0.042	0.155	0.088	-0.131	-0.103	0.318	0.166
	(0.116)	(0.150)	(0.163)	(0.172)	(0.175)	(0.197)	(0.192)
Health shock	0.158	0.382 **	0.391 *	0.223	-0.100	-0.106	-0.082
	(0.132)	(0.189)	(0.208)	(0.228)	(0.284)	(0.279)	(0.319)
Log(income transfers)							
Labor market shock	0.175	0.096	0.294	0.551 **	0.611 **	0.916 ***	0.374
	(0.203)	(0.234)	(0.247)	(0.252)	(0.305)	(0.312)	(0.397)
Family shock	0.130	-0.135	-0.370	-0.031	0.093	-0.625 **	-0.096
	(0.199)	(0.235)	(0.231)	(0.237)	(0.248)	(0.262)	(0.446)
Health shock	0.746 ***	-0.220	0.252	0.882 ***	0.375	0.392	0.606
	(0.0191)	(0.280)	(0.299)	(0.300)	(0.342)	(0.330)	(0.460)
Employment months							
Labor market shock	0.116	-0.143	-0.641 **	-0.514 *	-0.204	-0.801 ***	-0.174
	(0.224)	(0.272)	(0.272)	(0.272)	(0.301)	(0.303)	(0.278)
Family shock	0.252	0.330	0.620 **	-0.097	0.352	0.338	0.381
	(0.216)	(0.253)	(0.258)	(0.262)	(0.257)	(0.226)	(0.296)
Health shock	-0.060	0.448	0.231	-0.076	-0.531	-0.415	-0.392
	(0.219)	(0.306)	(0.302)	(0.336)	(0.370)	(0.369)	(0.442)
Number of obs.	1863	1576	1448	1278	1148	855	486

Notes: Standard errors are robust to within-twin variation. *** ($p < 0.010$), ** ($p < 0.050$), * ($p < 0.100$). Additional controls include the number of chronic diseases and the prior earnings level (1980).

Appendix A

Heritability of stressful life events

We examined the components of heritability and shared environment in experiencing different types of adverse events using our twin data. An event was considered to have occurred if an individual reported in 1990 ever experiencing a specific event. Table A1 reports the intra-class correlations of the SLE index and its three classes between DZ and MZ twins. The within-pair correlation of the SLE index was 0.12 for DZ twins and 0.23 for MZ twins. Therefore, MZ twins are much more similar to each other in their reporting of adverse life events than are DZ twins. The pattern is more striking when the labor market shocks, family shocks and health shocks are analyzed separately. For example, we find that there is no significant discrepancy between the intra-class correlations of health shocks between DZ and MZ twins (0.161 vs. 0.158). This observation most likely reflects the fact that random health shocks are beyond one's own control.

The results suggest that exposure to negative life events is partly explained by genetic factors. We evaluated this pattern further using the DF-model of DeFries and Fuller [64], which yields estimates for the shared environment and heritability of SLE. We used the following equation, which is estimated by using OLS (Ordinary Least Squares):

$$SLE_{1j} = \alpha_0 + \beta_1 SLE_{2j} + \beta_2 R_j + \beta_3 R_j SLE_{2j} + \varepsilon_{1j} , \quad (1)$$

where SLE_{1j} is the SLE index for twin 1 in family j, SLE_{2j} is the SLE index for twin 2 in family j, and R is the genetic relatedness (0.5 for DZ twins and 1 for MZ twins). Thus, the variation in

experiencing stressful life events is decomposed into components that are attributable to shared environment (coefficient β_1) and genetic effects (coefficient β_3).

The intra-correlation of the outcome variable within MZ twins was, in some cases, more than twice that for the DZ twins, i.e., $r_{MZ} > 2r_{DZ}$. This pattern suggests that non-additive genetic effects may be present and that the model can yield estimates that fall within the categories $\beta_3 > 1$ and/or $\beta_1 < 0$ [65]. In this setting, reasonable values can be obtained by fitting a constrained DF-model that estimates only the genetic and nonshared environmental variance components:

$$SLE_{1j} = \alpha_0 + \beta_2 R_j + \beta_3 R_j SLE_{2j} + \beta_4 D_j SLE_{2j} + \varepsilon_{1j}, \qquad (2)$$

where D is 0.25 for DZ twins and 1 for MZ twins. Here, the contribution of the genetic effect is the sum of the parameter estimates $\beta_3 + \beta_4$. Thus, this specification omits the term of shared environment, i.e., we set $\beta_1 = 0$. In both specifications, the double-entry method was used as in Cherny *et al* [66], in which each twin is entered twice in the model: once as the proband and once as the co-twin. In accordance with Kohler and Rodgers [66], we calculated the asymptotic standard errors for double-entry twin data.

The estimates for the shared environment and genetic heritability are reported in Table A2. In the case of labor market shocks, the estimate for shared environment was negative (-0.142) in Model (1), indicating the presence of additive genetic effects. Because the estimate for the shared environment was negative, our inference for labor market shocks are based on Model (2).

The estimate for heritability in the SLE index was 0.23. Under the standard assumptions of the model,[12] the result suggests that the variation in exposure to adverse shocks is heritable at a rate of 23%. As expected, genetic effects appear to explain the variation particularly in labor market shocks (25%) and family shocks (17%), with no influence of the shared environment. These events are likely to be determined by individuals' own behavior. The variation in plausibly random health shocks is, by contrast, statistically significantly explained by shared environment (0.16%). By contrast, the contribution of heritability is statistically zero. These results support the external validity of our estimates, because Bemmels *et al*. [21] found similar results for plausibly non-random and random life events.

Table A1. Intra-class correlations within DZ and MZ twins

	Intra-class correlations	
	DZ-twins	MZ-twins
SLE	0.119 ***	0.233 ***
Labor market shocks	0.057 ***	0.257 ***
Family shocks	0.089 ***	0.176 ***
Health shocks	0.161 ***	0.158 ***

Note: *** ($p < 0.010$)

[12] The DF-model is based on four key assumptions: 1) genes and the environment have additive effects; 2) the additive environmental influence is similar for DZ and MZ twins; 3) there is no assortative mating; and 4) there is no correlation or interaction between the shared environment and genetic factors (e.g., [68]). A discussion of the DF-model and criticisms of it are presented in Maczulskij [35] and Conley and Fletcher ([69] pp. 20-29).

Table A2. OLS estimates of DF-model

	Model (1)		Model (2)	
	Genetics	Shared environment	Genetics	Shared environment
SLE	0.225 ***	0.006		
	(0.079)	(0.057)		
Labor market shocks	0.396 ***	-0.142 **	0.254 ***	0
	(0.080)	(0.056)	(0.033)	
Family shocks	0.166 **	0.006		
	(0.082)	(0.058)		
Health shocks	0.006	0.164 ***		
	(0.080)	(0.057)		

Notes: *** ($p < 0.010$), ** ($p < 0.050$)

Appendix B

Table B1. Within-MZ correlations between stressful life events and individual characteristics

Men	SLE index	Labor market shocks	Family shocks	Health shocks
No. of diseases, 1981	0.03	0.02	0.04	0.03
Smoking, pack-years in 1981	0.04	0.04	0.11**	-0.05
Alcohol use, 1981	0.04	0.05	-0.003	0.03
Extraversion, 1981	0.02	0.06	-0.03	0.06
Neuroticism, 1981	0.08 *	0.10**	0.05	0.00
Earnings in euros, 1980	0.01	-0.002	0.014	-0.01
Employment, 1981	-0.03	-0.05	-0.03	-0.01
Education years, 1981	-0.03	0.01	-0.07	0.04
Women	SLE index	Labor market shocks	Family shocks	Health shocks
No. of diseases, 1981	0.01	0.10 **	-0.01	0.02
Smoking, pack-years in 1981	0.05	0.05	0.06	0.03
Alcohol use, 1981	0.06	0.16***	-0.02	0.04
Extraversion, 1981	-0.06	-0.04	-0.02	-0.05
Neuroticism, 1981	0.05	0.08 **	0.002	0.03
Earnings in euros, 1980	-0.07 *	-0.06	-0.01	-0.06
Employment, 1981	-0.05	-0.09 **	-0.05	-0.04
Education years, 1981	0.09 **	0.04	0.02	0.04

Notes: *** ($p < 0.010$), ** ($p < 0.050$), * ($p < 0.100$).