

# Testing the human capital model of education: Do universities shape their students' character traits?\*

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## **Abstract**

Do universities teach soft skills that society values highly? Testing the human capital model of education, we investigate whether university education shapes students' character traits such as being conscientious, open-minded, emotionally stable, or agreeable. We follow the human capital decisions and the evolution of skills of an Australian birth cohort from adolescence into young adulthood. To control for the personality-related selection into tertiary education, we utilize both fixed effects and coarsened exact matching methods. University education does not shape those character traits associated with a strong work ethic, intellect, and creativity. Yet, we find robust evidence that university education offsets a general decline in outward orientation as individuals age and enhances levels of agreeableness for men from disadvantaged backgrounds. We contribute to a recent discussion on the added value of university education to society and the skill mix that universities should teach.

**JEL classification:** H52, I12, J24.

**Keywords:** University education, personality traits, psychic cost, change in personality, public provision of education.

## 1 Introduction

Universities have come under pressure regarding the skills they teach their students. The skill-sets that make workers productive in the digital age arguably have changed from the skills that companies sought in the pre-globalization era. Journalists Laura Pappano and Thomas L. Friedman suggested that universities should teach their students creativity ("Learning to Think Outside the Box", NYT, 5 Feb 2014), humility, leadership, and the ability to learn on the fly ("How to Get a Job at Google", NYT, 22 Feb 2014). Redefining the skill set that should be taught at university may also result in a re-think of how to recruit talent. Psychologist Adam Grant recently challenged the US college admission system by arguing that colleges should recruit creative students who have strong character traits and emotional skills rather than focussing exclusively on grade-point averages ("Throw Out the College Application System", NYT, 4 Oct 2014). Governments make relatively large contributions to finance university education: subsidies to core teaching activities vary between less than 0.8% of GDP in Australia and over 2% of GDP in the United States (OECD 2013). It is therefore justified to ask whether universities provide the skills a modern economy needs as suggested by the human capital model of education (Mincer 1958; Schultz 1961).

In this study, we seek to contribute to this discussion from the perspective of the Australian tertiary education sector, which is similarly structured to the US tertiary education sector.<sup>1</sup> We ask whether the Australian university sector teaches their students soft skills, character traits which not only society-at-large values (e.g. dependability, kindness, emotional stability), but also traits that have widely been associated with high productivity and good health (see Almlund et al.

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<sup>1</sup>Both sectors select students, among others, on the basis of a standardized high-school entry exam - Australia uses the so-called ATARs (Australian Tertiary Admission Rank), the US uses the so-called SATs (Standardized Assessment Tests) - and each government spends 1.4% and 1.2%, respectively, of the country's GDP on tertiary education.

2011, for an overview).

To identify the effect of university education on the dynamics in character traits is however difficult because individuals with specific character traits are more likely to self-select into the university track. Human capital accumulation, often measured in terms of years of education, has been shown to correlate strongly with a trait called conscientiousness in a German sample of individuals aged 21 to 94 (Almlund et al. 2011). Lundberg (2013a,b) demonstrated for a young US American cohort that, some character traits - especially openness to experience which is associated with creativity - are almost equally predictive of college graduation than cognitive ability (Lundberg 2013a, p. 436).

Figure 1 stylizes the complex relationship between skills, self-selection, and human capital accumulation. When adolescents face the choice of continuing their education, this choice is likely to depend on the individual's ability to finance further studies and her parental encouragement to do so (parental socioeconomic status). The decision will also depend on the individual's cognitive abilities (e.g. achievement tests) and on motivation and openness to learning, which we call here soft skills. Finally, peer groups to which the student is exposed to and the quality of the high school where the student graduated from will also play an important role in the decision to go to university.

In this stylized model, university education will build students' subject-specific skills, which we refer to as hard skills. University education also builds soft skills, dependability, ethical standards, or openness to new ideas. This skill-building effect is consistent with the human capital model of education (Mincer 1958; Schultz 1961).<sup>2</sup> In the short-run, university education may also

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<sup>2</sup>Signalling models would deny such skill-building effect of universities. They would explain the observed effect of university education on wages by signalling: a university degree signals to the employer that the student has inherent abilities (Arrow 1973; Spence 1973; Stiglitz 1975; Weiss 1995).

have a negative effect on the psychic health of the student (e.g. Heckman et al. 2006), if the program of study is very challenging. At the moment we refrain from explaining the mechanisms how universities transform and build hard and soft skills, but we will be more explicit about this process in the next section. What is important here is that both hard and soft skill in combination with the student’s psychic health are valued in the labour market and therefore will have an effect on the student’s employment potential. In the long-run, these skills will affect lifetime earnings, wealth, and health.

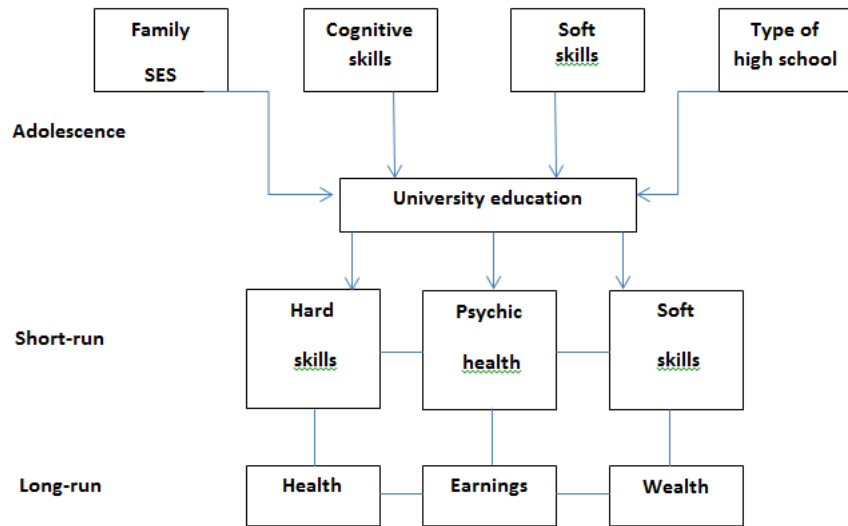


Figure 1: The human capital model of university education: self-selection by, and production of hard and soft skills

Our stylized model emphasizes that controlling for the selection effect into university education by socioeconomic status, ability, and character traits is the prime challenge to identify the causal effect of university education on the dynamics of soft skills.

To test the human capital model of university education, we will follow the human capital decisions of a cohort of 15 to 19 year-old Australians over eight years. Using data from a nationally-representative longitudinal survey - the Household, Income, Labour Dynamics of

Australia (HILDA) Survey - we measure character traits - which we will proxy with the Big Five personality traits - of these adolescents in 2005, before they potentially enter university and re-assess their traits in 2009 and 2013. Our analysis relies on the assumption that personality traits are still malleable in young adulthood and can noticeably change over an eight-year window.<sup>3</sup> One particular advantage of HILDA is that it has collected the same personality data over three waves - 2005, 2009, and 2013 - which makes it currently the only nationally-representative data set world-wide to do so.<sup>4</sup>

This unique data feature allows us to deal with the above outlined confounding factors. On the one hand, we apply fixed-effects models to control for individual-specific unobserved heterogeneity that may correlate with personality and the decision to go to university. In our case, this individual-specific effect is likely to capture all accumulated human capital including unobserved motivation and the quality of the school the students attended. On the other hand, we use coarsened exact matching (CEM), a relatively new method that uses the discretisation of the data to perfectly match individuals in the treatment group with individuals in the control group, to better control for differences in initial personality traits. Changes in character traits are less likely for individuals who start out already at very high levels of e.g. conscientiousness or openness to experience. CEM has the advantage that it requires even fewer modelling assumptions than e.g. propensity score matching and it does not risk to worsen the balance of some covariates be-

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<sup>3</sup>Personality traits measured by the Five Factor Model, sometimes referred to the Big-Five, have been shown to be relatively stable in adulthood over a four-year window, however Cobb-Clark and Schurer (2012) and Specht et al. (2011) show that the younger age-groups appear to exhibit the largest changes in both the Australian and German data, respectively.

<sup>4</sup>To the best of our knowledge there is only one study which collected the Big-Five personality data over three time periods, the (Finnish) Jyvaeskylae Longitudinal Study of Personality and Social Development (JYLS), which began in 1968. The sample size of this study is 369 individuals and it is not nationally representative. Another exception is the German Socio-Economic Panel which collected the Big-Five personality instrument for their youth sample (roughly 300 individuals) in every year between 2006 and 2012.

tween treatment and control groups when widening the search criteria to increase the number of matched twins, which often happens with nearest-neighbour matching (Ho et al. 2007; Iacus et al. 2011b). This method has been used successfully in the applied health and education economics literature (e.g. Jones et al. 2011; Schurer et al. 2015). Finally, to understand better the potential psychological and social barriers to university education, we conduct the analysis separately for men and women and by socioeconomic background.

Similar to Lundberg (2013a), we find strong selection effects into university. Adolescents who score high on ratings of conscientiousness and perceptions of mastery (locus of control), and low on ratings in extraversion between the ages of 15 to 19 have a higher probability to graduate from university by ages 23 to 27, over and above the influence of cognitive ability and parental socioeconomic background. Conditioning on this selection effect by personality, we find no evidence that universities shape their students' conscientiousness, a proxy for work ethic, and openness to experience, a proxy of being cultured and creative, or that university education entails long-term psychic costs. However, university education offsets a general decline in extraversion as individuals age and increases scores on agreeableness for male students from low socioeconomic backgrounds.

Our results are important in two ways: On the one hand, Australian universities do not contribute to the training of broader skills that society values at large, at least not on average. Given the very high private returns of a university degree - for Australia this is estimated to be a US\$120,000 net increase in lifetime earnings (OECD 2012) - these results may open a debate on what outputs and outcomes publicly-funded tertiary education aims to achieve other than lifting students into higher-paid jobs. On the other hand, our robust finding of a buffering effect of university education on extraversion - a personal disposition to be outward oriented and so-

ciable - emphasizes that the tertiary education sector may play a role in shaping character traits of young adults, a conclusion also drawn in Dahmann and Anger (2014) for the secondary education system. This conclusion may result in the possibility for complementing early childhood interventions that focus on pre-school children (e.g. Dee and West 2008; Heckman et al. 2013) with personality-boosting interventions in the secondary and tertiary education sector.

## **2 University education, human capital, and personality**

The high private returns of university education have been demonstrated repeatedly in the social sciences. Across all OECD countries, individuals with completed tertiary education earn, on average, 55% more than individuals who did not obtain such a qualification. The premium on tertiary education has increased by 10 percentage points in the OECD in the last ten years. Almost one-third of the OECD population completed university education in 2012 (OECD 2012).

There is variation across countries on both the private returns to education and the proportion of each cohort who get some form of tertiary education. In more upwardly-mobile countries such as Australia (Leigh 2007), almost 35% of working-age men, and over 40% of working-age women obtained a tertiary qualification in 2012 (OECD 2012).<sup>5</sup> Australia's higher level of tertiary education participation rates, despite high tuition fees, can be explained by the availability of Government-funded loans and subsidies to relieve the costs of university education since the late 1980s,<sup>6</sup> and by the particularly high private returns of a university degree in the magnitude of a US\$120,000 net increase in lifetime earnings (OECD 2012).<sup>7</sup> Its high private returns make

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<sup>5</sup>The average is higher for younger cohorts (25-34 year old: 45%), and lower for older cohorts (55-64 year old: 30%).

<sup>6</sup>These are the Higher Education Loan Programme (HELP) and the Higher Education Contribution Scheme (HECS). Some students are directly funded by the Commonwealth Government through subsidies and means-tests support programmes such as Youth Allowance and Ausstudy Payment.

<sup>7</sup>This calculation is based on 2008 data. Similar figures are presented in Borland (2002) for the scenario of a 4%



university education a classic investment good for individuals (e.g. Freeman 1999).

There are more than just economic benefits of university education. High levels of skills usually grant access to jobs that are more interesting, require continuous learning, and are less physically straining over the life cycle.<sup>8</sup> Job satisfaction and autonomy is higher for employees who work in occupations that require university qualifications. Finally, students operate in an environment where thinking deeply is considered a virtue, where one can broaden one's own cultural interests at low cost, and have a lot of fun. Higher education has therefore also the characteristics of a consumption good.

Yet, if higher education brings along all these advantages, why are not more people going to university? A potential explanation is that fighting your way through a degree is associated with high psychic cost (See Heckman et al. 2006, for arguments in favour of this hypothesis). Even with high levels of cognitive ability, studying and sitting exams, dealing with failure and constant deadlines is hard. Going to university requires a strong academic mind-set and intellectual engagement, and a sincere enjoyment of challenge. Conley (2003, 2005) has devised a model on college readiness, which stresses the importance of "tools" or "habits of mind" (p. 39). The tools comprise various skills and aptitudes, such as

"...critical thinking, analytic thinking and problem solving; an inquisitive nature and interest in taking advantage of what a research university has to offer; willingness to accept critical feedback and to adjust based on such feedback; openness to possible failures from time to time; and the ability and desire to cope with frustrating and

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discount rate and in Daly et al. (2010) for different bachelor degrees. Overall, the private rate of return in Australia lies somewhere in-between 20% pre-HECS and up to 15% post-HECS (Borland 2002; Daly et al. 2010; Leigh 2008).

<sup>8</sup>Differences in levels of physical pain between university graduates and individuals with minimum education peak dramatically before retirement age (Schurer et al. 2014).

ambiguous learning tasks" (Conley 2003, p. 8).

Of course, not all universities provide such stimulating environments, but Conley's idea of college readiness makes clear that the choice to go to university will be highly selective, not only on cognitive but especially on non-cognitive abilities.

Notwithstanding the arguments of important selection effects into university education, working one's way through a university degree is a treatment in itself. At high-quality universities academic staff expect and demand a high level of intellectual engagement from students, such as inquisitiveness, engagement with intellectual problems, and enjoyment in solving puzzles, the delivery of assignments on time, honesty, and the ability to manage scarce time resources. Going through such a treatment for three to five years is likely to shape an individual's personality. Going through university does not only require the ability to pursue long-term goals and persistence, but also practices these traits through everyday routines.

Such a treatment-effect hypothesis would be predicted by the human capital model of education (Mincer 1958; Schultz 1961), which states that education should teach students knowledge and skills that are highly valued by employers or by society at large. Students who underwent a degree should not only have acquired subject-specific knowledge, but also broader skills such as learning how to think for oneself, working on tight deadlines, being independent, and being more interested in a wide range of topics. This hypothesis is in stark contrast to the screening/signalling theory of university education (Arrow 1973; Spence 1973; Stiglitz 1975; Weiss 1995) which claims that university education does not teach labor-market relevant skills, but functions as a screening device for employers to separate the more from the less productive individuals. The signalling theory of university education could be another explanation why not every member of a birth

cohort seeks university education: the added-value of the skills acquired at university may not outweigh the high opportunity costs of university education.

To the best of our knowledge, Lundberg (2013a) appears to be the only study to date which assesses the relationship between character traits, measured by the Five Factor Model, and the probability to complete a 2- or 4-year college degree for a representative sample of young US Americans.<sup>9</sup> She finds that individuals high on sociability skills and low on emotional stability are less likely to have finished a college degree, while individuals high on conscientiousness and agreeableness are more likely to do so. Most interestingly, individuals from low socioeconomic backgrounds increase their probability to graduate from college by being more open to experience (Lundberg 2013a).

A cross-sectional analysis of the relationship between university graduation and the Big-Five personality traits using a similar specification as in Lundberg (2013a) and nationally-representative data from Australia in the year 2013 confirms the high education returns to openness to experience, conscientiousness, and emotional stability and the penalties of extraversion. A one-standard-deviation increase in openness to experience is associated with a 6 percentage point or a 21% increase in the probability of having a university degree. What we cannot find is that these returns are particularly strong for people from disadvantaged backgrounds as measured by their father's occupation class score. In fact, the returns are higher for people from relatively advantaged backgrounds for all relevant personality traits. The educational penalties of extraversion are only found for men. For instance, a one-standard deviation increase in extraversion is associated with a 5 percentage point or 13% decrease in the probability of having attained a university

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<sup>9</sup>Strictly speaking, Almlund et al. (2011) also report statistics on the associations between the Big-Five personality traits and university education in Germany, but their article is an overview article of the economics of personality psychology, and the authors touch upon the issue only marginally. They find that university education is positively correlated with conscientiousness and negative with Neuroticism.

degree. Although not as large as the returns to cognitive ability, the effect of personality traits on university graduation are sizable.

Table 1: A logit model for having a university degree, showing marginal effects at the mean

	All	Men by SES		Women by SES	
		High	Low	High	Low
Cognitive abil. (std.)	0.16*** (0.00)	0.21*** (0.01)	0.10*** (0.01)	0.17*** (0.01)	0.10*** (0.01)
Extraversion (std.)	-0.01*** (0.00)	-0.05*** (0.01)	-0.01** (0.01)	-0.02 (0.01)	-0.00 (0.01)
Agreeableness (std.)	-0.00 (0.00)	-0.01 (0.01)	-0.01 (0.01)	-0.02* (0.01)	0.00 (0.01)
Conscientiousn. (std.)	0.02*** (0.00)	0.04*** (0.01)	0.00 (0.01)	0.03*** (0.01)	0.01* (0.01)
Emotional stab. (std.)	0.02*** (0.00)	0.03** (0.01)	0.01* (0.01)	0.03*** (0.01)	0.01* (0.01)
Openness to exp. (std.)	0.06*** (0.00)	0.08*** (0.01)	0.05*** (0.01)	0.07*** (0.01)	0.04*** (0.01)
Base prob	0.28	0.38	0.17	0.43	0.19
Pseudo R <sup>2</sup>	0.18	0.18	0.19	0.13	0.13
Observations	11395	2210	2768	2606	3076

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors in parentheses.

*Note:* The Big-Five personality traits are measured in 2013, and each is standardized to mean 0, and standard deviation 1. Cognitive ability is measured as the average of three standard measures collected in 2012, and is also standardized to mean 0 and standard deviation 1. Further control variables are age, father's occupational class standardized to mean 0 and standard deviation 1, country of birth and non-major urban area. SES: High socioeconomic background is measured by father's occupational class score  $\geq 40$ , SES: Low socioeconomic background is measured by father's occupational class score  $< 40$ .

*Source:* HILDA, wave 13.

The direction of causality from Table 1 is ambiguous. These estimation results are obtained from regressing contemporaneous information of college graduation on contemporaneous measures of personality for a sample representative of all ages. We do not know whether the associations reflect a treatment effect of university education on personality or a selection effect into university by personality.

We are interested both in degree to which individuals self-select into university education by personality and, conditional on this self-selection effect, by how much universities shape this special form of human capital. To separate these two effects, we select in our subsequent analysis a sample of 15-19 year-old adolescents who have not (yet) entered university and follow them over an eight-year period. We measure their Big-Five personality traits before they potentially enter the university track in 2005, and then re-measure their personality in 2009 and 2013. This sample selection allows us to estimate the effects of adolescents personality on the probability of entering university, which we then interpret as measures of college readiness. Then we investigate whether for the sample members who went on to university experienced a change in personality between 2005 and 2013 (2009) that is significantly different from the change in personality traits of comparable young adults who did not go to university using OLS and fixed-effects models. We pay special attention to the problem that individuals who enter university score already very high on most personality traits, which makes future increases less likely. To control for differences in starting levels we use coarsened-exact-matching methods (Iacus et al. 2011a) that identifies a perfect statistical twin for the treatment group and then compares the outcomes of interest, on average, between these statistical twins.

### **3 Previous evidence on the variation of personality during young adulthood**

Personality matters in many ways in shaping individual lives. The "enduring patterns of thoughts, feelings, beliefs, and behaviors" (Roberts 2009, p. 140) that people engage in facilitate self-selection into occupations, educational attainment, healthy lifestyles, and risk-taking behavior. For economists, personality is a reflection of an alternative skill set (Almlund et al. 2011), and they may be distinct from economic preferences (Becker et al. 2012). The focus on skills brings personality into the

realm of economics, because they can be introduced as inputs into decision-making models in a similar way as cognitive ability or education.

A number of different personality inventories have been developed by psychologists, but the five-factor model is broadly accepted as a meaningful and consistent construct for describing human differences by psychologists (Goldberg 1992, 1993). The American Psychological Association Dictionary (2007) describes these as follows:

- **Openness to experience** (Intellect) - The tendency to be open to new aesthetic, cultural, or intellectual experiences.
- **Conscientiousness** - The tendency to be organized, responsible, and hardworking.
- **Extraversion** - An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience; characterized by positive affect and sociability.
- **Agreeableness** - The tendency to act in a cooperative, unselfish manner.
- **Neuroticism** (vs. Emotional stability) - A chronic level of emotional instability and proneness to psychological distress.

It has been shown widely that these Big-Five personality traits have value to employers. Personality traits have been linked with job performance (Judge 1999). Higher wages are generally associated with higher scores on the openness to experience scale (Heineck and Anger 2010; Mueller and Plug 2006)<sup>10</sup>, while higher scores on the agreeableness and neuroticism scale are associated with lower wages (Fletcher 2013; Heineck and Anger 2010; Mueller and Plug 2006; Nyhus

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<sup>10</sup>Note, the productivity gains of openness to experience reported in Heineck and Anger (2010) disappear when exploiting the longitudinal nature of their data.

and Pons Nyhus and Pons). Conscientiousness is often hailed as a super-trait to influence school performance and health behaviors (Roberts et al. 2007), it has been shown to boost wages at the start of young people's careers (Fletcher 2013; Nyhus and Pons Nyhus and Pons). Gensowski (2014) has shown that the impact of conscientiousness on wages is furthermore increasing with age and education, as is the positive role of extraversion.

The early work of psychologists argued that personality develops throughout adolescence and remains relatively stable from age 30 onwards (e.g. Costa and McCrae 1988; McCrae and Costa 1994). The fixed-personality hypothesis is more contested today, as some psychologists have shown that mean-level personality changes in samples may occur up until the age of 50 (e.g. Roberts et al. 2006).

It is now generally accepted in the psychology literature that individuals become more agreeable, more conscientious, and less neurotic, while transitioning from adolescence into adulthood, and these results hold across many cultures (Bleidorn et al. 2013). Evidence from twin samples shows that these intra-individual changes are particularly salient in age groups 17 to 24, but continue until the end of the 20s (Hopwood et al. 2011). Evidence from longitudinal survey data replicates these insights, stating that if at all, changes in personality occur most strongly before an individual reaches working age (Cobb-Clark and Schurer 2013, 2012; Specht et al. 2011).

Although the age-gradient in personality has been widely documented, little is known about the factors that change personality over the lifecourse. Some studies identified cohort differences in personality due to institutional differences in which adjacent cohorts grew up (e.g. Bianchi 2014; Cameron et al. 2013; Twenge 2000) or identified some of the childhood origins of adulthood personality (Fletcher and Schurer 2014), but these studies say nothing about the determinants of individual-specific changes over time and whether higher education can play a role in this

change.

To the best of our knowledge, the only contribution in this field is from a German study that exploits a high school reform that increased learning intensity to identify a causal impact of schooling on personality change (Dahmann and Anger 2014). The reform made individuals more extraverted and more neurotic, which the author's explained through the higher interaction requirements between students and teachers, and the higher degree of pressure in the curriculum.

## **4 Data**

To conduct our analysis, we use data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The first wave of the annual survey began in 2001 with 19,914 panel members from 7,682 households, with a top-up sample of 5,477 individuals from 2,153 households in the eleventh wave (Summerfield et al. 2013). It collects information on a wide range of household and individual characteristics, such as labor market dynamics, household income and formation, self-assessed well-being and other health-related outcomes, educational background, lifestyle and values, etc. Of particular interest to our analysis is a module on personality traits that was collected as part of the self-completion questionnaires in waves 5, 9 and 13 and the cognitive ability test scores available in wave 12, and therefore we restrict our analysis to nine wave between 2005 and 2013.

### **4.1 Estimation Sample**

The main change analysis is conducted with a sample of adolescents aged between 15 and 19 years in wave 5 (2005), when data on personality traits were first collected. In total, we have 560 teenagers for whom complete information on all variables is available for the analysis between



2005 and 2013. Out of these 560, 185 (33%) will either graduate from university or have entered university at some point in time before 2013,<sup>11</sup> but we observe a large degree of heterogeneity in university participation: Only 25% of adolescents from a disadvantaged background, as measured by the father's occupational prestige score, will enter the university track (N=255), while adolescents from an advantaged background are twice as likely to do so (N=305).

## 4.2 University participation or graduation

We derive the variable 'degree attainment' from a variable that describes the highest level of education achieved in any particular wave. An individual with university education has obtained either a bachelor or honors degree, a graduate diploma or graduate certificate, or a master or doctoral degree. We further identify individuals who have entered the university track after 2005, but may not have finished their degree by the time we observe them last in 2013. By 2013, 33% of the sample have entered the university track, while 23% have completed a degree.

## 4.3 Cognitive ability tests

An individual's cognitive skills are measured by three tests conducted in Wave 12 (2012): (1) the 'Backward digits span' test (BDS), (2) a 25-item version of the 'National American Reading Test' (NART) and (3) the 'Symbol-digit modalities' test (SDM). Details on the tests and how they were conducted are provided in Wooden (2013). The BDS measures working memory span and

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<sup>11</sup>In 2005, we have 1231 teenagers in the respective age-group 15-19. The majority of these teenagers, 858 or 70%, can be tracked and have completed an interview in 2013. The main reasons for dropping out of our sample are: (1) Sample member no longer living with household (N=97, 8.8%); (2) Refused to respond - other reason (N=90, 7.3%); (3) Household not issued to field due to persistent non-response (N=79, 6.4%); and (4) Refused - too busy (N=42, 3.4%). We conclude from these numbers that there is a heterogeneity of reasons why teenagers can no longer be tracked. Important for our analysis is that teenagers moving out of the house is not the main reason for dropping out of the sample. For these 97 teenagers it could be the case that they change their personality the most because they leave their parents home. In this case, we would under-estimate the effect of university education on personality change.

is a traditional sub-component of intelligence tests. The interviewer reads out a string of digits which the respondent has to repeat in reverse order. NART is a short version of the National Adult Reading Test that measures pre-morbid intelligence. Respondents are shown 25 irregularly spelled words which they have to read out loud and pronounce correctly. SDM was originally developed to detect cerebral dysfunction but it is now a recognized test for divided attention, visual scanning and motor speed. Respondents have to match symbols to numbers according to a printed key that is given to them. Participation rates were high (> 93% in each test) (Wooden 2013, p. 4).

We use the average of the three scores, after scaling each to be a percentage of the maximum observed score of all participants, as a summary measure of cognitive ability. This measure is standardized to mean 0 and standard deviation of 1.

#### **4.4 Personality and mental health measures**

The personality traits inventory administered in the self-completion questionnaire in waves 5, 9, and 13 of the HILDA Survey is based on the Big-Five Personality Inventory (Goldberg 1992). Of the 40-item Trait Descriptive Adjectives in Saucier (1994), 30 are included in the version used in the HILDA Survey, with an additional six from different sources. Respondents were asked to self-assess on a seven-point scale the degree to which each adjective describes them, with 1 indicating "not at all" and 7 indicating "very well". Of the 36 items, only 28 are used in the derivation of the five personality scales (Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Openness to Experience). Eight items are not used after testing for item reliability (e.g. an item was omitted if the highest factor loading was not on the expected factor). The distribution of most traits is left-skewed, which means that a larger proportion of the sample agrees with the

statements about their personality underlying each trait (See Cobb-Clark and Schurer 2012, for a detailed description). We standardize each measure to mean 0 and standard deviation of 1.

As previous studies have shown a strong association between internal locus of control and human capital investment decisions (e.g. Coleman and Deleire 2003), we control for internal locus of control in the educational attainment equations. A measure of locus of control is derived from seven available items from the Psychological Coping Resources component of the Mastery Module developed by Pearlin and Schooler (1978), which were collected in waves 3, 4, 7, and 11 in HILDA, but we use data from wave 4. Mastery refers to beliefs about the extent to which life's outcomes are under one's own control. Specifically, respondents were asked the extent to which they agree with seven statements describing their control attitudes. Possible responses range from 1 (strongly disagree) to 7 (strongly agree). We construct a continuous measure of internal locus of control using factor analysis (See Cobb-Clark and Schurer 2013; Cobb-Clark et al. 2014, for a description), which we standardize to mean 0 and standard deviation 1.

To assess the potential psychic cost of university education, we complement our change-in-personality analysis by assessing changes in mental health measured by the SF-36 mental health scale (Ware Jr 2000). For instance, if the psychic cost of university education are high and permanent, then mental health should decrease as much as emotional stability. The mental health measure is standardized to mean 0 and standard deviation of 1, where larger values correspond to better mental health.

#### **4.5 Other control variables**

Apart from the individual's age and gender, we control for father's occupation using the Australian Socioeconomic Index 2006 (AUSEI06) occupational status scale (McMillan et al. 2009)

which is derived from the Australian and New Zealand Standard Classification of Occupations (First Edition, 2006). The reference point for the classification is when the individual was aged 14. If the father was not in employment then, the classification would be based on any previous employment; if the father was deceased, then his occupation when he was alive was used. This measure is bound between 0 (lowest status) and 100 (highest status), and we standardize it to mean 0 and standard deviation of 1. Values of 80 and above indicate professional, managerial, and legislative occupations, while values of under 30 indicate elementary and manual occupations.

We also control for country of birth with three dummy variables indicating whether the individual was born in Australia, in a mainly English-speaking country (i.e. United Kingdom, New Zealand, Canada, USA, Ireland and South Africa), or in any other country. In addition, we include a binary variable to indicate whether the individual lived in a non-major urban area according to the Australian Standard Geographical Classification (2001). Summary statistics of all control variables are reported in Table A.1 in the Online Appendix.

## **5 Empirical strategy and estimation results**

### **5.1 Does personality predict who's going to university?**

We start our analysis by using logistic regression to model the probability of attaining a university degree by 2013. The base probability of having a university degree is 23%, 17% for men and 27% for women in 2013. The Big-Five personality traits are measured in wave 5 when the sample members were between 15-19 years of age and before they entered university. Further control variables are cognitive ability measured in wave 12, a continuous measure of internal locus of control measured in wave 4, being female, country of birth, and non-major urban area. The

dependent variable is whether the individual has completed a university degree by wave 13.

Conditioning on non-missing observations, the estimation sample is 477 individuals<sup>12</sup> (column 1), 218 men (column 2), 259 women (column 3), 230 individuals from advantaged backgrounds as measured by values of greater than 30 on the father's occupational class score (column 4), and 205 individuals from disadvantaged backgrounds (column 5).

Table 2: A logit model for attaining a university degree by 2013, showing marginal effects at mean

	(1) All	(2) Male	(3) Female	(4) High SES	(5) Low SES
Cognitive ability (std.)	0.11*** (0.02)	0.05** (0.02)	0.17*** (0.03)	0.15*** (0.03)	0.07*** (0.02)
Extraversion (std.)	-0.03 (0.02)	-0.06** (0.02)	-0.01 (0.03)	-0.04 (0.04)	-0.02 (0.02)
Agreeableness (std.)	0.02 (0.02)	-0.01 (0.02)	0.03 (0.03)	0.05 (0.03)	0.01 (0.02)
Conscientiousness (std.)	0.05*** (0.02)	0.05*** (0.02)	0.04 (0.03)	0.05 (0.03)	0.05*** (0.02)
Emotional stability (std.)	-0.02 (0.02)	0.01 (0.02)	-0.02 (0.03)	-0.04 (0.04)	0.01 (0.03)
Openness to experience (std.)	0.01 (0.02)	0.03 (0.02)	-0.01 (0.03)	-0.05 (0.03)	0.01 (0.03)
Locus of control (std)	0.05** (0.02)	0.04 (0.02)	0.08** (0.04)	0.10** (0.04)	-0.01 (0.02)
Base prob	0.23	0.17	0.27	0.32	0.15
Pseudo R <sup>2</sup>	0.14	0.16	0.17	0.12	0.15
Observations	477	218	259	230	205

*Note:* The sample includes individuals who were interviewed throughout waves 5 to 13, but excludes 83 individuals who entered but have not completed university yet from the control group. Personality is measured in wave 5, while university education is measured in wave 13.

*Source:* HILDA, waves 5 to 13.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors in parentheses.

In Table 2, column (1) we report the marginal probability effect for a one-standard deviation

<sup>12</sup>Note, we have dropped all 83 individuals who have entered but not yet completed the university track to make the control group cleaner. It is likely that individuals who have entered but not yet completed university education have similar personality traits as individuals who have completed their degree. Leaving them in the control group reduces the likelihood of identifying treatment effects of personality on university graduation.

change in personality or cognitive ability on the probability of having completed a degree by wave 13. We consider only wave 13 data on education to give our young sample members enough time to enter (and complete) university. Many students from disadvantaged backgrounds, for instance, enter university as mature students.

Conscientiousness and internal locus of control are the only traits which are associated with degree attainment for this young sample. A one-standard-deviation increase in each increases the probability of degree attainment by 5 p.p. or 22%. While this effect is the same across the sexes and SES for conscientiousness, it varies substantially for internal locus of control. A one-standard-deviation increase for women increases the probability of university graduation by 8 p.p. or 30%, and the returns are similarly high for young adults from high SES (10 p.p.).

Further, we still find a penalty of extraversion on university graduation but it is present only for men (-6 p.p.). Interestingly, youth openness to experience and emotional stability have no statistically-significant effect on the probability to obtain a university degree. These results are robust to considering the alternative dependent variable of having entered (or completed) the university track (extended sample of 580 individuals), which affects 33% of these young adults (Results are provided upon request). These effects are sizable as they capture between 50% and 100% of the effect of cognitive ability on university graduation.

## **6 The influence of university education on personality change**

We have shown so far that individuals high on conscientiousness, cognitive ability, and internal locus of control and low on extraversion are distinctly more likely to obtain a university degree. In this section we will investigate whether university education changes students' personality traits. To answer this question, we first investigate how much change in the Big-Five personality

traits we observe in our youth sample over an eight-year window (2005-2013) (Section 6.1) and then we test whether university education contributes significantly to this change (Section 6.2 and 6.3).

### **6.1 How much personality change do we observe in the sample?**

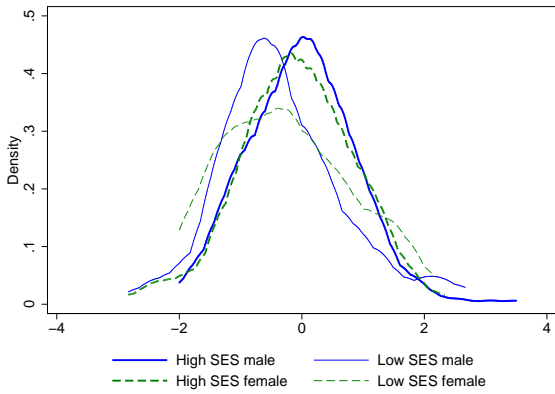
On average, young adults become more conscientious by almost 0.5 of a standard deviation (SD), more agreeable by 0.25 SD, and less extroverted by 0.14 SD (See Table A.1 in the Online Appendix).<sup>13</sup> All personality trait changes are almost (but not fully) centered around zero because some individuals increase while others decrease their personality scores over time which can be observed in Figures 2(a) to 2(e). On the vertical axis we report the changes in the personality traits on the original score. For instance, a negative change of 2 implies that the individuals reduced their score on average by 2 units on an index that ranges from 1 to 7. These figures demonstrate the almost normal distribution in changes for all of the Big-Five personality traits for the eight-year window. Important differences emerge across the sexes and social strata.

For some individuals the distribution is slightly shifted towards the left or right indicating a tendency to decrease or increase in the relevant personality trait. For instance, male adolescents from low socioeconomic backgrounds tend to become less emotionally stable, extraverted, and agreeable, and more open to experience, while men and women from high socioeconomic backgrounds tend to become more extraverted and more emotionally stable. Young women generally tend to become more agreeable and less open to experience, while young men tend to become slightly more open to experience independent from their socioeconomic backgrounds.

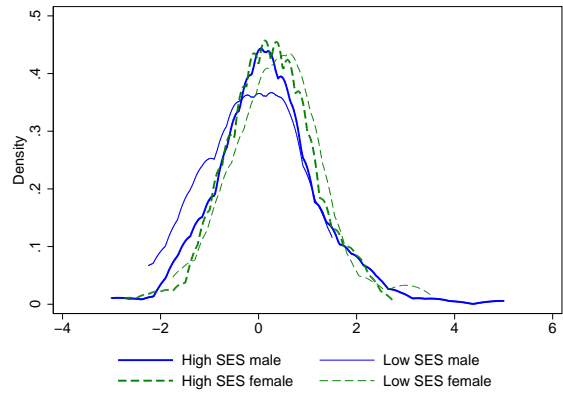
The distributional plots of personality change in Figure 2 do not tell us how many individuals

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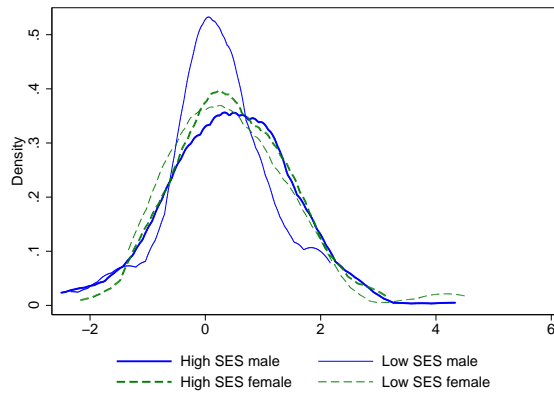
<sup>13</sup>When considering a four-year window, we observe on average a zero change for all of the Big-Five personality traits, a result that is also reported in Cobb-Clark and Schurer (2012).



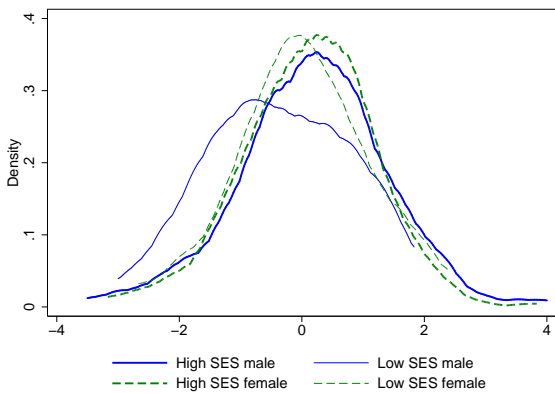
(a) Extraversion



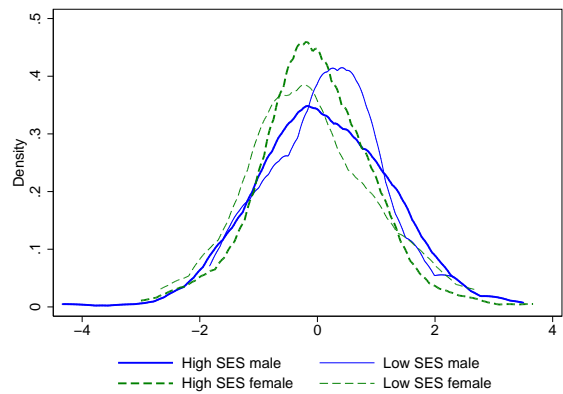
(b) Agreeableness



(c) Conscientiousness



(d) Emotional stability



(e) Openness to experience

Figure 2: Change in Big-Five personality scores between 2005 and 2013, by gender and socioeconomic background



change their personality scores in a statistically meaningful way, because the observed changes may be due to measurement error (Cobb-Clark and Schurer 2012). To understand better the proportion of teenagers who significantly increase or decrease in their self-reported personality domains, we calculate what is referred to in the psychology literature as the *Reliable Change Index* (RCI) (Jacobson and Truax 1991). It measures the proportion of individuals who decreased or increased their scores in a statistically-reliable way, taking into consideration the variation in personality observed in a "functional" population and the degree of noise in the measurement tool.<sup>14</sup> The RCI is calculated for each individual in the sample, and if the change between two time periods is greater than some cut-off value, then this change is deemed reliable. Personality changes that lie within two standard deviations within the mean personality score of the benchmark population are considered as unreliable or zero changes. Section A in the Online Appendix describes the construction of the RCI in detail.

Table 3 reports the RCI for each of the five personality traits for both medium- (2005-2009) and long-run (2005-2013) changes. Columns (1) and (4), (2) and (5), and (3) and (6) report the proportions of individuals who decrease, remain unchanged, and increase, respectively, in the respective personality domain in a statistically-reliable way. The majority of teenagers did not change their personality assessment over the eight-year time period. The most constant dimensions, in order of relevance, are extraversion (91% unchanged), openness to experience (89% unchanged), conscientiousness (81% unchanged), and emotional stability (80% unchanged). Agreeableness is the most malleable trait, for which more than 22% of the sample changed their self-reports. For some dimensions we find an asymmetry in the likelihood of experiencing increases relative to de-

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<sup>14</sup>This measure was initially devised to find a statistical criterion to assess the effectiveness of psychotherapy taking into consideration the variation of a particular state of mind in a normal, functional population and the reliability of the measurement tools a clinician has available to assess the state of mind of the patient.

creases. Almost seven times larger is the proportion of teenagers in our sample who become more conscientious than the proportion that become less conscientious (17% versus 2.5%). We find a similar asymmetry for agreeableness (15% versus 8%). For all other dimensions, there is roughly the same proportion of individuals that reduce and increase their personality scores. When considering a four-year window, we draw almost identical conclusions, with the exception that a larger proportion of teenagers did not change their personality scores in a reliable way.

Table 3: Reliable Change Index

	Medium-run changes 2005 to 2009			Long-run changes 2005 to 2013		
	Decrease	Unreliable	Increase	Decrease	Unreliable	Increase
Extroversion	3.77	93.02	3.22	5.66	90.74	3.60
Agreeableness	8.58	80.62	10.81	7.82	77.58	14.60
Conscientiousness	5.01	84.43	10.57	2.52	80.62	16.87
Emotional stability	7.90	83.14	8.96	9.24	80.06	10.70
Openness to experience	4.32	91.16	4.52	5.68	88.51	5.81

*Note:* The RCI controls for both the noise in the personality measurement and the potentially large spread in the general population score of personality. See definition of Reliable Change Index in Eq. (1).

*Source:* HILDA, Waves 5, 9, and 13.

We have shown that, even in young adulthood where individuals undergo a series of important life changes, personality is relatively stable over a long time period. Yet, personality is not fixed. The most malleable traits are agreeableness, conscientiousness and emotional stability, while the most fixed traits are extraversion and openness to experience. We will now turn to investigate whether university education, one of the most important environmental changes in a young adult's life, has explanatory power in explaining significant changes in personality scores.

## 6.2 Does university change personality?

To test whether university education shapes character traits we use both OLS and fixed effects regression models applied to our sample of 560 adolescents. In the raw data, individuals who will go on to university significantly differ from individuals who will go to university in terms of pre-treatment observable characteristics. Table 4 demonstrates that youth who will enter the university track are almost twice as likely to have a mother with 12 years of education and 15 percentage points more likely to have completed a vocational qualification. They are also more likely to live in major urban areas. There are no age or country of origins differences. They also score higher on agreeableness, conscientiousness, and openness to experience in the year 2005, but there are no differences for emotional stability or extraversion. These differences

The dependent variable is a measure of change in each of the Big-Five personality traits between 2005 and 2013 (or mental health, for comparison), standardized to mean 0 and standard deviation of 1. The main independent variable is an indicator of having entered the university track by 2013 for at least one year, which makes up 33% or 185 individuals of the estimation sample. To allow for heterogeneity in the university effect, we include in our estimation model a continuous measure of the father's occupation class and an interaction term between the dummy variable of university track and the father's occupational class. As we standardize the father's occupational class score to mean 0 and standard deviation 1, the coefficient on this interaction term is interpreted in terms of 1 SD increase away from the zero mean.<sup>15</sup> There may be important differences in the effects by socioeconomic status as university education changes the peer group for those from low socioeconomic background to a much higher extent than for those from high

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<sup>15</sup>The fixed effects models do not include an interaction term between university education and father's social class for the reason that we were not able to construct confidence intervals for this interaction term.

Table 4: Difference in means of relevant covariates before treatment and before matching (between youth who will go on to university and youth who will not)

	control	treatment	Diff	t-stat	p-value
Age	24.731	24.908	-0.177	-1.360	0.174
Edu mother < Yr 10	0.371	0.197	0.173	3.931	0.000
Edu mother Yr 11 or equiv	0.169	0.079	0.090	2.693	0.007
Edu mother Yr 12 or equiv	0.448	0.724	-0.276	-5.960	0.000
If mother completed qual.	0.595	0.758	-0.163	-3.548	0.000
Father OSS	45.974	59.748	-13.774	-6.081	0.000
COB: AUS	0.946	0.941	0.005	0.232	0.816
COB: Eng speaking	0.017	0.000	0.017	1.629	0.104
COB: Other	0.037	0.059	-0.022	-1.155	0.248
Major urban	0.650	0.797	-0.147	-3.384	0.001
Non-major urban	0.350	0.203	0.147	3.384	0.001
Extro 2005	4.721	4.570	0.150	1.573	0.116
Agree 2005	5.077	5.261	-0.184	-2.099	0.036
Consc 2005	4.458	4.745	-0.287	-3.062	0.002
Emoti 2005	4.810	4.930	-0.120	-1.213	0.225
Openn 2005	4.306	4.584	-0.278	-2.872	0.004

*Note:* Includes all respondents aged 15 to 19 in wave 5. Father's occupational class is defined via the Father's Occupational Prestige Score. A one-standard deviation increase in occupational prestige is 25 points on a scale from 0 to 100.

*Source:* HILDA, waves.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors in parentheses.

socioeconomic backgrounds. Further control variables are gender, age, and location.

The estimation results for the full sample are reported in Table 5. Having entered the university track is associated with an increase in extraversion by one-third of a standard deviation (0.34 SD, standard error 0.09) for the average teenager.<sup>16</sup> The interaction effect between university track and father's occupational class is not statistically significant (0.04 SD, standard error 0.09).

Teenagers whose fathers' score two standard deviations below the mean occupational class (centered at 0) report positive changes in agreeableness of 0.46 SD, while teenagers whose fathers' score two standard deviations above the mean occupational class report negative changes of -0.46

<sup>16</sup>The average adolescent is born into a family where the father's occupation class score is standardized to 0, or 49 on the original score that ranges from 4.9 to 100. Scores from 80 onward represent manual occupations of professionals, legislators, and managers. A score lower than 30 represent manual and elementary occupations.

SD.<sup>17</sup> A two-standard deviation increase or decrease in father's occupational class away from the mean implies that the father worked either in legislative/managerial or an elementary occupation, respectively.

University education is not significantly associated with changes in conscientiousness, openness to experience, emotional stability, or mental health.

When controlling for individual-specific, time-invariant heterogeneity, our conclusions about the treatment effects on extraversion and agreeableness do not change. The treatment effect of university education on changes in extraversion remain large and statistically significant in the first-difference estimation model. In this model without interaction terms between university education and father's socioeconomic class, the treatment effect of university education on extraversion is 0.19 SD (standard error 0.09, lower panel in Table 5).<sup>18</sup>

In the first-difference model, the heterogeneous treatment effect of university education on agreeableness is larger than in the OLS model. The estimated coefficient on university education is 0.31 (SE 0.17), and the estimated interaction effect between university education and father's social class is -0.01 (SE < 0.001). The differential path in the evolution of agreeableness between the socioeconomic classes stems from the observation that young men and women from low socioeconomic backgrounds increase their levels of agreeableness while young men and women from advantaged backgrounds keep their levels constant while attending university. Both start out with the same levels of agreeableness in 2005 in a statistical sense, but the average score is

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<sup>17</sup>The calculation is based on the estimated interaction term  $\text{Completing bachelor} \times \text{Father's occupational class (std.)}$ :  $0.00 \pm 2(\text{SD}) \times (-0.23)$ .

<sup>18</sup>Note, the estimated coefficient on university education on extraversion is the same (0.20 SD) in a first-difference model with an interaction term between university education and father's occupational class. However, the standard error has blown up to 0.19 and therefore the effect is no longer statistically significant. Since the interaction effect is not statistically significant, neither in the OLS nor in the first-difference model, we refrain from interpreting this interaction model.

higher for children from advantaged backgrounds (5.15 versus 5.28,  $p$ -value = 0.66). By 2013, their scores differ by roughly one-third of a standard deviation (5.70 versus 5.35,  $p$ -value = 0.14). One explanation that is consistent with the observed data is that children from disadvantaged backgrounds adopt more strongly the behavioral styles governing interpersonal relationships at university.

In the first-difference model, we now also find positive treatment effects of university education on both emotional stability and mental health, especially so for students from disadvantaged backgrounds. On average, students increase their emotional stability scores and their mental health by 0.4 SD and 6.7 points, respectively.

We explore further the possible heterogeneity in these treatment effects by sex using an OLS specification. The positive extraversion effects of university education are obtained for both male (0.39 SD, standard error 0.14) and female adolescents (0.30 SD, standard error 0.13) (See Table 6 panel 1 and 2, OLS results). The positive treatment effect of university participation on agreeableness on students from low socioeconomic backgrounds is driven by male sample members. Being at university increases the agreeableness score by almost 1 SD of male adolescents whose fathers worked in elementary occupations relative to the mean (2 SD below the mean). For male adolescents born into privilege, whose fathers worked in professional or managerial occupations (FOC > 2 SD below the mean) decreased their agreeableness scores by 0.73 SD relative to the mean.<sup>19</sup>

It may be possible that we miss out on some of the treatment effects of university participation because we consider only changes along a continuum of personality, whereas treatment effects

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<sup>19</sup>The calculation is based on the estimated interaction term  $\text{Comple}(ed/ing) \text{ bachelor} \times \text{Father occupational class (std.)}$ :  $0.13 \pm 2(\text{SD}) \times (-0.43)$ .

Table 5: Estimated effects of university participation on changes in the Big-Five personality traits and mental health: OLS and Fixed Effects models

	(1)	(2)	(3)	(4)	(5)	(6)
	Extro	Agree	Consc	Emoti	Openn	Mental
<b>Cross-sectional analysis of change (OLS) between 2005 and 2013 (N=560)</b>						
Comple(ed/ing) bachelor	0.34***	0.00	-0.09	0.03	0.01	0.13
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Father occup. class (FOC) (std.)	-0.02	0.09	-0.06	-0.07	-0.05	-0.09
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Comple(ed/ing) bachelor × FOC	0.04	-0.23**	0.01	-0.08	-0.01	-0.06
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)
R-squared	0.03	0.03	0.02	0.02	0.01	0.02
<b>Longitudinal analysis of change (first-difference estimator) between 2005 and 2013 (N=560, T=2)</b>						
<b>Without interaction term</b>						
Comple(ed/ing) bachelor	0.19**	-0.04	-0.13	-0.02	-0.04	2.13
	(0.08)	(0.09)	(0.09)	(0.10)	(0.09)	(1.62)
R-squared	0.02	0.07	0.18	0.01	0.00	0.01
<b>With interaction term</b>						
Comple(ed/ing) bachelor	0.20	0.31*	-0.15	0.38*	0.17	6.65**
	(0.19)	(0.17)	(0.18)	(0.20)	(0.20)	(3.16)
Bachelor × FOC	0.00	-0.01**	0.00	-0.01**	-0.00	-0.09*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)
R <sup>2</sup>	0.03	0.08	0.18	0.02	0.01	0.01

*Note:* Includes all respondents aged 15 to 19 in wave 5. Father’s occupational class is defined via the Father’s Occupational Prestige Score. A one-standard deviation increase in occupational prestige is 25 points on a scale from 0 to 100.

*Source:* HILDA, waves 5 and 13.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors in parentheses.

may matter at the extreme ends. Therefore, we re-estimated the benchmark model with a logit model in which the outcome is a binary indicator that takes the value 1 if the individual changed his or her personality score by more than 1 SD, and 0 otherwise. The upper panel of Table 7 reports the marginal probability effects of university participation on the probability of increasing the respective personality trait by more than 1 SD, calculated at the mean level of father’s occupational class.<sup>20</sup> Yet again, we confirm the treatment effect of university participation on the

<sup>20</sup>The same specification is used as in baseline OLS models, including an interaction effect between Comple(ed/ing) bachelor and father’s occupational class. Reported are the marginal probability effects for the interaction term is calculated at the mean of the father’s occupational class which is centered at 0. The marginal effects in the

Table 6: Estimated effects of university participation on changes in the Big-Five personality traits and mental health by gender and socioeconomic status (OLS estimates)

	(1)	(2)	(3)	(4)	(5)	(6)
	Extro	Agree	Consc	Emoti	Openn	Mental
<b>Male adolescents (N=248)</b>						
Completed(ing) bachelor	0.39*** (0.14)	0.13 (0.14)	0.03 (0.14)	0.19 (0.13)	0.02 (0.15)	0.19 (0.16)
Father's occup. class (FOC) (std.)	-0.02 (0.08)	0.10 (0.09)	-0.12 (0.09)	-0.09 (0.08)	-0.09 (0.08)	-0.04 (0.07)
Completed(ing) bachelor × FOC	0.01 (0.15)	-0.43*** (0.14)	-0.08 (0.14)	-0.09 (0.12)	0.02 (0.14)	-0.04 (0.14)
R <sup>2</sup>	0.03	0.05	0.02	0.05	0.03	0.02
<b>Female adolescents (N=312)</b>						
Completed(ing) bachelor	0.30** (0.13)	-0.09 (0.11)	-0.18 (0.12)	-0.07 (0.12)	-0.02 (0.13)	0.11 (0.11)
Father's occup. class (FOC) (std.)	-0.01 (0.08)	0.10 (0.09)	0.02 (0.08)	-0.05 (0.09)	0.00 (0.09)	-0.13 (0.09)
Completed(ing) bachelor × FOC	0.04 (0.12)	-0.15 (0.12)	0.01 (0.12)	-0.09 (0.12)	-0.06 (0.12)	-0.07 (0.11)
R <sup>2</sup>	0.04	0.02	0.01	0.02	0.00	0.02
<b>Low SES (&lt; mean score on father's occupational prestige index, N=255)</b>						
Completed(ing) bachelor	0.34** (0.15)	0.24* (0.13)	-0.17 (0.14)	-0.02 (0.13)	0.08 (0.14)	0.12 (0.13)
Father's occup. class (FOC) (std.)	-0.07 (0.08)	0.11 (0.08)	0.10 (0.07)	-0.06 (0.08)	-0.01 (0.08)	-0.02 (0.07)
Completed(ing) bachelor × FOC	0.23 (0.17)	-0.23* (0.13)	-0.14 (0.15)	0.16 (0.14)	-0.17 (0.14)	-0.05 (0.12)
R <sup>2</sup>	0.05	0.03	0.03	0.03	0.04	0.02
<b>High SES (High SES (≥ mean score on father's occupational prestige index, N=305)</b>						
Completed(ing) bachelor	0.33*** (0.12)	-0.19* (0.11)	-0.04 (0.12)	0.04 (0.12)	-0.03 (0.12)	0.12 (0.12)
Father's occup. class (FOC) (std.)	-0.11 (0.08)	-0.01 (0.08)	-0.09 (0.08)	0.04 (0.08)	-0.09 (0.09)	-0.03 (0.08)
Completed(ing) bachelor × FOC	0.10 (0.12)	-0.06 (0.11)	-0.03 (0.11)	-0.29** (0.11)	0.04 (0.12)	-0.14 (0.12)
R <sup>2</sup>	0.03	0.03	0.04	0.05	0.01	0.03

Note: Includes all respondents aged 15 to 19 in wave 5.

Source: HILDA, waves 5 and 13.

\* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01. Standard errors in parentheses.

probability of experiencing positive changes in extraversion of more than 1 SD. The marginal logit model with interaction terms are calculated following Karaca-Mandic et al. (2012).



probability effect is 7 percentage points, or, in terms of the base probability, a 39% increase.

In the lower panel of Table 7 we report the marginal probability effects of university participation to report changes in personality in the extreme left-tail of the distribution (negative changes greater than 1 SD). Teenagers in university education are less likely to decrease their extraversion scores by 13 percentage points (significant at 1% level), their agreeableness scores by 5 percentage points (significant at 10% level), and their mental health scores by 9 percentage points (significant at 1% level). As proportion of the base probability, these percentage-point probabilities imply a reduction in the probability by 50% (extraversion), 42% (agreeableness), and 64% (mental health), respectively.

Table 7: A logit for if Big-5 and mental health has increased (upper panel) or decreased (lower panel) by more than 1 SD between 2005 and 2013

	(1) Extro	(2) Agree	(3) Consc	(4) Emoti	(5) Openn	(6) Mental
<b>Probability to increase personality score by more than 1 SD</b>						
Comple(ed/ing) bachelor	0.07*	-0.05	-0.04	-0.03	-0.04	-0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
Base prob	0.18	0.22	0.31	0.23	0.19	0.15
Pseudo R <sup>2</sup>	0.01	0.02	0.01	0.03	0.03	0.03
<b>Probability to decrease personality score by more than 1 SD</b>						
Comple(ed/ing) bachelor	-0.13***	-0.05*	0.01	-0.03	0.00	-0.09***
	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Base prob	0.26	0.12	0.09	0.18	0.17	0.14
Pseudo R <sup>2</sup>	0.02	0.04	0.03	0.02	0.00	0.03
Observations	560	560	560	560	560	560

*Note:* Respondents aged 15 to 19 in wave 5. Marginal effects for treatment effect captures interaction with father's occupational class (evaluated at the mean value in the sample, 0) and is calculated following Karaca-Mandic et al. (2012).

*Source:* HILDA, wave 5 and 13.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors in parentheses.

The marginal probability effects of university education on the left-tail of the distribution are larger than the marginal probability effects on the right-tail of the distribution ( $p$ -value <

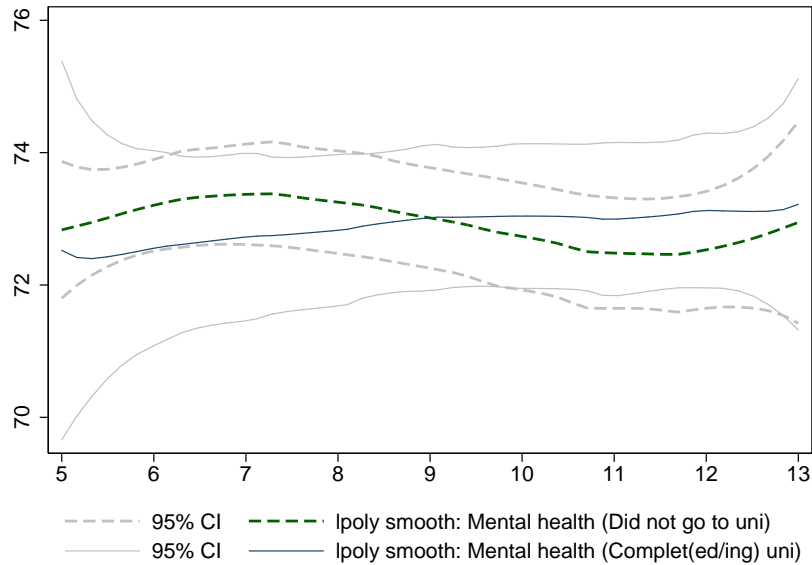
0.001). We therefore find robust, statistically significant effects of university participation for extraversion and agreeableness, in in some cases also on mental health. In light of a general trend of adolescents to become less extraverted over time, as reported in Table 3 (columns 5-6), we conclude that individuals who go to university are not generally more likely to become more extraverted, but they are less likely to follow the general trend of decreasing their extraversion scores.

Last, we find no evidence in favour of the hypothesis that university education comes at very high psychic costs. At best, we find evidence in favor of a buffering effect of university education on mental health, which is consistent with the large literature that links health with education (for an overview see ?). To corroborate this finding, we plotted in Figure 3 the mental health path between 2005 and 2013, separately for adolescents who go to university and adolescents who do not (non-parametric estimation). In anything, the mental health of adolescents who go to university at some point in time between 2005 and 2013 is steadily increasing, while the path of those who do not is decreasing, although these differences are not statistically significant.

### **6.3 Controlling for initial differences in personality**

One drawback of the above method to study personality-score changes is that we cannot control for the fact that teenagers in 2005 start out at different positions in the personality distribution, and therefore maybe more or less likely to move up or down the scale over time. This holds especially true for individuals who self-select into university education. As shown in Table 2, teenagers high on conscientiousness and low on extraversion (men) are more likely to complete a university degree at a later stage. For these individuals, being at the high end of the conscientiousness or low end of the extraversion scales in 2005, a further increase or decrease in

Figure 3: Average mental health from wave 5 to 13, by treatment (started university education) and control group (did not go to university)



self-reports is less likely in 2013 than teenagers in the comparison group who started out at a lower or higher level, respectively, in 2005.

To get a better handle of this potential identification problem, we complement the regression analysis by employing coarsened exact matching that allows us to better and more transparently balance the data between treatment and control group. In general, matching methods have the advantage that they are semi-parametric in nature which reduces the potential misspecification of the conditional mean of the outcome of interest and the arbitrary specification of impact heterogeneity (see Imbens 2004). CEM has the additional advantage that it requires even fewer modelling assumptions than e.g. propensity score matching and it does not risk to worsen the balance of some covariates between treatment and control groups when widening the search criteria to increase the number of matched twins, which often happens with nearest-neighbour matching (Ho et al. 2007; Iacus et al. 2011b).

Rather than matching treatment and control group on the basis of closeness on a summary

measure of covariates or of the average minimum distance across all covariates, CEM starts out by identifying a statistical twin for each treated unit on the basis of an exact match across all control variables for as many treated units as possible. For continuous variables, exact matching can be done by splitting their support into the very small, yet intuitive, intervals (e.g. income deciles for continuous income). For this group of exact matches the covariates are perfectly balanced. Therefore, the causal effect of the treatment can be calculated non-parametrically as a simple difference in means on the matched data, assuming that there are no further unobserved confounding variables. For the unmatched treatment group members, CEM suggests to widen the intervals into which the control variables can be categorised. Coarsening is often naturally used by researchers to reduce the noise in the categories (e.g. variables that are categorical are often presented as binary variables) or to allow for heterogeneous effects across the distribution of a continuous variable (e.g. non-linear age effects).

CEM exploits this natural, but admittedly, case-specific way of broadening the categories. For instance, instead of using the exact age as basis for matching, one could coarsen age into age categories of let's say five-year intervals, and then repeat the exact matching procedure on the yet unmatched treatment group units. This process of coarsening variable-by-variable and exact matching continues until no more exact matches can be identified. Individuals who cannot be matched perfectly, even after coarsening most generously all covariates, will be discarded from the data. In this approximately balanced data one can no longer calculate the causal effect of the treatment as difference in the means between treatment and control group. For the approximately balanced groups, one can employ either a regression model that controls for those variables that were coarsened to estimate the treatment effect or to report a weighted average of local treatment

effects across the matching generations (Iacus et al. 2011b).<sup>21</sup>

It should be emphasized that CEM, just as much as regression analysis and conventional matching methods, identify the treatment effect of interest by conditioning on a key set of control variables and the ignorability assumption that there are no relevant omitted variables. Although they cannot be interpreted as causal effects, they do make the treatment variable (here: university education) more independent of the potentially confounding variables (here: initial levels of personality).<sup>22</sup>

Given our small sample, we match individuals on the basis of the following coarsened categories: Sex (0,1); Age: Being above versus being at or below age 25 in 2013 (0,1); Mother's education: whether mother has completed year 11, year 12, or any educational qualification after leaving school (0,1); Family household income: Being above or at the mean household income versus being below (0,1); Degree of urbanization: Major urban versus non-major urban (0,1); Being from an English-speaking background (0,1); Personality: Above versus below the median of 4 (on a 7-point scale) for each of the five personality domains, respectively ( $5 \times 0,1$ ). Out of 210 teenagers who went to university at some point in time after 2005 and strictly before 2013, we could perfectly match 105 individuals (50%), and we could match 93 out of the 153 individuals who completed a university degree (61%). Table A.1 in the Online Appendix shows that the covariates of interest are well balanced except for father's occupational class. In a robustness check, we repeat the same analysis by matching on the basis of father's occupation class.

On the basis of a perfect-statistical twin comparison, we cannot find statistically-significant changes in any of the five traits at conventional significance levels (5% or better) due to university

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<sup>21</sup>See Schurer et al. (2015) and Jones et al. (2011) for similar approaches in the economics literature.

<sup>22</sup>Matching methods may come at another cost: In small samples they may lead to a loss of efficiency.

education (See A.2 in the Online Appendix). However, we do find an economically meaningful difference in personality change between treatment and control group for extraversion. The change in extraversion for the control group is -0.17 SD, whereas for the treatment group (teenagers who enrolled into or completed a university degree) this change was 0 (p-value of 0.45). The difference between the two groups is only significant at the 17% significance level, but the result qualitatively match our fixed effects and OLS results: most adolescents became less extraverted over time, whereas teenagers who have entered the university track did not change their extraversion levels. A qualitatively similar result is obtained for the smaller treatment group of 93 individuals who completed university education between 2005 and 2013.<sup>23</sup> When using father's occupational class to perfectly match treatment and control variables, the change in extraversion for the control group is -0.203 SD, while for the treatment group it is 0.023 SD. The difference between treatment and control group is statistically significant at the 5% level.

## 7 Conclusion

Recently, a public discussion has emerged on whether universities should alter their recruitment policies to identify and attract talent and which skills, other than field-specific knowledge, they should teach. The New York Times featured many opinion pieces reflecting this change in thinking. Various articles from leading scholars and journalists emphasized the need to improve students' creativity, socioemotional skills, attributes of ownership, and the ability to learn on the fly, all character traits that society-at-large values highly.

To contribute to this discussion from an empirical perspective, we explored in this study which

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<sup>23</sup>Given the small sample it is not surprising to obtain very imprecise estimation results and we cannot explore the heterogeneity in the treatment effect across gender and socioeconomic disadvantage.

personality traits are associated with the probability to obtain a university degree and which of these traits are boosted by university education, implicitly testing the human capital model of education. Following a sample of 15-19 year old teenagers from 2005 until 2013, we find that high levels of conscientiousness and internal locus of control tendencies, and low levels of extraversion, over and above the influence of cognitive ability, are strong predictors of degree attainment. These results strengthen Lundberg's (2013) finding on conscientiousness and (low) extraversion, and Coleman and Deleire's (2003) finding on internal locus of control as boosters of human capital investments. Measures of conscientiousness, internal locus of control, and extraversion could therefore be useful selection indicators for university entry in addition to grade-point averages.

On the other hand, we find little evidence that universities shape personality traits that are commonly associated with a hard work ethic (conscientiousness), intellect (openness to experience), and emotional stability. These characteristics are all highly valued not only in terms of their effects on productivity and long-term health (see Almlund et al. 2011), but they are also characteristics that make a good citizen. However, our data shows that university education boosts levels of extraversion, a result that holds even when controlling for individual-specific heterogeneity and differences in initial starting values. Moving from adolescence into young adulthood, most individuals experience a general decline in extraversion, but individuals who go to university do not. Extraversion captures mostly sociability and an outward orientation. University life may foster these tendencies because it encourages participation in club activities, social functions, and communication with fellow students and academic staff.

We have also explored the possibility that individuals who go on to university suffer substantial psychic costs (Heckman et al. 2006), which may deter children from low socioeconomic backgrounds more strongly. Over an eight-year window, adolescents who go to university are no

more likely to develop mental health problems or become less emotionally stable than comparable adolescents who do not. If anything, university education helps to reduce this probability at the extreme end of the distribution and to strengthen other personality traits that are deemed valuable to society: students from low socioeconomic backgrounds tend to become more agreeable, which is a measure of collaboration and kindness, through university education.

Our results have two important implications. On the one hand, they may open a debate on what outputs and outcomes publicly-funded tertiary education aims to achieve other than lifting students into higher-paid jobs. On the other hand, our robust finding of a buffering effect of university education on extraversion - a personal disposition to be outward oriented and sociable - emphasizes that the tertiary education system could theoretically play a role in shaping character traits of young adults, a conclusion also drawn in Dahmann and Anger (2014) for secondary education system. This conclusion may result in the possibility for complementing early childhood interventions that focus on pre-school children (e.g. Dee and West 2008; Heckman et al. 2013) with personality-boosting interventions in the secondary and tertiary education sector.

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## ONLINE APPENDIX

## A Description of the Reliable Change Index (RCI)

Equation (1) describes the construction of the Reliable Change Index (RCI) using personality scores from both period 1 and 2, Cronbach's  $\alpha$ , and the spread of change in personality across the two time periods that would be expected if no actual change had occurred. The latter ( $\sigma_{\Delta P^k}$ ) can be approximated by the spread in the personality score in the general population (in our case all adult groups) weighted by the reliability of the personality measurement ( $\alpha_k$ ), i.e.  $\sigma_{\Delta P^k} = \sqrt{2(\sigma_{P^k}\sqrt{1-\alpha_k})^2}$ :

$$RCI_i = \frac{P_{i,2}^k - P_{i,1}^k}{2\sigma_{\Delta P^k}} = \frac{P_{i,2}^k - P_{i,1}^k}{\sqrt{2(\sigma_{P^k}\sqrt{1-\alpha_k})^2}}. \quad (1)$$

If the personality measure contains a lot of noise (small  $\alpha_k$ ), then large changes in personality scores from period 1 to 2 cannot be reliably interpreted as true changes. Further, if the spread in the general population score of personality is very large, which implies a large deviation from some norm that is represented by the mean of the personality score, then any changes in personality must be very large as well to be considered a true change. Assuming a normal distribution of the personality scores in the population in both time periods considered (which we find to be true in our data), the individual change in personality scores is considered reliable if the absolute value of the RCI is greater than 1.96.

Table A.1: Summary statistics of estimation sample

	Mean	St. Dev.	Min	Max
Extraversion (Wave 13)	4.544	1.015	1.67	7
Agreeableness (Wave 13)	5.357	0.877	1	7
Conscientiousness (Wave 13)	4.974	1.036	1.167	7
Emotional stability (Wave 13)	4.925	1.120	1	7
Openness to experience (Wave 13)	4.396	1.037	1	7
Change in Extraversion (Wave 5 to 13)	-0.135	0.953	-2.83	3.5
Change in Agreeableness (Wave 5 to 13)	0.231	0.989	-3	5
Change in Conscientiousness (Wave 5 to 13)	0.439	1.022	-2.5	4.5
Change in Emotional stability (Wave 5 to 13)	0.085	1.139	-3.5	4
Change in Openness to experience (Wave 5 to 13)	0.011	1.051	-4.3	3.67
Change in M.Health score (Wave 5 to 13)	0.468	18.434	-56	60
Increase in Extraversion $\geq$ 1 SD	0.182	0.386	0	1
Increase in Agreeableness $\geq$ 1 SD	0.220	0.414	0	1
Increase in Conscientiousness $\geq$ 1 SD	0.305	0.461	0	1
Increase in Emotional stability $\geq$ 1 SD	0.227	0.419	0	1
Increase in Openness to experience $\geq$ 1 SD	0.186	0.389	0	1
Increase in M.Health score $\geq$ 1 SD	0.150	0.357	0	1
Decrease in Extraversion $\geq$ 1 SD	0.257	0.437	0	1
Decrease in Agreeableness $\geq$ 1 SD	0.118	0.323	0	1
Decrease in Conscientiousness $\geq$ 1 SD	0.086	0.280	0	1
Decrease in Emotional stability $\geq$ 1 SD	0.184	0.388	0	1
Decrease in Openness to experience $\geq$ 1 SD	0.168	0.374	0	1
Decrease in M.Health score $\geq$ 1 SD	0.139	0.347	0	1
Completed/ing) university or higher	0.359	0.480	0	1
Father's occupation score	49.801	24.664	4.9	100
Age	24.784	1.378	23	27
Female	0.557	0.497	0	1
Country of birth: Eng speaking	0.013	0.111	0	1
Country of birth: other	0.043	0.203	0	1
Non-major urban residence	0.311	0.463	0	1
Summary cognitive measure (obs = 477)	0.546	0.119	0.23	0.83
Completed/ing) university or higher, by wave				
wave 9 (obs = 487)	0.355	0.479	0	1
wave 10 (obs = 503)	0.348	0.477	0	1
wave 11 (obs = 497)	0.318	0.466	0	1
wave 12 (obs = 480)	0.327	0.470	0	1
wave 13 (obs = 484)	0.331	0.471	0	1
Completed/ing) university or higher, by father's OSS				
low (obs = 255)	0.251	0.434	0	1
high (obs = 305)	0.491	0.501	0	1

*Note:* Estimation sample is 560 teenagers who were aged 15-19 in 2005.

Table A.2: Robustness check for change analysis: Coarsened Exact Matching

	Group	Changes		Levels	
		Mean	p-value	Mean	p-value
<b>Individuals who enrolled into or completed university degree</b>					
Extraversion	0	-0.175	0.17	4.698	0.42
	1	-0.007		4.811	
Agreeableness	0	0.026	0.31	5.348	0.59
	1	0.144		5.412	
Conscientiousness	0	0.501	0.37	5.130	0.91
	1	0.387		5.114	
Emotional Stability	0	0.188	0.44	5.101	0.92
	1	0.076		5.116	
Openness to Experience	0	-0.070	0.88	4.393	0.32
	1	-0.050		4.532	
<b>Individuals who completed university degree</b>					
Extraversion	0	-0.154	0.31	4.634	0.66
	1	-0.017		4.703	
Agreeableness	0	0.112	0.90	5.476	0.89
	1	0.097		5.460	
Conscientiousness	0	0.513	0.53	5.242	0.93
	1	0.432		5.253	
Emotional Stability	0	0.185	0.74	5.047	0.56
	1	0.136		5.133	
Openness to Experience	0	-0.116	0.88	4.465	0.51
	1	-0.095		4.563	

*Note:* Reported are differences in mean by treatment and control group and p-value of t-test on equality of mean between treatment and control group. Out of 201 individuals who entered or completed university, we were able to find for 105 a perfect match and discarded the remaining 96 individuals. Out of 153 individuals who completed university, we were able to match 93 individuals perfectly, and discarded the remaining 60 individuals. Matching is based on: Age (above versus below or equal to 25 years), Sex (0,1), Mother's education (above versus below or equal to mean years spent in school), Parent's household income (above versus below or equal to mean income), urban region (0,1), English-speaking background (0,1), and each personality trait (above versus below or equal to mean response in sample).

*Source:* HILDA, waves 5 and 13.



Table A.1: Difference in means of relevant covariates before treatment after matching (between youth who will go on to university and youth who will not)

	control	treatment	Diff	t-stat	p-value
Age	24.699	24.839	-0.140	-0.701	0.484
COB: AUS	0.914	0.925	-0.011	-0.268	0.789
COB: Eng speaking	0.022	0.000	0.022	1.422	0.157
COB: Other	0.065	0.075	-0.011	-0.286	0.775
Father FOC	48.051	59.559	-11.509	-3.259	0.001
Mother < Year 10	0.228	0.151	0.078	1.349	0.179
Yr 11 or equiv	0.152	0.086	0.066	1.390	0.166
Yr 12 or equiv	0.620	0.763	-0.144	-2.134	0.034
If mother completed qual.	0.703	0.811	-0.108	-1.695	0.092
Extro 2005	4.850	4.804	0.046	0.305	0.761
Agree 2005	5.349	5.325	0.024	0.216	0.829
Consc 2005	4.684	4.810	-0.127	-0.972	0.332
Emoti 2005	4.908	4.982	-0.074	-0.523	0.602
Openn 2005	4.608	4.622	-0.013	-0.098	0.922

*Note:* Includes all respondents aged 15 to 19 in wave 5. Father's occupational class is defined via the Father's Occupational Prestige Score. A one-standard deviation increase in occupational prestige is 25 points on a scale from 0 to 100.

*Source:* HILDA, waves.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors in parentheses.