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Mental disorders and lifetime earnings

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ABSTRACT

In advanced countries in particular, the mental well-being of adolescents and young adults is gaining increased amount of attention. Yet little is known about lifetime labor market costs attributable to mental disorders nor the related heterogeneity by the age of onset of psychiatric conditions. This paper contributes by documenting the lifetime labor market performance deficits related to severe mental health-related problems. Using longitudinal socio-economic and health register data with a 45-year follow-up, I document that psychiatric admission history is associated with substantial losses in labor market performance. Age of first admission matters: having the first admission one year earlier than the affected controls is associated with €10 000 - 13 000 loss. Overall, results provide an economic rationale for early intervention in mental illnesses as deficits in the labor market are larger, the earlier first psychiatric admissions emerge.

JEL Classification: I10, J21, J31

Keywords: Mental disorders, Employment, Wage differentials

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1 Introduction

Mental disorders are detrimental to individuals affected but also costly for the national economy. Mental disorders are ranked the fourth leading cause of disability worldwide and the fifth in high-income income countries. In advanced countries, mental illnesses are increasingly becoming a greater concern for the well-being of adolescents and young adults. Mental disorders are the most common reason for disability ages below 35 and the share of disability-adjusted life years (DALY) attributable to mental and substance use disorders is increasing (GHDx database, 2014). The cost of mental ill-health in Europe is estimated to be €600 billion or around 4% of GDP. Around 40% of the estimated loss has been attributed to losses in work productivity (OECD, 2018). Survey-based studies have also documented negative association between depressive symptoms and educational attainment (McLeod and Kaiser, 2004), employment (Smith and Smith, 2010; Greve and Nielsen, 2013; Mousteri et al., 2019) and income (Ettner et al., 1997; Smith and Smith, 2010; Chatterji et al., 2007, 2011; Hakulinen et al., 2016; Banerjee et al., 2017). However, there is a shortage of more elaborate estimates for the lifetime productivity losses of mental ill-health and economic consequences mental disorders by the age of onset (first psychiatric admission).

This study contributes to the prior literature by documenting the repercussions of mental disorders on labor market performance throughout the working life. The main purpose is to provide a set of estimates for work productivity losses associated with mental disorders. First, I ask how large are the deficits in labor market performance for those with a history of any psychiatric admission. As a second step, I examine more closely how much does age of first admission matter for lifetime work productivity. At this stage, I also discuss more closely to what extent premature loss in follow-up (death or emigration) affects the relationship between mental disorders and lifetime labor market performance. Additionally, I also investigate how much 'healthy" siblings, i.e. individuals who have no psychiatric admission history but one of their same-sex siblings have at least one recorded psychiatric admission, earn relative to comparable individuals with no identified family

history of psychiatric disorders.

I use rich Finnish administrative register data sources and examine how lifetime earnings differ between those that are treated for mental disorders (any mental disorders and its subcategories psychotic disorders, mood disorders and anxiety disorders) or alcohol-related problems and comparable unaffected individuals. The register-based approach using Finnish socio-economic and psychiatric admission panel data for years 1971-2015 has four major advantages. First, the dataset is large and comprises 300,000 individuals born 1951-1955 and covers their whole working age. Second, administratively collected data ensures that this study faces no considerable threat from attrition which is common in longitudinal survey studies in psychiatry (Allgulander, 1989; Haapea et al., 2008; Cheung et al., 2017) and that data consists of psychiatric admission information that has been evaluated to be high quality (Sund, 2012). Third, lifetime perspective minimizes biases related to shorter snapshots in follow-ups which might occur because association between current and lifetime earnings differ systematically by age (Haider and Solon, 2006) especially for women (Böhlmark and Lindquist, 2006) and because adolescent-onset psychiatric disorders are subject to relatively high mortality rates (Nordentoft et al., 2011) and delays in the first treatment contact since the onset of symptoms could be even decades in less severe cases (Wang et al., 2007). Thus, assuming that the expected lifetime earnings (or compensations to be exact) equal the expected lifetime worker productivity and that long psychiatric admission follow-up can capture most severe psychiatric problems to a large extent, this study can provide a plausible estimate for lifetime losses in work productivity attributable to severe mental health problems.

While it is very challenging to assess the impact of mental disorders on labor market performance and causal evidence practically non-existent, it is important to learn from studies that can document the lifelong trajectories of labor market differences between mentally ill and healthier individuals. This information will help policymakers in their decisions of allocating scarce resources to psychiatric care and preventive medical care. This paper complements the scarce literature on mental disorders and long-term labor market outcomes which has mainly focused on most severe mental disorders such as

schizophrenia. Hakulinen et al. (2019a) use Finnish administrative data similar to the one used in this study. They find early-onset (ages 15-25) of severe mental disorders to have a substantial earnings deficit relative to other individuals and this tends to increase by age. Whereas the median earnings of the comparison group increase from €18 000 to €35 000 between ages 25 and 52, median total income of early-onset individuals is between €7 000 and €20 000 depending on diagnosis and age. Greve and Nielsen (2013) use Danish administrative records to study the link of psychiatric admission history with employment in adulthood. They find schizophrenia to severely hinder employment but surprisingly also find the age of first schizophrenia admission to be negatively correlated with adulthood employment at age 35-45.

Relative to these studies, this paper extends the time frame and estimates the loss of work productivity related to in a wide spectrum of psychiatric disorders and thus aims to provide estimates that are relevant resource allocation in public health. I find that those who are treated for any mental disorder diagnosis earn about 37 percent less than individuals with psychiatric admission history. Early onset is especially damaging as those with a psychiatric admission before age 30 earn less than about 65 percent of the lifetime earnings of their unaffected peers. The labor market deficits are larger for men in both absolute and relative terms. Furthermore, the labor market deficit is not confined only to individuals with psychiatric admission, but also their ”healthy” siblings face a labor market deficit.

The rest of the paper is organized as follows. Section 2 briefly presents information on Finnish psychiatric services and the changes in the provision of the services in the recent decades. Section 3 presents the empirical framework. Section 4 describes the data and timeline of measurement and section 5 shows the main results. Section 6 discusses the results and section 7 concludes.

2 Institutional background

This paper studies the association between the age of the first psychiatric admission and lifetime earnings taking advantage of panel data from 1970 until 2015. The psychiatric admission data consists of both psychiatric hospitalizations and outpatient visits in specialized psychiatric care but not outpatient visits in primary health care. To access psychiatric care, patients need a referral, typically given by a general practitioner working in a health center. The most of the patients in specialized psychiatric care in Finland are outpatients with the fraction increasing every year. In 2018, less than 30 000 patients was treated in hospital for psychiatric causes, third of which involuntarily in treatment (THL, 2020). Financial barriers in seeking psychiatric treatment are non-existent or modest. In psychiatric outpatient clinics, the services are provided with free of charge but inpatient stays are accompanied with modest about €20 fee up to 7 days, after which the treatment is free.

The changes in the provision of psychiatric care have been dramatic since 1970. In the early 1970s, psychiatric health care system placed priority on inpatient care with almost 90% allocate to long-term care. In 1975 the were more than four mental hospital beds in Finland per 1000 inhabitants (Salokangas, 1994). Mental health acts implemented in 1978 and 1991 aimed at dehospitalisation and improvements in outpatient care and rehabilitation. As a result, the majority of the mental hospital of the 1970s have been closed and the total amount mental hospital beds decreased to 0.76 per 1000 inhabitants by 2000. Patients previously treated in hospitals, continued their treatment in community mental health centers (Salokangas, 1994).

In the early 1990s, psychiatry saw further changes in organization: the independent psychiatric organizations in district level ceased and psychiatric care was integrated in the general hospitals and the mental health policy was decentralized to local level. These changes were implemented during the time of deep recession in Finland. Although inpatient bed resources dropped dramatically, the number of patients did not. Treatment periods were just shortened and thus increased pressure for health service provision in the

outpatient care. (Pylkkänen, 2012).

3 Empirical framework

3.1 The association between the ever-treated and never-treated

To estimate the association between severe mental disorders on lifetime earnings, I estimate the following equation

$$Y_i = \alpha D_i + \mathbf{X_{0i}}\beta + \varepsilon_i, \tag{1}$$

where Y_i is the lifetime labor market performance (earnings, income and total employment years) of an individual i observed 1970-2015 in 2017 prices. The treatment variable denoted by in D_i. D_i is a binary variable indicating whether an individual has a history of psychiatric admissions or alcohol-related admissions [1]. X_{0i} includes a set of variables on individuals' background information from the Census 1970, at the start of follow-up. This variable set includes time-invariant characteristics (birth cohort, urban status 1970 and sex) for the study subjects and information on their parents' socio-economic background including household income (the total income of both parents) quartile within the subregion of origin and the residential subregion 1970 fixed effects. ε_i include unobserved characteristics.

Besides the first admissions of any mental disorders, I also examine three psychiatric subcategories: psychotic disorders (or schizophrenia spectrum disorders), mood disorders and anxiety disorders. Alcohol-related admissions are also used as a complementary

[1] Contrary to the approach of Hakulinen et al. (2019a), secondary diagnoses are not considered here because the quality of subsidiary diagnoses in Finnish Discharge Register has been considered poor (Sund, 2012).

"exposure" variable although the only part (i.e. alcoholic psychosis and alcoholism) of diagnosis set overlaps with any mental disorders. However, all alcohol-related admissions (incl. alcohol cirrhosis, alcohol poisoning, alcohol-related injury) are considered relevant not only because alcohol abuse and dependence are often associated with other psychiatric conditions (Kessler et al., 1997) but also because early alcohol use initiation, alcohol-related injury, alcohol dependence are all connected (Hingson et al., 2000) and early alcohol dependence is associated with greater psychiatric co-morbidity (Chen et al., 2011). Only primary diagnoses are used in this study. [2]. In determining the psychiatric subcategory of first psychiatric admission I use the primary diagnosis of the first psychiatric admission. If an individual was given multiple psychiatric diagnoses during his/her first visit, I use the hierarchy of the diagnoses using the following structure: schizophrenia, mood disorder, anxiety disorder, and alcohol abuse.

To identify a causal effect of mental disorders on lifetime income it would be necessary for unobserved characteristics to be uncorrelated with the treatment status conditional on observed characteristics. However, this condition will not hold. A body of literature suggests that mental disorders are correlated with personality traits and cognitive ability. This linkage is likely to hold even if a number of the commonly used observable characteristics are controlled for. For instance, a Swedish study exploiting conscription data finds that within-sibling differences in late adolescence (age 18) in mental conditions (assessed by Armed Forced Qualification test) are linked to 20 % decreased earnings adulthood but this is reduced by about 60% when cognitive and non-cognitive ability are controlled for (Lundborg et al., 2014). Although their study differs from this study in terms of variables for mental health and study sample, it reasonable to assume personality traits and cognitive ability are negatively correlated with poor mental health and with adult labor market performance also in the absence of psychiatric diagnosis or psychiatric admission. In this case, a comparison that does not include measures of cognitive or non-cognitive ability will produce estimates that are biased downwards (away from zero).

[2]The ICD diagnoses used to construct the outcome measures are presented in Table S1 in the Appendix

Inclusion of proxies for cognitive and non-cognitive ability as control variables help to diminish selection bias, but economically meaningful confounding is still likely to remain. The best way to counter selection bias, in general, is to implement randomized controlled trials (RCTs) or exploit "naturally occurring incidence" or natural experiments. However, RCTs that have a direct and substantial effect on mental health are not feasible in the human environment and proper "natural experiments" that have a direct impact exclusively on mental health are practically impossible to come by. While acknowledging these limitations, this study aims to provide meaningful estimates for labor market performance deficits related to mental disorders by extending by benefiting from the scope of the follow-up.

To mitigate the confounding, I use three analytic subsamples of the full sample: i) high school (Finnish upper secondary school) sample, ii) sibling sample and iii) twin sample. In the high school sample, I use the information on the grade point average (GPA) measured at age 18 which works as a proxy for ability. However, this sample is particularly selective as schizophrenia is known to associate with cognitive deficiency especially among the ones with early-onset (Rajji et al., 2009), and thus the ones with most disabling conditions are less likely to attend high school and be included in this sample. The use of sibling and twin design aims to mitigate the confounding related to unobserved characteristics by reducing differences in genetic and growth environment between the treated and controls. Perhaps most notably, this design removes confounding related to family history with mental disorders. Although the sibling and twin fixed-effect strategies may provide an improvement over the usual comparison in the full sample, confounding remains nevertheless. This confounding is ultimately related to the fact that the treatment status is far from random assignment. As twins with the same treatment status (both untreated or treated pairs) are excluded, the twin fixed estimates stem from exposure-discordant pairs. Thus focusing on twins does not remove bias but just results in a shift in the source of bias (Frisell et al., 2012).

Psychiatric literature has found that not only schizophrenia patients exhibit neuropsychological deficits but also their unaffected relatives. Genetic proximity to the affected

individuals appears to be linked to the severity of the "healthy sibling" effect: among discordant twin pairs, the healthy monozygotic twins outperform by dizygotic comparisons in neuropsychological tests (Cannon et al., 2000). To investigate to what extent the healthy sibling phenomenon is present in this study, I use equation (1) but replace D_i with an indicator that which takes value 1 if a "healthy" individual has at least one same-sex sibling with psychiatric admission history and value 0 if none of the same-sex siblings of a "healthy" individual have been recorded any psychiatric admissions.

3.2 The age at the first admission heterogeneity

To examine the linear association between the age at first psychiatric admission between on lifetime earnings, I add 1 with an interaction age at first admission and D_i and I estimate the following equation

$$Y_i = \alpha D_i + \gamma D_i \times AAFO_i + \mathbf{X_{0i}}\beta + \varepsilon_i, \tag{2}$$

where $AAFO_i$ is the age at the first admission of a given psychiatric diagnosis of an individual i observed 1970-2015. For the untreated (82% of sample) $AAFO_i$ is randomly assigned between years 16-64. Psychiatric literature considers the age of onset to be related to the projected lifetime risk of a psychiatric condition (Kessler and Wang, 2008). Thus information on the age of onset has potential capturing heterogeneity in the lifetime work productivity within the group of admitted individuals. Because the information on the actual age of onset of the mental illness[3] is not available, I use the year of the first psychiatric admission as an indicative measure of the age of onset of a psychiatric disorder. Unlike the actual onset of a disorder, this measure is easily measurable but

[3]Here I refer to the age of onset as the age when the first symptoms of a disorder appear. For discussions on alternative criteria see de Girolamo et al. (2019).

it can be preceded by years of untreated illness. Psychiatric literature suggests that the actual age of onset psychiatric disorders could occur 2-6 years before hospitalization in schizophrenia (Häfner et al., 1993). For the disorders of low severity and free of long-term disabilities, the treatment delays are longer (Narrow et al., 2002), even decades (Wang et al., 2007) . Evidence suggests that treatment contact could be faster for mood disorders compared to anxiety disorders and that women seek treatment faster than men (Wang et al., 2007).

When studying the age at first admission heterogeneity, I assume that the differences in the first admission age roughly correspond to differences in the age of onset. Assuming equal timing difference between true onsets and first treatment contact and a duration of untreated illness of approximately three years, the difference in outcomes between two groups with age at the first admission 25 and 27 would then correspond roughly the differences in the outcomes of groups with the ages of onset 22 and 24. If this assumption holds, the absolute differences in age at first admissions are informative about absolute differences in the age of onset and the related differences in labor market outcomes.

In terms of statistical methodology, the observed age of the first admission heterogeneity may provide an economic rationale for choosing time-to-event (duration) analysis in population-wide epidemiological studies over cumulative incidence (linear or logistic regression) analysis. Observing time in follow-up is important whether the event occurs for an individual or not. Consider the analysis of mental disorders two groups with the identical number of people at risk that have the same cumulative incidence but differ in terms of the average age of the first admission (among treated) or the age of death. In this example, the cumulative risk rates are the same for two groups but incidence rates, which are calculated using total person-years in the denominator instead of the number of people, are different. In the context of this study, if the affected individuals in the treatment group experienced psychiatric admissions on average one year earlier relative to the control group, then the treatment group exhibits a higher psychiatric incidence rate than the control group even if cumulative risk during a long follow-up would be identical. If age at first admission is positively correlated with lifetime earnings, the timing of the first ad-

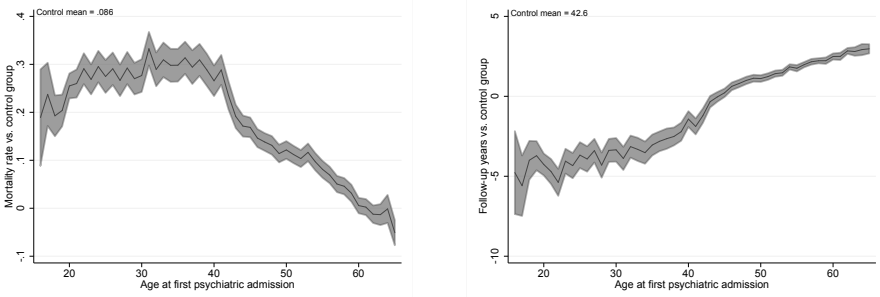
missions itself would possess economically valuable information. For instance, one could thus consider measuring the long-term health effects of plausibly exogenous changes in education or immigration policies using survival methods instead of using ordinary least squares methods measuring differences in health incidences at different stages after the policy change.

3.3 Controlling for differences in attrition

Psychiatric disorders are associated with premature mortality especially in adult-onsets cases (Nordentoft et al., 2011). The resulting attrition would lead upward biases in estimates of age of the first admission and lifetime labor market performance in studies that observe outcomes years or decades after the first treatment contact. This possibly explains why Greve and Nielsen (2013) find the age of first schizophrenia admission to be negatively correlated with employment at age 35-45. Another possibility is bias related to the period of measurement. If the later age admission occurs fairly near the year of measurement, the ongoing acute treatment may heavily affect current employment and thus provide a very contrasting picture between the contemporary employment and lifetime employment years. These caveats can be addressed by increasing the time of follow-up.

In this study, those who die or emigrate during the follow-up are not excluded from the study population, they just do not contribute to the income and employment measures during the years they are missing in the follow-up. This might lead to equations (1) and (2) to produce greater differences between the treatment and group relative to contemporary comparisons that are estimated conditional on being alive and living in Finland. On the other hand, the imputation of missing data with zeros leads to upward biases for the late onset psychiatric admission cases because the first admissions at the end of the follow-up have a zero mortality rate whereas their counterparts with no psychiatric admissions have a positive mortality rate. To control for these biases, I supplement the equations (1) and (2) with control variable total years in the follow-up. Total years in follow-up is calculated by summing up the indicators of being alive and living in Finland during the measurement points.

Figure 1 visualizes the differences in all cause mortality and the total years in the follow-up by age at the first admission of the treatment group in comparison to the control group. The differences in the total follow-up years vary by the age of the first admission. Using the total follow-up years as a control variable adjusts estimates for the age of the first admission heterogeneity in both ends of the spectrum. Early-onset cases tend to be lost in follow-up earlier than average healthy average whereas the cases with their first admission near retirement ages are by construction present near the end of follow-up. Individuals with a late onset of a psychiatric disorder are less likely to be lost in follow-up relative to controls with no psychiatric admission history.



(A) All-cause mortality rate and age of first admission

(B) Total years in follow-up and age of first admission

Figure 1: Visualization of differences in observed mortality and total follow-up years between the treated and control group by age of first admission (with 95% confidence intervals). Illustrations are based on estimating equation where response variable are indicator for all-cause mortality and total years in the follow-up and sole explanatory variables are indicators for no psychiatric admission, and indicators for the age of first admission at age 16 to 64.

Individuals with early-onset mental disorders are at a higher risk of premature mortality than comparable individuals with later onset. Adjusting for follow-up years provides the treated unaffected comparisons that spent an equally short period alive in Finland. The control group as a whole is less likely to die (while living in Finland) during the follow-up than the individuals with psychiatric admission history. Relative to the control group, the total length of follow-up is shorter in the early-onset group but longer for later onset (admission at age < 40) group. This is likely due to a higher rate of emigration of

'healthy individuals". This is confirmed by a casual data inspection of mortality rates in the population that is present for less than 20 years during 1971-2015: All-cause mortality rate is 80% among admitted and 30% among the control group. On the other end of the first admission age spectrum, adjustments force the affected to be compared with "healthy individuals" that are present and alive near the end of follow-up and with high probability have never emigrated.

To sum up, the adjustment for follow-up years will provide the affected individual comparisons that have had an equal time frame to work in Finland. While this creates another type of selection problem, the benefit of this adjustment comes from the possibility of comparing lifetime estimates with the typically reported contemporary estimates which entail the condition of being alive and present in administrative region in question.

4 Data

4.1 Timeline of measurement

I have access to panel data that contains socio-economic and health information on individuals born 1951-1955 from 1971 until 2015. The year 1971 is a natural starting point because high quality, population-wide Finnish administrative records on socio-economics, mortality and hospital admissions start at this stage. This study focuses on the Finnish birth cohorts of 1951-55 to ensure the good coverage of parental socio-economic information (at least 80 % rate of identification of both parents) and follow-up period that covers almost the entire working-age from late adolescence to retirement age. We focus on individuals who reside in Finland and live with their parents during Census 1970. This strategy allows for obtaining parental socioeconomic information for the study population. These conditions result in over 304,530 individuals at the start of the follow-up of which 259,397 ($\approx$ 85%) are alive and living in Finland at the end of follow-up in 2015. Individual-level socio-economic panel data is gathered from Statistics Finland and includes Finnish Census data for years 1970, 1975, 1980, 1985 and Finnish Linked

Employer-Employee Data (FLEED) for years 1987-2015. Furthermore, complete information on the related causes of death (Statistics Finland) and psychiatric hospital admission (The National Institute of Health and Welfare (THL)) covering the years 1971-2016 and psychiatric outpatient visits 1998-2016 are linked to the study population using personal identifiers. Figure 2 describes the timeline of measurement.

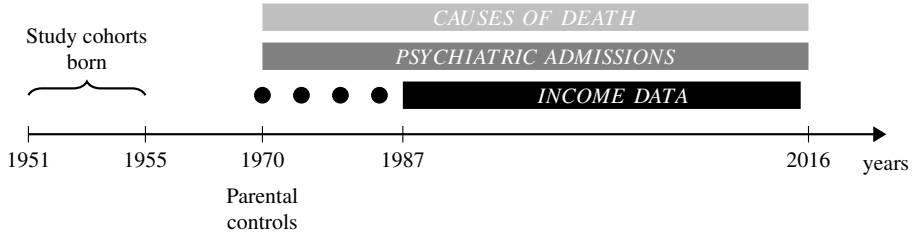


Figure 2: Timeline of measurement

4.2 Outcome variables

Statistics Finland provides the Finnish longitudinal Census file 1970-1985 and annual Finnish Longitudinal Employer-Employee Data (FLEED) 1987-2015 which include annual taxable income (labor income, pensions, and benefits), labor income and entrepreneurial income, employment status, occupation, the municipality of residence, the highest education degree and a set of information related to family. This study focuses on labor income and employment as the main outcome variables which give indication of the societal burden of mental disorders attributable to lost work input. However, there are some concerns in interpreting the labor income deficits as lost productivity. This so-called traditional "human capital approach" does not take account for the possibility of replacing an ill person with an unemployed worker. If this change would come with low "friction costs", the lost productivity would be overstated. However, mental illnesses may also cause "preseenteism", i.e. working at low productivity level while ill, which underestimate the productivity costs attributed to mental disorders (Drummond et al., 2015).

Income information comes from the Finnish Tax Administration and covers all people living in Finland during the administrative year. Annual income information has been linked to respective years of Census files and FLEED except for Census 1970 which includes income information about the year 1971. The Census was conducted every five years from 1970 to 1985. We, therefore, lack employment and income information for years 1972-74,1976-79,1981-84 and 1986. To compute estimates for lifetime labor market performance, I employ individual-level linear interpolation to cover the missing income and employment [4]. To account for inflation, I use consumer price index information from Statistics to convert all annual income in 1971 to 2016 to income to 2017 prices (euros).

The main outcome is labor income as it describes the best the difference in labor productivity. The alternative income measure, total taxable income, includes also capital income, pension income, and benefits that arise from early pension schemes (e.g. disability pension) and employment and other social benefits (sickness allowance, parental leave). Analysis of taxable income will describe differences in income and thus help to explain financial differences rather than differences solely on labor productivity. The third outcome, total years employed, equals the total of annual binary employment indicators except for interpolated values that can also take values between 0 and 1.

4.3 Explanatory variables

Information on mental disorders is retrieved from THL (The National Institute of Health and Welfare) from a dataset that includes psychiatric hospital discharges covering the years 1971-2016 and outpatient visits in primary health care for the years 1998-2016. Because all Finnish psychiatric hospitals and outpatient facilities are public, all admissions and discharges are recorded in the registers during these periods. The admission data includes information on the dates of admission and discharge, and the diagnoses (primary and secondary) recorded by the doctor.

[4]This is done by imputing the missing years with an equaling the convex combination of the values from the nearest observed years. For instance, employment in the year 1977 is assigned a value $\frac{2}{5} * (employment_{1980} - employment_{1975}) + employment_{1975}$.

Table 1: Cumulative incidence of mental disorder admissions by analytic sample and diagnosis

	Full sample		HS sample		Sibling sample		Twin sample	
Diagnosis	Male	Female	Male	Female	Male	Female	Male	Female
Any mental disorder	0.193	0.161	0.187	0.173	0.487	0.486	0.5	0.5
Psychotic disorder	0.032	0.031	0.034	0.032	0.084	0.097	0.081	0.109
Mood disorder	0.074	0.093	0.089	0.105	0.174	0.27	0.169	0.267
Anxiety disorder	0.043	0.060	0.049	0.066	0.106	0.181	0.092	0.225
Alcohol-related causes	0.109	0.031	0.078	0.026	0.262	0.090	0.261	0.078
Observations	159969	144141	24495	38713	8333	6320	284	258

Notes: The table displays the cumulative incidences of mental disorder and alcohol-related admission by sex in all four analytical samples. Sibling and twin samples require within the same-sex sibling or twin pair (or other multiparity) variation in the lifetime incidence of psychiatric treatment. Inclusion to the full sample requires within-group variation in mental disorder status in cells stratified by the birth cohort, sex, subregion 1970, urban status 1970 and within subregion household income quartile. The high school (HS) sample further extends this by adding the requirement of an exact match by within subregion high school GPA quartiles.

Table 1 displays the summary statistics of the cumulative incidence of any mental disorder in all analytic samples used in this study. Overall the incidence of any mental disorder related admissions is about 18 percent. From the psychiatric subcategories, mood disorders (which include also bipolar and depressive disorders) is the largest category in women and alcohol-related admission in men. Overall, men are more likely to be treated for mental health-related problems than women. The incidences in high school, sibling and twin samples reflect the sample inclusion criteria. Individuals who graduated from upper secondary school (from now on high school) have the cumulative incidence of any psychiatric admission of 13,5% and those who did not graduate from high school have an incidence of 19,5%. In the high school sample, the inclusion criteria of within cell variation in the full fixed effects specification (i.e. all control variables included) increases the cumulative psychiatric incidence compared with population averages. In the sibling and twin samples, it is required that the affected sibling (twin) has at least one same-sex sibling (twin) without psychiatric admission history. As I do not have access to information on the zygosity of twins, it is not possible to tell whether twins are identical

or not [5]

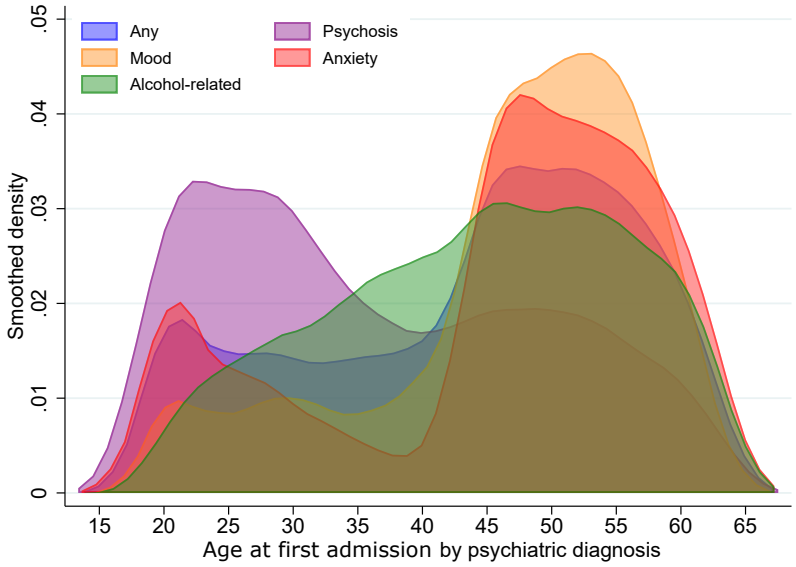


Figure 3: Smoothed density of first admission age by diagnosis

Mental disorders commonly emerge in adolescence and often persist into adulthood (Kessler et al., 2005; Patton et al., 2014). Psychiatric research suggests that the great majority of all lifetime cases of psychiatric disorders start by age 24 (Kessler et al., 2005). For this study sample, the psychiatric admission data suggests the mean age of treatment is about 43.5 years. Figure 3 shows that the first admission in our data occurs later in adulthood. This underlines the discrepancy between the age of onset and the first psychiatric admission age. The delay between the actual age of onset and first admission is typically shortest for the most disabling conditions, such as schizophrenia. For other outcomes, the peaks occur in middle age, although a minor peak in anxiety disorders occurs also at age 20.

[5]However, using the fact the monozygotic twins are always of the same-sex, one could compute indicative information on zygosity in discordant twin pairs. The share of female-male pairs within discordant twin pairs is 43,9% whereas for non-discordant (both unaffected or affected) pairs sex-mix share is 39,5%. This difference is statistically significant. As the discordant pairs are slightly more likely to be of different sex, I assume that the analytic twin sample that includes only discordant pairs is more likely to include more dizygotic twin pairs than monozygotic twin pairs.

Table 2 displays background characteristics at the start of follow-up by treatment status. Treatment status is given value 1 is an individual has recorded at least one psychiatric admission during the follow-up period and value 0 otherwise. The study sample is ethnically very homogeneous: only 0.1 percent of the study sample have other than Finnish or Swedish as their mother tongue (only 0.2 percent are born abroad). This is partially due to restrictions related to birth year and being present at the start of follow-up. Among the natives, Swedish speakers are less likely to be admitted to psychiatric treatment. The treated are more likely to have been born in urban areas. They are also more likely to be men and in the working population at age 15-19, and less likely to have attended high school. The parents of the affected have lower total earnings in 1970 and the father is less likely to work in agriculture and to have a tertiary education.

Table 2: Sample characteristics by lifetime psychiatric admission status sample in all analytic samples

	Full sample		HS sample		Sibling sample		Twin sample	
	Not admitted	Admitted	Not admitted	Admitted	Not admitted	Admitted	Not admitted	Admitted
Finnish-speaker (%)	94.0	96.1	93.4	96.6	97.1	96.0	94.4	96.0
Swedish-speaker (%)	5.9	3.8	6.5	3.3	2.8	3.9	5.3	3.9
Female (%)	48.4	42.8	61.6	59.4	43.2	43.1	47.6	47.6
Urban indicator for birth (%)	26.8	27.8	45.2	40.6	22.6	22.4	22.1	22.9
Urban status 1970 (%)	47.9	49.1	65.2	59.3	46.1	45.6	47.2	46.9
In the working population (%)	33.6	39.6	2.19	2.77	42.9	44.5	43.5	47.2
Income in 1971	392	416	169	166	449	433	438	417
Years in follow-up	42.63	42.22	42.64	43.08	42.21	42.33	42.59	42.75
Sample birth order	1.34	1.37	1.27	1.28	1.76	1.79	NA	NA
High school degree	30.4	21.9	100	100	21.4	17.6	19.6	17.3
Parent information 1970								
HH total income in 1971	3271	3066	4720	4628	2876	2884	3136	3135
Father's age	48.5	48.8	47.6	48.0	48.2	48.2	50.2	50.3
HH head works in agriculture (%)	29.9	27.6	17.1	20.5	32.2	31.9	32.8	33.2
House owner	76.3	73.1	74.0	73.5	73.3	73.4	76	77.1
Father's education (%)								
Primary	79.6	81.7	56.8	60.4	84.1	84.3	79.3	79.3
Upper secondary	9.81	9.09	13.9	13.6	8.68	8.51	10.3	10.3
Lower tertiary	10.3	8.96	28.2	25.1	6.94	6.94	9.23	9.23
University	0.28	0.22	1.12	0.88	0.27	0.28	1.11	1.11
Observations	249999	54111	51908	11300	7519	7134	270	270

Notes:Sample characteristics of the treated and control group in all four analytical samples. Sibling and twin samples require discordance between same-sex siblings or twin pairs (or other multiparity) in lifetime incidence of psychiatric admissions. Inclusion to full sample requires within cell variation in mental disorder status by birth cohort, sex, subregion 1970, urban status 1970 and within subregion household income quartile. The high school (HS) sample further extends this by adding a requirement of an exact match by within subregion high school GPA quartiles.

Those that have a history of psychiatric admission are highly likely to have predisposed psychiatric condition years before the first contact. This is likely to show as divergence in school and labor market performance before the actual psychiatric event. The probability of attending high school among the discordant twins highlights this. The treated twin is about 2 percentage points less likely to finish high school relative to the "healthy twin". To a large extent, sibling and twin samples balance the sample concerning parental characteristics but there are minor differences because I allow same-sex siblings and twin comparisons to include more than two siblings. The main analyses are conducted using only time-invariant background characteristics observed at the start of follow-up as the control variables. In the second sample, the high school sample, I only include those who have finished high school and for whom I have access to information on the grade point average. I use this information to compute relative grade point average (GPA) at subregion-level, and use it as a proxy for within subregion differences in cognitive ability. I use relative school performance within the region of origin is instead of absolute performance to account for region-specific grading assessment, and to account for the fact that relative performance may be more correlated with well-being within regions as opposed to performance relative to peers in more distant regions.

5 Results

Table 3 reports the associations between psychiatric admissions and lifetime income in absolute and relative terms for all four analytic samples by the diagnosis category of the first admission. The first column displays the point estimates for the lifetime income differences between the treated relative and the control group without controlling for background characteristics. The individuals with no psychiatric admission history, the estimates for lifetime earnings, taxable income and employment years are €0.9 million, €1.1 million and 32.5 years. Relative to the healthy controls, those who are treated for any psychiatric reason earn 37 percent less (€-0,34 million) during lifetime relative to the control group. Adjusting for the socio-economic background and the total years in follow-

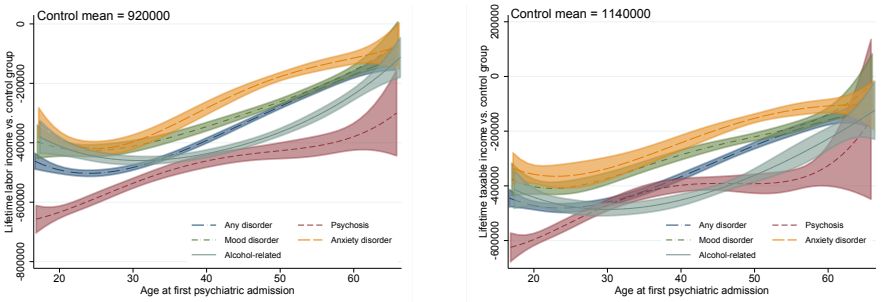
up has a negligible impact on the point estimate (column 2). When looking at the high school sample which adds a control variable on relative school performance, the difference reduces to 33 percent (column 3). Same-sex sibling fixed effect estimates (columns 4) that aim to mitigate the role of genetic and environmental differences between subjects, produce point estimates that are around the same ballpark with full sample and high school sample estimates. For twins (column 5) the difference is smaller (-37%).

Lifetime earnings disparity is the largest for the psychosis (incl. schizophrenia) admissions (unadjusted -65%, adjusted -57%) and amounts to over half a million euro deficit in 2017 prices. For mood and anxiety disorders the differences are 29 % (-30 %) and 26 % (-25 %). Earnings differences in alcohol-related admissions are larger (-40 %, -41 %) than in any mental disorders. All estimates are statistically significant except for twin FE-design, which produces statistically not significant estimates for alcohol-related admissions.

Both in relative and absolute magnitudes, the labor market deficits are smaller in lifetime taxable income (on average 10pp. smaller deficit) than in labor income (Table S2). This is in line with recent evidence that finds that income transfers cushion against financial consequences in psychiatric admission in Finland (Hakulinen et al., 2019b). A major part of the differences in income due to decreases in employment. Those with psychiatric admission history work approximately 8.1 (7.7) years less than their comparisons. In psychotic conditions, the deficit is the largest and amounts to 16.6 years (14.9) whereas in mood (5.4 (6.1)) and anxiety disorders (4.8 (5.2)) the deficit is smaller (Table S3). Results suggest that people with mental disorders do not only work less but also work in less lucrative occupations during their working careers. This is not surprising as a considerably smaller fraction of the treated individuals went to high school relative to "healthier" controls.

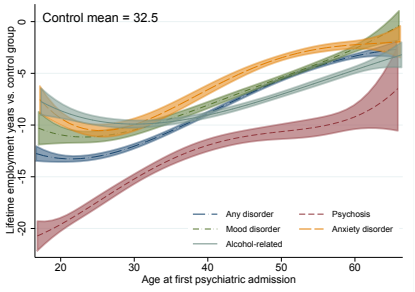
Age of the first admission matters. The visualization of the polynomial regression on the age of first admission and labor market performance suggests roughly linear the link between the first admission age and labor market performance. For the ease of interpretation, I also examine the link using linear interaction with the age of the first admission

and an indicator of any mental disorder with the first admission age centered at age 40. To estimate the difference between those with psychiatric admission history and those without any psychiatric admission history across different ages at first admission, the control group is randomly assigned an age of the first admission between ages 16-64. The resulting estimates suggest that a one-year reduction in the age of onset is associated with about €13 000 loss in lifetime earnings (Table 4). This reduces to €9 000 when follow-up years and other background characteristics are controlled for. For psychotic and mood disorders one year earlier admission is associated with about €11 000 loss (adjusted estimate €7



(A) Lifetime earnings

(B) Lifetime taxable income



(C) Lifetime employment years

Figure 4: The age of first admission and the labor market deficits. Graphs refer to polynomial regression (fourth-order) estimates for the association of age of the first admission and the deficit in labor market performance (with 95% confidence intervals) between the treated and control group. Those who have no psychiatric admission history are randomly assigned with the age of the first admission between ages 16-64. The control variable set includes total years in follow-up, sex, urban status 1970 and childhood subregion, birth cohort and parental income quartile fixed effects.

000). In anxiety disorders and alcohol-related causes, the losses are €9 500 (€8 000) and €11 000 (€5 500). These losses are greater for those who attended high school and fairly similar in the sibling design. Twin design suffers from low statistical power for the reliable examination of age heterogeneity in the labor market performance. To a large extent, the estimates are similar for lifetime taxable income (Table S4). For employment, one year earlier psychiatric admission is associated with a loss of about 0.43 years (0.27 years). First admission age heterogeneity is similar in psychotic disorders and somewhat smaller mood (0.37 (0.23) years) and anxiety disorders (0.32 (0.21) years). In alcohol-related admissions, the age heterogeneity is considerably smaller (0.34 (0.14) years)) (Table S5). The adjusted lifetime earnings estimates are also roughly the same relative magnitude between men and women (see (Figures S1 to S3 in the Appendix) in psychotic disorder and alcohol-related admission although in general men's (-39%) is larger than women's (-33%).

Without adjusting for the time in follow-up, estimates for labor market performance are severely hindered for men with early-onset mental disorders compared to women. Adjusting to time in follow-up reduces labor market performance deficits at an early age (before age 30) admissions by 15-20 pp. for men but only by 5 pp. for women. This is because men have a higher excess mortality risk in early age admissions relative to women. On the other end of the spectrum, the non-adjustments can result in surprising results: Later age admissions in mood and anxiety disorders are associated with higher lifetime employment years relative to the control group. This finding stems from differences in the observation window: the individuals with late age onset are by construction alive and present in Finland near the end of follow-up whereas healthier controls are more likely to be lost due to emigration or mortality.

Overall, I find that earnings and employment disparity decreases by later admission age and this link roughly linear both with and without adjustments for control variables. This finding is consistent with the insight from psychiatric literature on the age of onset being a strong determinant of severity of psychiatric disorder but in contrast with Danish evidence reported by Greve and Nielsen (2013). Their finding is surprising: the age of first

schizophrenia admission is negatively correlated with employment at age 35-45 in general and no systematic difference relationship with age of first admission and employment occurs in their sibling fixed effects design.

The risk of psychiatric disorders is correlated within families. Studies on schizophrenia have found that for the affected families the relative risk of schizophrenia can be 11 times the risk of a matched control group (Arajärvi et al., 2006). However, not all neuropsychological deficits are identified from the register data and therefore family-related risks might predict labor market performance even for those with no recorded mental disorders. When examining the labor market performance of the healthy sibling, I find that in comparison to individuals with the similar background but without psychiatric admission history among siblings, the healthy sibling earns 8% (adj. 5%) less in both and taxable income over the lifetime and works about 1 (0.6) year less than unaffected comparison (see Table S6). Surprisingly, the disparity is about the same for psychotic disorders -10 % (-5) and -1.5 years (-0.9)) but larger for alcohol-related admissions in earnings (-12 % (-8)) and smaller in mood or anxiety disorders. Comparisons between same-sex twins provide similar results with one notable exception: "healthy twin" affected with a psychotic same-sex twin earns about 20 percent less (-23% (-21%)) than comparable unaffected twins. This finding in line with the findings in psychiatric literature on healthy siblings and neuropsychological deficits. Since there is no statistically significant difference in lifetime employment years, this is likely to be driven by selection in the job market.

As discussed above, psychotic patients often suffer from cognitive deficits that can affect labor market choices and opportunities. Besides cognitive deficits, there might be some underlying predispositions linked to personality traits can affect career prospects. Furthermore, the parental time investments can matter. Akee et al. (2018) investigated the effects of income transfers to Indian tribal households and found that cash transfers resulted to increased parental investment on the children whose mental health worse than siblings'. However, Yi et al. (2015) found out that parents invest more in health of the children who experience a health shock but less educational investments relative to healthy siblings. In Finland, the education system is to a large extent free or subject to very small

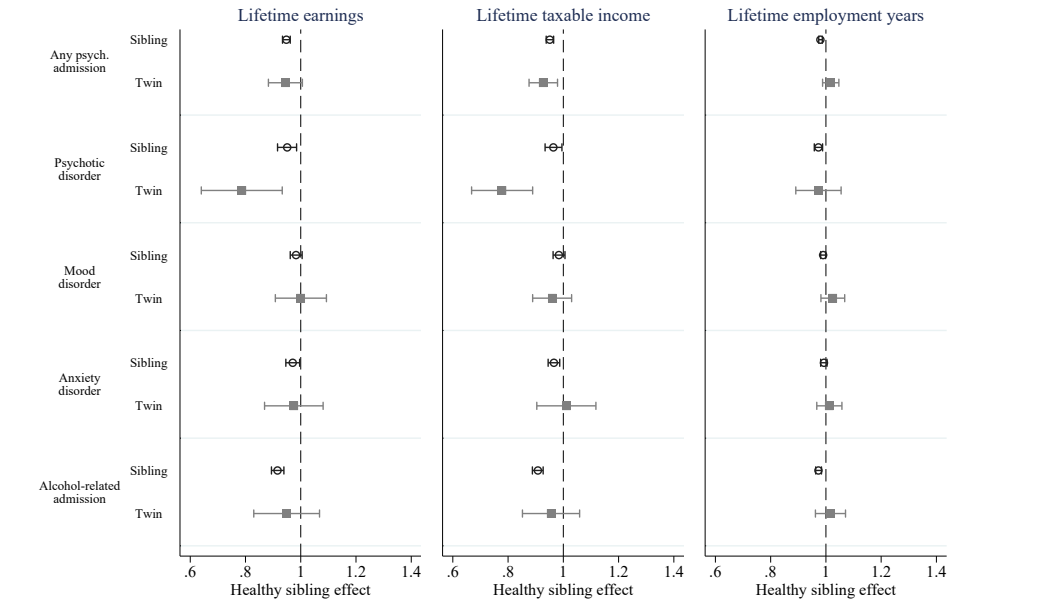


Figure 5: Healthy sibling effects. Point estimates (with 95 % confidence intervals) refer to relative lifetime labor market performance of healthy individuals who have a sibling with psychiatric admission history vs. healthy individuals with healthy siblings. The point estimates stem from a specification that includes the full set of background characteristics: sex, birth year, subregion 1970 fixed effects, relative household earnings (parents), the urban status of residence and total years in the follow-up. Table S6 in the Appendix presents the corresponding point estimates.

tuition fees and the investment that reinforce the initial differences are likely to stem from time investments. While parental investments may play a role, the differences in the healthy effects between the sibling and twin samples are supported by prior findings in psychiatry on the positive association between neuropsychological deficits and genetic proximity.

6 Discussion

Three results in particular should be emphasized. First, relative to healthy comparisons, the lifetime earnings differences are the greater the earlier first psychiatric admission oc-

curs. This finding is consistent with psychiatric literature that has documented early-onset (vs late-onset) of mental disorders associated with deficiencies in cognitive processes, occupational functioning and severity of mental illness throughout the life course. This underlines the need for shifting resources to the prevention and early intervention of mental disorders to increase well-being in adulthood and decrease societal burden linked to mental disorders. Furthermore, increased attention should be placed on securing a smooth transition of mental health services from adolescent services to adulthood, a process that is often overlooked and which is commonly creating disruption among the most severely ill individuals (Singh et al., 2010). As the age of the first admission correlates almost linearly within differential lifetime work productivity at the brink of adulthood, there is no economic rationale for concurrent discontinuities in mental health service provision.

Second, in comparison with labor income differentials, I find that deficits in taxable income are slightly smaller for women but larger for men. Taxable income includes items such as employment benefits, parental leave benefits, capital income, and pension income. The likely reason for the finding is that whereas for women social security items on employment, health insurance, and early retirement protect against losses in labor income, for men the capital income deficits of the mentally ill are large enough to overturn the cushioning effect of social security in absolute terms.

Third, the labor market deficits are not confined to the affected individuals but also their ”healthy” siblings face deficits in the labor market. Relative to unaffected comparisons that have unaffected siblings, the ”healthy” sibling of the affected earns 6% less in both labor and taxable income and works about 1 year less than the unaffected comparison. This deficit is larger for men relative to women both in absolute and relative terms. Overall, this phenomenon likely suggests that the ”healthy” siblings have an increased risk of less salient neuropsychological deficits and this also has labor market consequences.

While the ability of the register-based approach to capture only about half of the lifetime disorders is an obvious limitation, the lifetime perspective to mental disorders and labor market performance can provide value-added in three ways. First, it is the first study to document correlations between severe mental disorders and lifetime earnings.

As previously discussed, prior studies have studied some snapshots of adult outcomes and provided information on the association of depressive symptoms and labor market performance with varying periods usually between ages 20-50. But concerning the societal burden of diseases, advancing towards a lifetime perspective is important because mental disorders tend to be persistent. Estimates for the lifetime labor market performance deficit related to mental disorders work as a step in understanding the lifetime losses in work productivity associated with mental disorders.

Second, besides having access to a long history of income and employment, reliable information on severe psychiatric disorders is also crucial. The 45-year follow-up allows a profound investigation of the mental disorder and labor market performance in terms of the age of onset (first admission). As it is hard to pinpoint the age of onset of a mental disorder, the age of the first admission is adequate proxy especially when a long discontinuous study period is accessible. Many individuals suffer from mental health problems years before seeking help. This creates considerable delays between the age of onset and first psychiatric admission. In the case of schizophrenia, the age of onset could occur 2-6 years before hospitalization (Häfner et al., 1993). In less severe conditions, this could take much longer (Norman and Malla, 2001) but the vast majority of people with mental disorders seek treatment at some point during their life (Wang et al., 2007). Thus register-based research should aim to make use of complete psychiatric admission history to make an appropriate division between individuals who are mentally ill (treated for psychiatric conditions at some point in life) and healthier individuals.

Third, using high-quality administrative data with fully overlapping follow-up on psychiatric admissions and labor market performance from adolescence to retirement age, this study can provide reasonable case-control setup without the burden of participation bias, attrition or biases related to self-reports that often plague survey-based studies. Departure from sound data strategy prevents from the point estimates being driven by selection to participation. In epidemiological psychiatric studies, participation bias due to premature mortality among those with psychiatric admission history becomes a concern. If a researcher observes the study sample only in late adulthood, there will be an upward bias in

the labor market performance of the exposed group because the most severe psychiatric cases are more likely not to be alive. For instance, the cumulative incidence of suicide increases rapidly after the onset of illness in schizophrenia and tends to stabilize 20 years after onset (Nordentoft et al., 2011). Also if the study sample is not restricted to those present and observed at the start of follow-up at adolescence, the results might be affected by migration, notably immigration and more so in the case of rare psychiatric events such as for schizophrenia. Furthermore, while using short follow-ups one can capture the differences in present economic deficits, they may give a misleading view of the lifetime association because they do not take account for full labor market history. For instance, as Figure S4 shows, there are considerable employment differences between admissions groups 15-20, 20-30 and 30-40 until age 40 after which the groups follow similar employment patterns.

This study emphasizes the importance of the age of the first admission as a predictor of relative labor market performance among the affected individuals. Indeed, knowing the age when mental illnesses emerge is important because it helps an effective organization and targeting of relevant services to reduce the detrimental impact of mental disorders (de Girolamo et al., 2019). By documenting the long-term repercussions in the labor market associated with different ages of onset of psychiatric problems, this study highlights the scale of the potential gains related to early intervention in mental disorders. Although vulnerability to mental disorders is not exogenous but is partly determined already at birth and signs of brain compromise begin years before the onset of clinical symptoms (Bearden et al., 2015), early interventions have potential reduce the damage in the long-term (Hegelstad et al., 2012). On the other hand, longer delays are associated with a reduced response to treatment (Perkins et al., 2005) which makes the recognition of the damage differentiated by the age of onset of great importance. Lifetime perspective is integral to providing policy-relevant estimates for the labor market deficits of mental disorders. Particularly, this is important for distinguishing heterogeneity in labor market deficit estimates by the age of the first admission, information which is useful when considering age-specific treatment and intervention in psychiatry. In the future, research should focus

on long-term economic evaluation of different randomized early intervention schemes to provide policymakers estimates of the long-term economic benefits of resources allocated to early intervention.

7 Conclusion

This study examined the lifetime labor market repercussions of psychiatric admissions. To provide a thorough description of the linkage between mental disorders and labor market performance, this study makes use of Finnish administrative register data that combines high-quality information on family, labor market outcomes and health for a period of almost half a century. This study highlights the economic inequality related to mental health which is particularly emphasized for the early-onset disorders. While this analysis does not address the means of how to promote mental health and reduce this deficit, the results provide information on the scope of lifetime labor market performance losses associated with mental disorders.

Table 3: Psychiatric admission history and the deficit in lifetime earnings (in 1000 euros)

Sample	Main sample		HS	Sibling	Twin
	(1)	(2)	(3)	(4)	(5)
Any disorder	-341	-335	-403	-263	-315
	[-346,-336]	[-340,-330]	[-417,-389]	[-278,-247]	[-410,-220]
Constant	917	916	1228	836	1178
%	0.628	0.634	0.672	0.686	0.733
N	301658	301658	71331	14653	2867
Psychotic	-596	-526	-728	-421	-461
	[-607,-586]	[-537,-515]	[-759,-697]	[-494,-347]	[-838,-83]
Constant	917	915	1225	828	1151
%	0.350	0.426	0.406	0.492	0.600
N	253784	253784	61244	8370	1769
Mood	-270	-278	-375	-226	-246
	[-278,-263]	[-285,-270]	[-393,-357]	[-264,-189]	[-430,-62]
Constant	917	918	1227	844	1165
%	0.705	0.698	0.694	0.732	0.789
N	265022	265022	64328	9737	2093
Anxiety	-241	-233	-282	-197	-296
	[-251,-230]	[-243,-224]	[-307,-258]	[-249,-146]	[-543,-50]
Constant	917	917	1226	840	1178
%	0.737	0.745	0.770	0.765	0.749
N	258234	258234	62478	8950	1939
Alcohol-related	-370	-380	-400	-291	-252
	[-378,-362]	[-387,-372]	[-433,-368]	[-329,-253]	[-801,298]
Constant	919	919	1229	833	1162
%	0.597	0.587	0.674	0.651	0.783
N	263020	263020	61748	9606	1798

Notes: The average marginal effects (with 95% confidence intervals) of psychiatric admission on lifetime earnings (in €1000) in 2017 prices. The shaded rows below the predicted margin of the control group (Constant) refers to percentage shares of lifetime earnings (in 2017 prices) vs. control group computed. The first column refers to a specification that uses the full sample without control variables, the second column used controls variables that include father's mother tongue, subregion 1970 fixed effects, relative household earnings in 1970 (within subregion 1970), birth cohort and sex. The third column compares high school graduates and uses the full set of control variables and adds local relative grade point average (standard deviations from the mean) as a control variable. Fourth and fifth consist of same-sex sibling and twin fixed effect estimates with only sex as a control variable.

Table 4: Age of first admission and the deficit in lifetime earnings (in €1000)

Sample		Main sample		HS	Sibling	Twin
		(1)	(2)	(3)	(4)	(5)
Any mental disorder	Admitted	-375	-358.9	-461.2	-287.2	-249.7
		[-379.8,-370.1]	[-363.6,-354.2]	[-475.7,-446.7]	[-302.4,-271.9]	[-323,-176.4]
	Admitted*age	13	8.9	12.7	8.7	7.1
		[12.6,13.4]	[8.5,9.3]	[11.6,13.8]	[7.2,10.2]	[-0.8,15.1]
	Constant	917.1	877.6	1523.8	916.5	805.8
		[914.2,920.1]	[868.8,886.3]	[1493.6,1554.1]	[787,1046]	[755.2,856.5]
	N	301658	301658	71331	14653	539
	R^2	0.042	0.190	0.211	0.658	0.706
Psychotic disorder	Admitted	-516	-475.3	-661.8	-361.6	-408.5
		[-528.9,-503.2]	[-488.2,-462.3]	[-695.4,-628.3]	[-449,-274.2]	[-786.6,-30.4]
	Admitted*age	10.8	7	10.7	8.9	-5.7
		[10,11.7]	[6,7.9]	[8.2,13.1]	[1.5,16.3]	[-52.5,41]
	Constant	917.1	880.7	1542.5	985.8	832.6
		[914.2,920.1]	[870.8,890.5]	[1508.5,1576.4]	[665.1,1306.5]	[748.6,916.7]
	N	253784	253784	61244	8370	305
	R^2	0.016	0.176	0.206	0.914	0.958
Mood disorder	Admitted	-331	-316	-434.6	-265.1	-260.5
		[-339,-323]	[-323.7,-308.3]	[-455.6,-413.6]	[-305.6,-224.5]	[-472.2,-48.9]
	Admitted*age	11.1	7.3	9.4	8.6	10.6
		[10.4,11.7]	[6.7,7.9]	[7.7,11.1]	[4.8,12.4]	[-10,31.2]
	Constant	917.1	880.4	1538.9	1025.3	814.5
		[914.2,920.1]	[870.8,890]	[1506.3,1571.5]	[800.1,1250.5]	[744.1,885]
	N	265022	265022	64328	9737	346
	R^2	0.010	0.171	0.203	0.823	0.861
Anxiety disorder	Admitted	-268.6	-256.7	-333.5	-222.7	-138.2
		[-278.8,-258.3]	[-266.4,-246.9]	[-360.5,-306.5]	[-276.4,-169]	[-404.9,128.6]
	Admitted*age	9.5	7.9	10	9	-4.1
		[8.8,10.2]	[7.2,8.6]	[7.9,12]	[4.2,13.7]	[-23.9,15.7]
	Constant	917.1	880.8	1547.3	999.3	799.6
		[914.2,920.1]	[871,890.6]	[1513.9,1580.7]	[724.2,1274.4]	[728.9,870.4]
	N	258234	258234	62478	8950	331
	R^2	0.005	0.168	0.200	0.875	0.922
Alcohol-related admission	Admitted	-401.9	-394.5	-447.8	-321.3	-388.8
		[-409.5,-394.4]	[-402.1,-387]	[-479.5,-416.1]	[-358.9,-283.7]	[-623.1,-154.5]
	Admitted*age	11.4	5.5	8.8	8.2	19.7
		[10.7,12.1]	[4.9,6.2]	[5.9,11.7]	[4.4,12]	[-12.9,52.3]
	Constant	918.8	885.2	1548	937.9	816.1
		[915.8,921.7]	[875.6,894.9]	[1514.2,1581.9]	[739.1,1136.7]	[737,895.2]
	N	263020	263020	61748	9606	343
	R^2	0.018	0.177	0.201	0.846	0.868

Notes: OLS estimates for the effect of psychiatric admission with interaction the age of the first admission (centered at age 40) on lifetime labor income with 95% confidence intervals. The control group consists of individuals with no psychiatric admissions. The first column refers to a specification that uses the full sample without control variables, the second column used controls variables that include father's mother tongue, subregion 1970 fixed effects, relative household earnings in 1970 (within subregion 1970), birth cohort and sex. The third column compares high school graduates and uses the full set of control variables and adds local relative grade point average (standard deviations from the mean) as a control variable. The fourth and fifth consist of the same-sex sibling and twin fixed effect estimates with only sex as a control variable.

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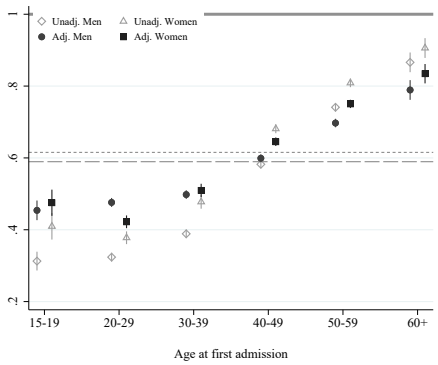
Appendix



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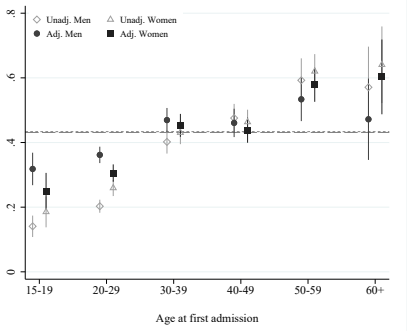

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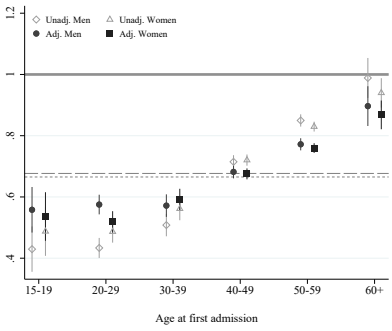

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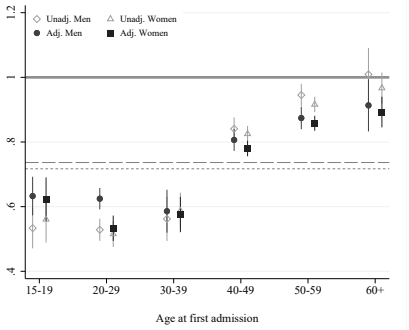

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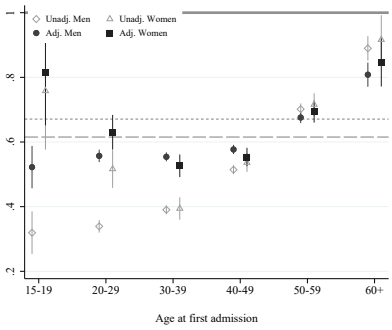
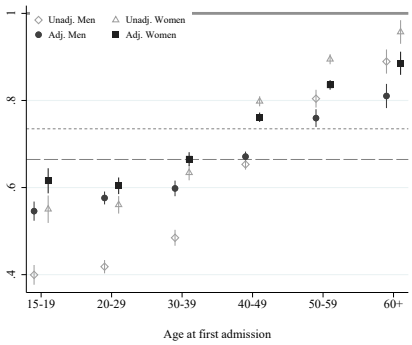


(e) Alcohol-related

Figure S1: Categorized age at first admission and the lifetime labor earnings relative to healthy controls. The percentage shares (with 95% confidence intervals) of lifetime earnings relative to the control group by the age of the first admission groups and sex. Estimates are calculated from the average marginal effects of predicted lifetime earnings. Percentage shares and confidence intervals are computed as shares of both unadjusted and adjusted (for the time in follow-up only) lifetime earnings prediction vs. the control group. All regressions include the childhood subregion, birth cohort and parental income quartile fixed effects and years in follow-up on a continuous scale. Dashed lines refer to the main effect of psychiatric admission history on the lifetime earnings of men (long dashed line) and women(short dashed line) with a continuous variable of total years in follow-up as the sole control variable.



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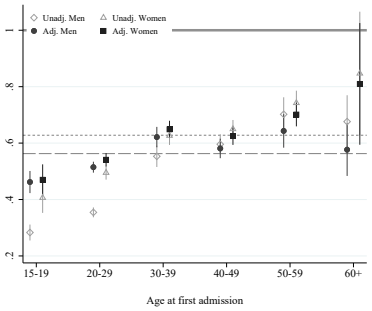

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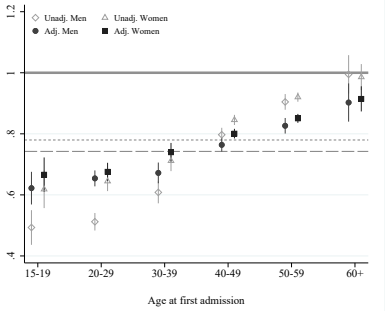

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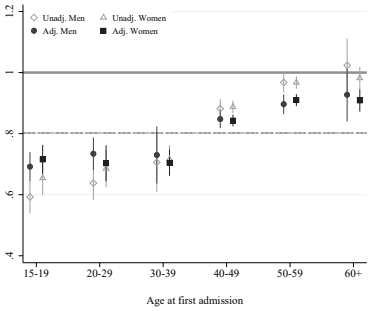

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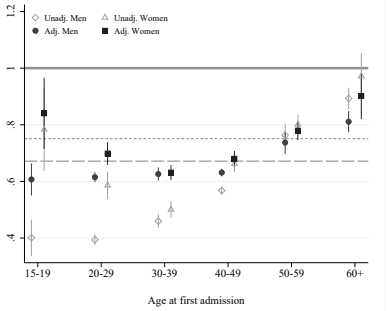
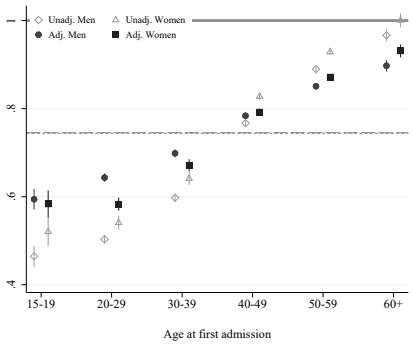
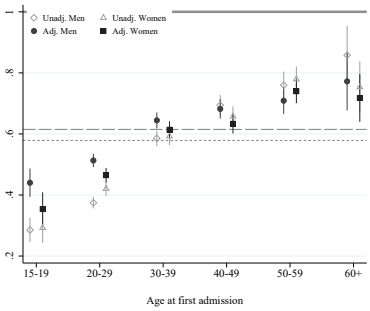


(e) Alcohol-related

Figure S2: Categorized age at first admission and the lifetime taxable income relative to healthy controls. The percentage shares (with 95% confidence intervals) of taxable income relative to the control group by the age of the first admission groups and sex. Estimates are calculated from the average marginal effects of predicted taxable income. Percentage shares and confidence intervals are computed as shares of both unadjusted and adjusted (for the time in follow-up only) taxable income prediction vs. the control group. All regressions include the childhood subregion, birth cohort and parental income quartile fixed effects and years in follow-up on a continuous scale. Dashed lines refer to the main effect of psychiatric admission history on the taxable income of men (long dashed line) and women(short dashed line) with a continuous variable of total years in follow-up as the sole control variable.



(a) Any disorder



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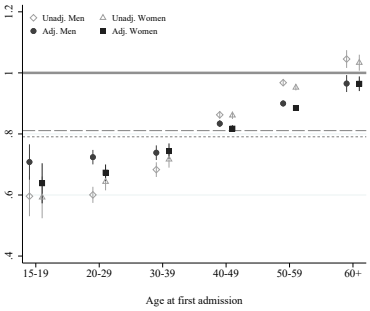
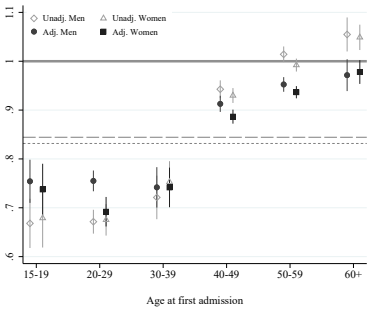
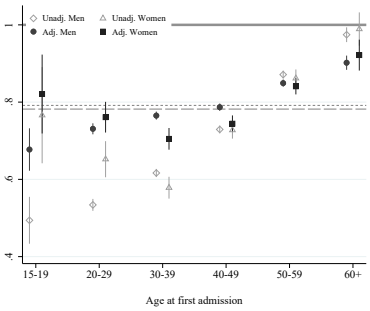


(c) Mood



(d) Anxiety



(e) Alcohol-related

Figure S3: Categorized age at first admission and the lifetime employment years relative to healthy controls. The percentage shares (with 95% confidence intervals) of total employment years to the control group by the age of the first admission groups and sex. Estimates are calculated from the average marginal effects of predicted total employment years. Percentage shares and confidence intervals are computed as shares of both unadjusted and adjusted (for the time in follow-up only) total employment years prediction vs. the control group. All regressions include the childhood subregion, birth cohort and parental income quartile fixed effects and years in follow-up on a continuous scale. Dashed lines refer to the main effect of psychiatric admission history on the total employment years of men (long dashed line) and women(short dashed line) with a continuous variable of total years in follow-up as the sole control variable.

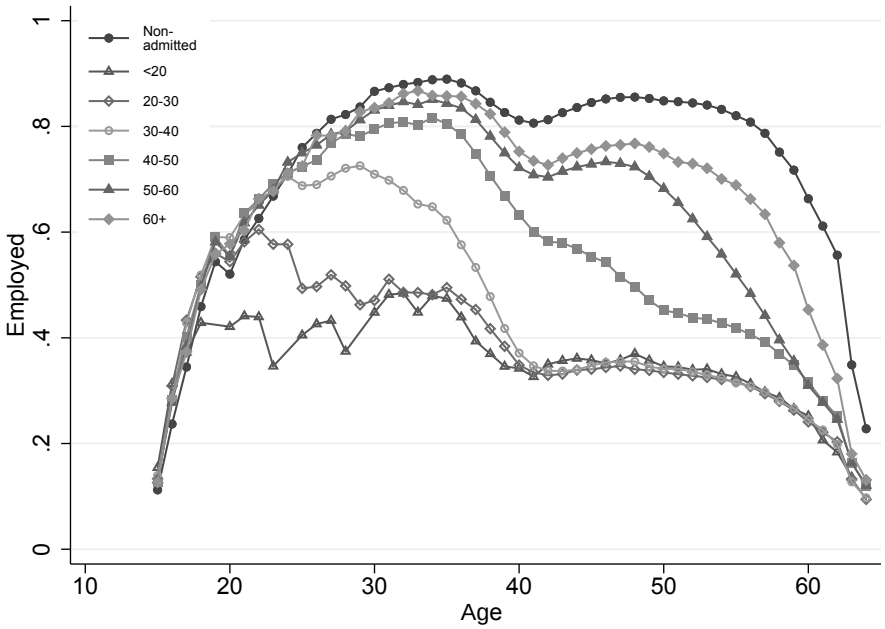


Figure S4: Age-employment profiles by age of first psychiatric admission. Age-employment profiles are averages over age by age of first (any) psychiatric admission. Employment information is based on the original (no imputation or treating missing data as zero) data received from Statistics Finland.

Table S1: Diagnosis codes used to form the first psychiatric admission information

	International Classification of Diseases, Revision		
Outcomes	ICD-8	ICD-9	ICD-10
Any mental disorder	291*-309*	291*-316*	F04*-F69*, F80*-F99*
Psychotic disorder	295*, 297*-299*	295*, 297*-299*	F20*-F29*
Mood disorder	296*, 298*,3004*	296,3004	F30*-F39
Anxiety disorder	305*, 30680, 30799, 3000-3003, 3005-3009	3000-3003	F40*-F489
Alcohol-related admissions	291,303,571,577	291, 303, 3050, 3575, 4255, 5353, 5710, 5713, 5770, 5771C, 5771D, 7607A, 7795A, E851	F10*, G312, G4051, G621, G721, I426, K292, K70, K860, K582, O354, P043, Q860, X45

Notes:Diagnoses used to form the study outcome measures. ICD-8, ICD-9 and ICD-10 refer to the International Statistical Classification of Diseases and Related Health Problems and its revision for years 1969-1986, 1987-1995, and 1996 onwards.

Table S2: Psychiatric admission history and the deficit in total taxable income

Sample	Main sample		HS	Sibling	Twin
	(1)	(2)	(3)	(4)	(5)
Any disorder	-321	-313	-379	-239	-308
	[-329,-314]	[-320,-306]	[-403,-356]	[-257,-220]	[-463,-153]
Constant	1136	1134	1474	1041	1437
%	0.717	0.724	0.743	0.771	0.785
N	301658	301658	71331	14653	2867
Psychotic	-559	-473	-676	-413	-679
	[-571,-546]	[-486,-461]	[-715,-638]	[-529,-298]	[-1728,371]
Constant	1136	1134	1471	1037	1430
%	0.508	0.582	0.54	0.602	0.525
N	253784	253784	61244	8370	1769
Mood	-241	-242	-354	-188	-168
	[-251,-231]	[-251,-233]	[-379,-328]	[-241,-135]	[-558,221]
Constant	1136	1136	1473	1049	1414
%	0.787	0.787	0.76	0.821	0.881
N	265022	265022	64328	9737	2093
Anxiety	-225	-206	-263	-167	-340
	[-238,-211]	[-219,-193]	[-299,-227]	[-219,-115]	[-640,-41]
Constant	1136	1135	1471	1042	1434
%	0.802	0.818	0.821	0.839	0.763
N	258234	258234	62478	8950	1939
Alcohol-related	-367	-389	-382	-284	-284
	[-381,-353]	[-403,-375]	[-462,-303]	[-329,-240]	[-1033,464]
Constant	1137	1139	1476	1037	1423
%	0.678	0.659	0.741	0.726	0.8
N	263020	263020	61748	9606	1798

Notes: The average marginal effects of psychiatric admission on taxable income (in €1000) in 2017 prices. For further information on the econometric specification see Table 3.

Table S3: Psychiatric admission history and the deficit in total employment years

Sample	Main sample		HS	Sibling	Twin
	(1)	(2)	(3)	(4)	(5)
Any disorder	-8.08	-7.671	-6.103	-6.963	-4.936
	[-8.194,-7.966]	[-7.77,-7.571]	[-6.297,-5.909]	[-7.271,-6.656]	[-6.068,-3.805]
Constant	32.492	32.419	31.51	31.473	31.239
%	0.751	0.763	0.806	0.779	0.842
N	301658	301658	71331	14653	2867
Psychotic	-16.584	-14.949	-14.117	-13.604	-10.587
	[-16.909,-16.259]	[-15.271,-14.627]	[-14.768,-13.465]	[-15.346,-11.862]	[-16.971,-4.203]
Constant	32.492	32.452	31.428	31.349	31.036
%	0.49	0.539	0.551	0.566	0.659
N	253784	253784	61244	8370	1769
Mood	-5.448	-6.114	-5.206	-5.353	-3.71
	[-5.62,-5.275]	[-6.268,-5.96]	[-5.479,-4.934]	[-6.062,-4.644]	[-5.929,-1.492]
Constant	32.492	32.536	31.531	31.696	31.241
%	0.832	0.812	0.835	0.831	0.881
N	265022	265022	64328	9737	2093
Anxiety	-4.799	-5.227	-3.985	-5.077	-3.389
	[-5.035,-4.563]	[-5.437,-5.017]	[-4.347,-3.623]	[-6.093,-4.061]	[-6.562,-0.217]
Constant	32.492	32.509	31.49	31.658	31.262
%	0.852	0.839	0.873	0.84	0.892
N	258234	258234	62478	8950	1939
Alcohol-related	-9.409	-7.732	-5.384	-7.575	-5.76
	[-9.588,-9.231]	[-7.889,-7.575]	[-5.763,-5.005]	[-8.333,-6.817]	[-10.886,-0.633]
Constant	32.532	32.402	32.422	31.413	31.413
%	0.711	0.762	0.829	0.757	0.814
N	263020	263020	61748	9606	1798

Notes: The average marginal effects of psychiatric admission on total employment years (in €1000) in 2017 prices. For further information on the econometric specification see Table 3.

Table S4: Age of first admission and the deficit in lifetime taxable income (in €1000)

Sample		Main sample		HS	Sibling	Twin
		(1)	(2)	(3)	(4)	(5)
Any mental disorder	Admitted	-357.6	-336.6	-438.3	-263.6	-195.5
		[-364.9,-350.4]	[-343.6,-329.5]	[-460.6,-415.9]	[-282.2,-245.1]	[-292.3,-98.6]
	Admitted*age	13.9	8.9	13	9	10.3
		[13.4,14.5]	[8.3,9.4]	[11.1,15]	[7.1,11]	[-3,23.6]
	Constant	1135.5	1111	1837.3	1145.6	975.1
		[1130.9,1140.1]	[1096.3,1125.6]	[1785.9,1888.6]	[1032,1259.2]	[900.2,1050]
	N	301658	301658	71331	14653	539
	R^2	0.017	0.120	0.122	0.650	0.702
Psychotic disorder	Admitted	-473.8	-423.3	-610.2	-353.9	-290.3
		[-489.7,-457.8]	[-438.7,-407.9]	[-655.4,-565]	[-481.6,-226.2]	[-629.1,48.5]
	Admitted*age	11.6	7.1	10.8	9.1	-2.7
		[10.5,12.7]	[6,8.2]	[7.3,14.3]	[-1.1,19.2]	[-42.4,37]
	Constant	1135.5	1114.8	1849.9	1205.4	993.5
		[1130.9,1140.1]	[1098.4,1131.2]	[1794.5,1905.2]	[941,1469.7]	[928.3,1058.7]
	N	253784	253784	61244	8370	305
	R^2	0.006	0.113	0.121	0.868	0.973
Mood disorder	Admitted	-305.4	-279.1	-415.7	-232.2	-185.2
		[-315.3,-295.6]	[-288.4,-269.9]	[-442.6,-388.9]	[-291.2,-173.1]	[-356.9,-13.6]
	Admitted*age	11.8	7.2	9.9	9.9	10.9
		[11,12.6]	[6.5,8]	[7.6,12.2]	[3.6,16.1]	[-6,27.7]
	Constant	1135.5	1115.6	1849.7	1263.4	979.8
		[1130.9,1140.1]	[1099.8,1131.5]	[1796.5,1903]	[1087.2,1439.7]	[919.8,1039.8]
	N	265022	265022	64328	9737	346
	R^2	0.004	0.111	0.121	0.778	0.913
Anxiety disorder	Admitted	-249.9	-227.5	-308.1	-192.6	-125.3
		[-264.9,-234.9]	[-241.7,-213.4]	[-355,-261.2]	[-246.4,-138.8]	[-352.7,102]
	Admitted*age	8.8	7.1	8.9	8.5	-2.5
		[7.7,9.9]	[6,8.1]	[5.3,12.5]	[3.8,13.2]	[-21.1,16.1]
	Constant	1135.5	1115.4	1857.3	1207.6	966
		[1130.9,1140.1]	[1099.2,1131.6]	[1802.9,1911.7]	[980.7,1434.4]	[903.3,1028.7]
	N	258234	258234	62478	8950	331
	R^2	0.002	0.110	0.119	0.885	0.940
Alcohol-related admission	Admitted	-405.8	-407.4	-455.2	-315.2	-366.4
		[-418.3,-393.2]	[-420,-394.7]	[-509.7,-400.7]	[-359.3,-271.1]	[-735.7,2.9]
	Admitted*age	14.1	6.7	13.6	7.5	32.3
		[12.9,15.3]	[5.6,7.9]	[6.8,20.4]	[3.4,11.5]	[-44.5,109.2]
	Constant	1137.3	1120.9	1863.1	1145.4	991.2
		[1132.6,1141.9]	[1104.6,1137.2]	[1805.8,1920.4]	[976.8,1314]	[804.3,1178.1]
	N	263020	263020	61748	9606	343
	R^2	0.007	0.113	0.117	0.842	0.755

Notes: OLS estimates for the effect of psychiatric admission with interaction the age of the first admission (centered at age 40) on lifetime taxable income with 95% confidence intervals. For further information on the econometric specification see Table 4.

Table S5: Age of first admission and the deficit in lifetime employment years

Sample		Main sample		HS	Sibling	Twin
		(1)	(2)	(3)	(4)	(5)
Any mental disorder	Admitted	-9.22	-8.42	-7.29	-7.71	-8.41
		[-9.33,-9.11]	[-8.53,-8.32]	[-7.51,-7.06]	[-8.03,-7.39]	[-10.08,-6.74]
	Admitted*age	0.43	0.27	0.26	0.27	0.35
		[0.42,0.44]	[0.26,0.28]	[0.24,0.27]	[0.23,0.3]	[0.17,0.54]
	Constant	32.49	31.58	31.73	31.15	32.14
		[32.45,32.54]	[31.45,31.71]	[31.45,32]	[28.17,34.13]	[31.06,33.22]
	N	301658	301658	71331	14653	539
	R^2	0.102	0.488	0.568	0.736	0.759
Psychotic disorder	Admitted	-13.37	-12.88	-12.65	-11.4	-15.21
		[-13.73,-13.01]	[-13.23,-12.53]	[-13.32,-11.97]	[-13.32,-9.49]	[-26.41,-4.01]
	Admitted*age	0.43	0.28	0.24	0.30	0.42
		[0.4,0.45]	[0.26,0.31]	[0.18,0.29]	[0.14,0.46]	[-0.88,1.72]
	Constant	32.49	31.86	31.76	33.18	32.85
		[32.45,32.54]	[31.72,32]	[31.48,32.04]	[26.59,39.78]	[30.45,35.25]
	N	253784	253784	61244	8370	305
	R^2	0.051	0.511	0.613	0.917	0.943
Mood disorder	Admitted	-7.51	-7.39	-6.32	-6.53	-7.54
		[-7.71,-7.3]	[-7.57,-7.2]	[-6.7,-5.94]	[-7.36,-5.7]	[-12.18,-2.9]
	Admitted*age	0.37	0.23	0.17	0.24	0.39
		[0.35,0.39]	[0.22,0.25]	[0.14,0.21]	[0.17,0.32]	[-0.12,0.91]
	Constant	32.49	31.81	31.81	33.66	32.28
		[32.45,32.54]	[31.68,31.95]	[31.54,32.08]	[28.68,38.64]	[30.79,33.77]
	N	265022	265022	64328	9737	346
	R^2	0.022	0.490	0.593	0.857	0.897
Anxiety disorder	Admitted	-5.75	-5.85	-4.88	-5.79	-3.37
		[-6,-5.51]	[-6.07,-5.63]	[-5.32,-4.45]	[-6.86,-4.72]	[-9.72,2.98]
	Admitted*age	0.32	0.21	0.17	0.21	0.00
		[0.3,0.34]	[0.2,0.23]	[0.14,0.21]	[0.11,0.3]	[-0.62,0.61]
	Constant	32.49	31.81	31.87	33.41	32.12
		[32.45,32.54]	[31.68,31.95]	[31.6,32.14]	[27.79,39.03]	[30.61,33.63]
	N	258234	258234	62478	8950	331
	R^2	0.013	0.492	0.600	0.891	0.924
Alcohol-related admission	Admitted	-10.38	-8.17	-6.03	-8.25	-10.54
		[-10.56,-10.21]	[-8.34,-8.01]	[-6.47,-5.59]	[-9.04,-7.45]	[-15.37,-5.71]
	Admitted*age	0.34	0.14	0.12	0.19	0.40
		[0.33,0.36]	[0.12,0.15]	[0.08,0.15]	[0.11,0.27]	[-0.16,0.95]
	Constant	32.53	31.84	31.82	32	32.32
		[32.49,32.58]	[31.71,31.98]	[31.55,32.09]	[27.66,36.33]	[30.97,33.66]
	N	263020	263020	61748	9606	343
	R^2	0.048	0.503	0.610	0.868	0.906

Notes: OLS estimates for the effect of psychiatric admission with interaction the age of the first admission (centered at age 40) and lifetime employment years. For further information on the econometric specification see Table 4.

Table S6: "Healthy sibling" effect on lifetime labor market performance by affected sibling's diagnosis

Outcome	Any disorder		Psychosis		Mood		Anxiety		Alcoho-related	
	BL	Full	BL	Full	BL	Full	BL	Full	BL	Full
Lifetime earnings (%)										
'Healthy' sibling	0.924	0.948	0.894	0.951	0.979	0.983	0.959	0.971	0.882	0.916
95 %CI	[0.909,0.939]	[0.934,0.962]	[0.856,0.933]	[0.916,0.985]	[0.955,1.003]	[0.962,1.005]	[0.931,0.986]	[0.946,0.996]	[0.856,0.907]	[0.894,0.939]
P	<0.001	<0.001	<0.001	0.005	0.085	0.13	0.004	0.024	<0.001	<0.001
N	128032	128032	109264	109264	124053	124053	118936	118936	115271	115271
'Healthy' twin	0.953	0.945	0.774	0.787	1.014	1.000	0.99	0.975	0.993	0.949
95 %CI	[0.883,1.024]	[0.883,1.006]	[0.614,0.934]	[0.64,0.933]	[0.909,1.12]	[0.908,1.093]	[0.869,1.11]	[0.869,1.081]	[0.868,1.119]	[0.83,1.068]
P	0.227	0.099	0.006	0.005	0.797	0.999	0.868	0.651	0.92	0.416
N	3054	3054	2556	2556	2956	2956	2847	2847	2734	2734
Lifetime taxable income (%)										
'Healthy' sibling	0.925	0.951	0.911	0.964	0.978	0.984	0.952	0.966	0.868	0.908
95 %CI	[0.91,0.94]	[0.938,0.965]	[0.876,0.946]	[0.934,0.995]	[0.955,1.002]	[0.963,1.006]	[0.928,0.976]	[0.945,0.987]	[0.845,0.89]	[0.888,0.927]
P	<0.001	<0.001	<0.001	0.022	0.072	0.157	<0.001	0.002	<0.001	<0.001
N	128032	128032	109264	109264	124053	124053	118936	118936	115271	115271
'Healthy' twin	0.93	0.927	0.802	0.778	0.98	0.96	1.016	1.011	0.983	0.956
95 %CI	[0.869,0.992]	[0.876,0.979]	[0.693,0.912]	[0.668,0.889]	[0.9,1.06]	[0.889,1.03]	[0.888,1.145]	[0.904,1.118]	[0.861,1.105]	[0.852,1.059]
P	0.041	0.011	<0.001	<0.001	0.635	0.287	0.805	0.843	0.795	0.413
N	3054	3054	2556	2556	2956	2956	2847	2847	2734	2734
Total employment years										
'Healthy' sibling	0.967	0.98	0.953	0.973	0.99	0.99	0.985	0.993	0.948	0.973
95 %CI	[0.959,0.976]	[0.974,0.987]	[0.932,0.974]	[0.958,0.988]	[0.978,1.003]	[0.981,0.999]	[0.97,1.001]	[0.981,1.004]	[0.934,0.962]	[0.963,0.984]
P	<0.001	<0.001	<0.001	<0.001	0.139	0.037	0.073	0.228	<0.001	<0.001
N	128032	128032	109264	109264	124053	124053	118936	118936	115271	115271
'Healthy' twin	1.013	1.017	0.993	0.973	1.044	1.025	1.015	1.012	1.023	1.017
95 %CI	[0.973,1.054]	[0.988,1.047]	[0.902,1.084]	[0.891,1.055]	[0.992,1.097]	[0.982,1.068]	[0.946,1.084]	[0.967,1.058]	[0.951,1.095]	[0.962,1.071]
P	0.539	0.28	0.879	0.526	0.109	0.261	0.68	0.605	0.533	0.558
N	3054	3054	2556	2556	2956	2956	2847	2847	2734	2734

Notes:Point estimates (with 95 % confidence intervals) refer to relative lifetime labor market performance of healthy individuals who have a sibling with psychiatric admission history vs. healthy individuals with healthy siblings. The point estimates stem from a specification that include no control variables (BL) and the full set of background characteristics: sex, birth year, subregion 1970 fixed effects, relative household earnings (parents), the urban status of residence and total years in follow-up (Full). 95 % confidence intervals and p-value are reported below the healthy sibling (twin) coefficient.

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