Do personality traits affect productivity? Evidence from the lab*

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Abstract

Survey data supports a strong relationship between personality and labor market outcomes, although the exact mechanisms behind this association remain unexplored. In this paper, we take advantage of a controlled laboratory set-up to test whether this relationship operates through productivity, isolating this mechanism from other channels such as bargaining ability or self-selection into jobs. Using a gender neutral real-effort task, we analyse the impact of the Big Five personality traits on performance. We find that in a real-effort task more neurotic subjects perform worse, and that more conscientious individuals perform better. These findings are in line with previous survey studies and suggest that at least part of the effect of personality on labor market outcomes operates through productivity. In addition, we find evidence that gender and university major affect the impact of the Big Five personality traits on performance.

JEL codes: C91, D03, J3, M5

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1 Introduction

Despite the large body of literature on the determinants of labour force participation and earnings, a substantial part of the wage inequality across a range of demographic characteristics and occupations still remains unexplained. The large increase in wage inequality in the US over the 1980s prompted a prolific strand of research (Katz and Murphy 1992, Juhn, Murphy and Pierce 1993, Hamermesh 1999), that reports not only increases in the wage gap across education and experience groups, but also a rise in the residual wage inequality.

In his seminal work, Becker (1964) highlighted the relevance of cognitive skills in explaining earning differences.[1] However, variations in cognitive abilities fail to fully account for the residual wage inequality.[2] More recently, labour economists have started to focus on the importance of non-cognitive skills in determining earnings (Heckman and Kautz 2012). Soft skills such as self-motivation, planning capabilities, industriousness, self-control or self-esteem interact with cognitive skills and are strong candidates to explain the remaining wage inequality (Bowles, Gintis and Osborne 2001).

Within the set of non-cognitive skills, personality traits are one of the most relevant instruments in the study of differences in earnings.[3] Mueller and Plug (2006) show that the effect of personality traits on earnings is of similar magnitude to the one of cognitive skills. In addition, these traits can help to account for the strong intergenerational correlation in labour market outcomes that cannot be attributed to parental education and wealth transmission (Mulligan 1999). Well-established evidence shows that while personality is genetically inherited to a large extent (Bouchard Jr and Loehlin 2001) it is still sensitive to parental investments (Borghans, Duckworth, Heckman and Ter Weel 2008).

Recent studies have linked job performance and wages to the so-called "Big Five" personality traits: openness, conscientiousness, extraversion, agreeableness, and neuroticism (Heckman et al. 2006, Fletcher 2013). Using survey data, these papers report a strong relationship between some of these personality traits and wages. Conscientiousness, antagonism (inverse of agreeableness) and

[1] See also Murnane, Willett and Levy (1995), Cawley, Heckman and Vytlacil (2001) or Heckman, Stixrud and Urzua (2006).

[2] For example, Blau and Kahn (2005) find that although cognitive test scores contribute to explain the higher wage dispersion in the US compared to other OECD countries, residual wage inequality is still substantial. Furthermore, Cawley et al. (2001) report that the share of wage variance that can be attributed to cognitive abilities is modest, and Heckman and Rubinstein (2001) present evidence that cognitive abilities fail to explain the variation in wages between GED recipients and high-school graduates.

[3] Personality is defined as the combination of emotional, attitudinal, and behavioural characteristics which are unique to an individual, and hence, are part of her set of productive skills.

emotional stability (the inverse of neuroticism) show a robust positive relationship with earnings, whereas there is some evidence of a positive effect of extraversion and openness to experience on wages. However, these correlations cannot disentangle whether the effects of personality traits on labour market outcomes operate through individual schooling (Cunha, Heckman and Schennach 2010), self-selection into jobs (Cobb-Clark and Tan 2011), engagement in training opportunities (Barrick and Mount 1991), and performance evaluation by supervisors (Caligiuri 2000). Moreover, personality traits may have less measurable effects on earnings through networking skills, bargaining abilities, or the availability of outside options.

To the best of our knowledge, this is the first paper to use a laboratory experiment to test the relationship between the Big Five personality traits and individual productivity. This exercise allows us to explore the mechanisms behind the relationship between personality traits and earnings found in observational studies, and to further understand how personality traits can explain the level of output and its distribution among individuals. An increasing number of labour economists are using laboratory experiments to tease out the potential confounds present in survey analysis (Charness and Kuhn 2011). This methodology can offer a valuable complement to the existing studies on the effect of personality on labour market outcomes. Unlike survey data, information in the lab is generated under closely monitored conditions, which allows a precise measurement of the performance of experimental subjects. Because the experimental task is unequivocally defined, it is possible to assess directly which personality traits are relevant for performance. Finally, the laboratory setting controls for other usually unobserved factors such as workplace environment and peer effects.

Experimental methods may suffer two fair criticisms regarding their external validity: artificiality of the task and use of undergraduate students as subjects. We believe that our experimental setting still provides valuable insights. While it is true that it is not possible to replicate a real work-environment in the lab, we chose a "real-effort" task, which is costly for subjects. More precisely, subjects are asked to add a series of five two-digit numbers under time pressure, as in Niederle and Vesterlund (2007). This task also requires high concentration levels and problem-solving skills under time-pressure which are valuable assets in the labour market. Regarding the second critique, ordinal changes in the Big Five personality traits are rare once early adulthood is reached (Roberts, Walton and Viechtbauer 2006). Furthermore, the advantage of employing a student population is that most of the participants have not entered the labour force yet. Our study is thus largely free from the self-selection bias arising from prior labour history. This, of course, comes at the potential cost of having a less representative sample. Thus, our contention is that our findings are likely to

apply to our subjects' future labour market outcomes.

We find evidence supporting the hypothesis that certain personality traits are correlated with labour market outcomes through productivity. Our findings support previous survey studies; neuroticism has a significant detrimental effect on productivity, while more conscientious individuals perform better. However, in our experiment, agreeableness is not correlated with lower productivity, suggesting that the link between agreeableness and labour market outcomes operates through other channels. We also find that two other traits, extraversion and openness to experience, have differential effects by gender and major of study. This support previous studies that argue that personality contributes to the gender wage gap. On the other hand, we find limited evidence of family background modulating the impact of the Big Five.

The study of the link between personality and productivity is important for two different reasons: first, employers are interested on a better understanding of this relationship. Anecdotal evidence shows the importance of personality in the workplace. For instance, Green, Machin and Wilkinson (1998) document that personnel managers find "attitude, motivation and personality" as the most important attributes when hiring. US employers ranked "attitude" as the most important skill among new employees in non-supervisory jobs (Bowles et al. 2001). Employers should be naturally interested on which extend these non-cognitive skills influence productivity rather than other wage determinant such as bargaining ability.

Secondly, understanding to what extent personality traits impact labour market outcomes through productivity or through other mechanisms is key to offer an adequate foundation for policy interventions because certain personality traits are more shapable than cognitive skills (Borghans et al. 2008). Evidence corroborates that personality is, to a certain extent, malleable in adolescence and early adulthood (see Almlund, Duckworth, Heckman and Kautz (2011) and references therein). A deeper understanding of the impact of personality on productivity can provide policy makers with a wider variety of instruments when designing policies aimed to improve the economic performance of disadvantaged groups and increasing social mobility. This is particularly relevant for educational programs targeted to individuals after the age of 10, when cognitive skills are already mostly established but personality is still being formed (for an example on these interventions see Martins (2010)).

2 Related Literature

Psychologists have profusely studied the link between personality and labour market outcomes or academic performance (see, for instance, Barrick and Mount (1991), Tett, Jackson and Rothstein (1991), Salgado (1997), Judge, Higgins, Thoresen and Barrick (1999) or Chamorro-Premuzic et al. (2005)). This literature shows a consistent strong positive effect of conscientiousness and emotional stability on job performance, while the effects of other personality traits are confined to certain occupations (extraversion has a positive effect on occupations involving social interactions) or particular job aspects (openness to experience is related to training proficiency).

Economists have only recently focused their attention on non-cognitive skills. Cognitive skills, while extremely important in determining educational and labour market outcomes (Cawley, Conneely, Heckman and Vytlacil 1997), fail to fully explain observed variation in performance (Heckman and Rubinstein 2001, Heckman and LaFontaine 2010). Early studies showed that traits such as high self-esteem and self-directness −the sense that own actions are the primary determinants of outcomes− positively affect real wages (Osborne 2000, Murnane, Willett, Braatz and Duhaldeborde 2001), in a higher order of magnitude than human capital (Goldsmith, Veum and Darity 1997). More recently, Heckman et al. (2006), Borghans et al. (2008), and Cobb-Clark and Tan (2011) find that non-cognitive skills such as self-control or self-esteem play a key role determining a wide variety of economic outcomes. Furthermore, the economic literature has devoted substantial attention to the importance of early childhood on social and economic outcomes (see, for instance, Cunha and Heckman (2008) or studies such as Deming (2009) or Heckman, Moon, Pinto, Savelyev and Yavitz (2010) on the effects of early interventions on the formation of non-cognitive skills).

While it is widely accepted in the Economics and Psychology literatures that cognitive skills can be summarized in a single factor ("g" or general factor), not such agreement has been reached with regard to non-cognitive skills. Some of the measures employed in the early literature, such as feelings of self-efficacy or self-esteem of individuals, are likely to suffer from a severe endogeneity problem. For instance, adverse economic shocks such as unemployment spells have a negative impact on self-esteem. Economists and psychologists have later focused on the Five Factor Model of Personality (Costa and McCrae 1992), commonly called the "Big Five". These five "factors" or personality traits are Extraversion, Agreeableness, Neuroticism, Conscientiousness, and Openness to Experience.[4]

[4]We describe each of these traits in more detail in Section 4.

The "Big Five" approach has become tremendously popular for several reasons. First, these personality traits are unlikely to experience ordinal changes (Roberts and DelVecchio 2000, Jones, Livson and Peskin 2006, Cobb-Clark and Schurer 2012), particularly after early adulthood.[5] Changes over time in absolute levels are extreme over childhood, but also likely to occur during adulthood (Roberts et al. 2006). However, they seem to be very gradual and determined by biological maturation rather than life experience (McCrae and Costa Jr 1999, Srivastava, John, Gosling and Potter 2003).[6] Moreover, the Big Five is a robust measure both across cultures and samples (Barrick and Mount 1991). For instance, McCrae and Terracciano (2005) report similar differences by gender in cultures with very different gender roles and expectations. Finally, the Big Five personality traits are considered to be largely uncorrelated with cognitive skills, defined as the ability to solve abstract problems (McCrae and Costa 1994, Stankov 2005)[7], although they impact performance in cognitive tests (Almlund et al. 2011). Hence, the Big Five personality traits constitute a truly distinct factor in the analysis of labour market outcomes, which in addition are less prone to the endogeneity problem that affects other personality measures such as self-efficacy and self-esteem.[8]

For all the aforementioned reasons, labour economists have increasingly incorporated the Big Five into their toolkit.[9] Using survey data from the Netherlands, Nyhus and Pons (2005) report a negative correlation between neuroticism and wages for both men and women, and a negative correlation of agreeableness with wages for women only. Mueller and Plug (2006) also find heterogeneous effects by gender in US data. More recently, Heineck and Anger (2010) estimate the impact of non-cognitive skills on earnings in a German sample and their interaction with cognitive skills as measured by an ultra-short IQ test. Viinikainen, Kokko, Pulkkinen and Pehkonen (2010) exploit longitudinal data from Finland to estimate the impact of personality traits measured at different points in life (including childhood) on labour income at age 43. Heineck (2011b) explores the tenure effects of past and present personality traits using longitudinal British data. Finally, Fletcher (2013) uses sibling fixed effects to control for family background and genetic endowments,

[5]For instance, Roberts and DelVecchio (2000) estimated traits consistency, for an interval of 6.7 years, of 0.54 during the college years, increasing to 0.64 at age 30, and to 0.74 between ages 50 and 70.

[6]Some studies (see, among others, Costa, Herbst, McCrae and Siegler (2000) or Sutin and Costa (2010)) report life experiences, such as divorce or hazardous work, to affect personality traits, but there is no consistent evidence on the matter.

[7]This is not the case for other personality traits, such as creativity (Csikszentmihalyi 1997), cognitive style (Perkins and Tishman 2001) or emotional intelligence (Mayer, Caruso and Salovey 1999). These traits, also known as "quasi-cognitive" traits, are strongly correlated with cognitive skills.

[8]Some studies (see, among others, Sutin and Costa (2010) or Costa et al. (2000)) report life experiences, such as divorce or hazardous work, to affect personality traits, but there is no consistent evidence on the matter.

[9]See the meta-analysis by Barrick and Mount (1991), Tett et al. (1991) and Salgado (1997) for a review of the personnel psychology literature using the Five Factor Model of Personality.

finding robust associations between personality traits and labour market outcomes, but substantial heterogeneity across demographic groups.

To summarize, the take home messages of this literature are: 1) Neuroticism and agreeableness are consistently correlated with lower earnings while more conscientious individuals present better labour market outcomes; 2) gender differences in the effects of personality traits can contribute to explain the gender wage gap; and 3) the estimated effect of personality is of comparable magnitude to that of cognitive skills.

In addition to wages and labour force status, other labour market outcomes are influenced by personality traits. For instance, Cobb-Clark and Tan (2011) report that non-cognitive skills have a different effect in the probability of being employed in certain occupations. Fletcher (2013) finds that emotionally stable and conscientious individuals are more likely to be employed; the latter effect may be due to their effective job seeking behaviour as documented by Uysal and Pohlmeier (2011). On the other hand, Caligiuri (2000) finds a positive correlation between conscientiousness and supervisor-rated performance. Therefore, the correlation between traits and wages or labour force status does not necessarily imply a different productivity of individuals with different distributions of personality traits.

To the best of our knowledge, ours is the first experimental study aimed to unbundle the relationship between personality traits and labour market outcomes. The closest contribution to ours is Müller and Schwieren (2012), who use a laboratory experiment to explore the relationship between the Big Five personality traits and entry into competition. They perform four rounds of the same task as ours under different compensation schemes. The payment in the first round is piece rate and hence comparable to ours. They find that openness is negatively related to performance in that round. On the other hand, they find that neuroticism relates to lower performance in competition and lower willingness to compete. We do not address competitiveness but we rather focus on performance as a first step to study the effect of personality on labour market outcomes.

3 Experimental Design

We used the ORSEE online system (Greiner 2004) to recruit a total of 359 University of New South Wales students as participants in the experiment during August 2013. In total, we ran 15 sessions in the Australian School of Business Lab with around 20-25 students per session.

The experiment consisted of five stages: welcoming and instructions, performance of the task, break, performance of the same task, and administration of the demographic and Big Five ques-

tionnaires. Upon arrival, participants were assigned to computer units separated by screens and received paper, pencil and written directions regarding the conditions of their participation in the experiment. Instructions were given orally through headphones. This was motivated by three main reasons. First, we wanted to replicate a work environment as closely as possible by recreating a hierarchy between employer and employee. Second, we wanted to isolate this interaction from personal characteristics of the employer as much as possible. It is well known that gender interactions between employer and employee have an impact on productivity (Delfgaauw, Dur, Sol and Verbeke 2013).[10] Finally, we prevent any emotional connotations due to personal affinity or sympathy which might easily appear in live interactions and affect the employer-employee interaction.

The instructions described the task and the payoff scheme. For each correct item in the task, subjects gained 20 experimental dollars and lost 3 per incorrect item. They were also informed that the exchange rate was 0.02 Australian dollar (AU$) per experimental dollar. No talking or other interaction among participants was allowed during the whole session.

The experimental session was divided into two rounds with a break in the middle. In each round, subjects were asked to answer as many additions of five 2-digit random numbers as possible in 10 minutes. Once an answer was submitted, it could not be changed, and the next sum showed up in the computer's screen immediately. The task was programmed using zTree (Fischbacher 2007). We chose this task because it measures productivity as a function of both cognitive and non-cognitive abilities such as concentration, effort, stress management and perseverance or industriousness. While openness and extraversion might not be relevant for it, we chose this task because we faced a trade-off between the length and complication of the task and the set of non-cognitive traits connected to it. In addition, this task is specially suitable for our purposes since it is gender neutral: men usually perform better than women solving abstract math problems, but there are no gender differences in arithmetic or algebra performance (Niederle and Vesterlund 2007).

Between the two rounds, participants had a 5-minute break and were not allowed to leave the lab or talk to each other. During the break, participants received a brief reminder of the task and conditions of the experiment ahead. No information about their actual performance was given.

The final stage was not timed. We collected various demographic characteristics together with

[10]To minimize any gender interaction effect, we created identical male and female voices. Since a gender is always assigned to a voice, we modified the original instructions to make them sound as given by male and female supervisors. The gender of the voice was randomized by session. Participants only interacted with experimenters of the same sex as the voice they received the instructions from. Gender interactions in hierarchical structures have proven to be relevant not only in working environments but also in educational achievements (Dee 2007).

the Big Five personality traits test. Subjects were not allowed to leave the room until all of them had finished the survey. Once they have completed both questionnaires, participants were informed of the total number of correct and incorrect summations they had accomplished. We paid them in cash their total earnings plus a show-up fee of AU$ 5. The average participant answered a total of 45.5 correct and 5 incorrect items, and earned AU$ 28.8 (around 25.8 US $).

Table 1 presents the descriptive statistics for the main variables used in the analysis. We designed the recruitment process in order to obtain a sample balanced by gender. On average, participants were 22 years old, and 30% of them were honour students or were following a master or PhD program. Subjects were asked to classify their family income in a seven-level Likert-like scale in order to minimize the non-response rate. We classified subjects as coming from a high income family if they reported a value of 5 or higher. Parental education was considered to be low if parents did not attend college, what was the case for 34% of the fathers and 50% of the mothers.[11]

Measures of the Big Five traits were obtained using the 44-item Big Five Inventory (John, Donahue and Kentle 1991, John, Naumann and Soto 2008). Contrary to survey studies, the lab environment allow the experimenter to choose the questionnaire that best fits the research question. We choose this mid-sized questionnaire to ensure an accurate measure of each personality traits without incurring in an excessively long questionnaire, which could induce measurement error, particularly after a "real effort" task. For all traits, we obtained a distribution of values that follows a normal distribution, with limited cases in very high or very low values.[12] As an indirect measure of ability, subjects were asked to report their average grade, according to the standard Australian classification.[13] Along with information on their labour force status and wage, we used these grades to perform a external validity check of our results.

Our tasks allows us to measure individual productivity in a number of ways. Our primary outcome measure is payment received. We also examine the total number of sums answered, and the total number of correct sums performed in the available time, to check for different strategies when maximizing the payment. On average, subject answered 50.5 sums, of which 45.4 were correct.

[11] Seventeen participants fail to report parental education. A dummy for missing information was included in those specifications that control for parental education, but the results are robust to dropping these observations.

[12] Krueger and Eaton (2010) classify mental disorders as extreme representation of one or more personality traits.

[13] Grades are classified, in ascending order, as Fail (FL), Pass Conceded (PC), Pass (PS), Credit (CR), Distinction (DN) or High Distinction (HD).

4 Hypotheses

Before moving to our results, let us describe our hypotheses on the relationship between personality traits and performance in our experimental task. Note that these hypotheses can only be partially derived from the literature reviewed in Section 2. Because ours is the first laboratory experiment relating personality and productivity, we expect the effects of personal traits on performance to be different from the ones observed in previous studies using survey data.

Neuroticism This trait is defined as lack of emotional stability and predictability and by the presence of mood changes. Common facets associated with this trait include being anxious, irritable, depressed, worried and insecure. Neuroticism has been consistently found to hinder job performance.[14] Some of the mechanisms at play in labour relations, such as lack of self-confidence, are likely to operate as well in our setting. In addition, we expect neuroticism to impair the ability to focus in our task, especially under time pressure. Hence, our hypothesis is that high levels of neuroticism should be correlated with low performance in our experiment.

Conscientiousness This trait measures the extent to which individuals are careful, responsible and hard working. Because it is associated to efficient, organized, achievement-oriented and self-disciplined individuals, conscientiousness shows a consistent positive relation with labour market outcomes.[15] In a similar way, we expect a positive relationship between conscientiousness and performance in our experiment, because being careful, efficient and focused should improve the accurateness in the task.

Openness Individuals who are open to new experiences are typically imaginative, artistic, curious, creative and intellectually oriented. The effects of this trait are potentially ambiguous. While flexibility and creativity might be helpful in many occupations, they might be a hindrance in others, especially in occupations which penalize autonomy and non-conformity.[16] In a laboratory setting, Müller and Schwieren (2012) observe a negative impact of openness on performance in the same task as ours. We expect a similar result and we conjecture that this result might be driven by creative and artistic individuals who are likely to find the task repetitive and therefore boring. They

[14] As in the economic literature, psychologists Barrick and Mount (1991) and Salgado (1997) find that emotional stability has a positive effect on job performance across all occupations.

[15] In the Psychology literature, Barrick and Mount (1991), Tett et al. (1991) and Salgado (1997), also find evidence of this link across occupations and criteria (wages, promotions, training).

[16] Mueller and Plug (2006) and Heineck (2011a) find substantial earnings advantages associated to openness, although Heineck and Anger (2010) find that high level of openness are detrimental for males' wages.

might also be more likely to engage in the experiment, as a new experience, but the characteristics of the task are likely to countervail this initial positive effect. Therefore, we expect a negative net effect of openness on performance in our task.

Agreeableness Defined as the tendency to cooperate and help others, agreeableness is associated to altruism, compliance, modesty, sympathy and trust. Survey evidence suggests that the overall effect of agreeableness on labour market outcomes is negative. Even though agreeable individuals may be more successful in team work, three mechanisms might countervail this positive effect in the workplace. First, helping others may reduce individual productivity. Second, agreeable people may be less effective when bargaining their wage. Finally, agreeable individuals may enter less stable and lower paid occupations.[17] None of these potential mechanisms are present in a laboratory setting, neither does our task benefits from team work. We expect agreeable individuals to be more prone to cooperate with the experimenter. But this desire to perform well might hinder rather than boost their performance if they get too stressed or anxious because of this. Hence, we have no clear hypothesis on the effect of agreeableness on performance in our task.

Extraversion This personality trait is defined as an orientation towards the outer world. It is described by facets such as warmth, gregariousness, assertiveness, activity and excitement seeking. Barrick and Mount (1991) suggest that extraversion actually consists of two components, ambition and sociability. Whereas it is hard to think that sociability could play a role in our experiment, the facets associated to ambition, such as assertiveness or activity, could have a positive impact on performance. Nonetheless, Sternberg and Ruzgis (1994) find that extroverts are less vigilant and show more fatigue than introverts during extended tests. In the context of our experiment, extraversion might have a negative effect on performance given the length and the nature of the task. Hence, the expected impact of extraversion on performance in our setting remains an open question.

To conclude this Section, let us summarize the hypothesis that we will take to the data:

Hypothesis 1 Neuroticism is negatively associated with performance.

Hypothesis 2 Conscientiousness is positively associated with performance.

Hypothesis 3 Openness has a negative relationship with performance.

[17] Fletcher (2013) finds that this negative effect of agreeableness also applies to employment status.

5 Results

This section presents our baseline results and investigates whether the relationship between personality traits and productivity is heterogeneous across individual characteristics. We estimate the following specification by Ordinary Least Squares (OLS):

$$Y_i = \alpha + \sum_{k=1}^{5} \beta_k \text{score}_{ki} + \gamma X_i + \varepsilon_i$$

where Y_i is our productivity measure, $k = 1, ..., 5$ are each of the Big Five personality traits (Extraversion, Agreeableness, Neuroticism, Conscientiousness and Openness), and X_i are personal characteristics. When looking at heterogeneous results, we interact the Big Five scores with personal characteristics such as gender, major of specialization or family background. We favour parsimonious specifications to account for the low statistical power innate to the sample size in experimental settings. All our specifications control for gender, age, major of specialization and level of study. In addition, our results are robust to controlling for parental background, and average grade in college as an imperfect measure of cognitive ability.

Furthermore, in order to minimize the number of parameters to be estimated, we assume that the effect of personality traits on performance is linear, which we carry on to our estimation of heterogeneous effects. We tested for non-linearities by including a series of dummies for different intervals of values of each trait, and found no evidence of this alternative specification providing a better fit for our data. To allow for an easier interpretation of our estimates, Big Five scores are standardized to have mean zero and standard deviation of one in all reported specifications.

5.1 Baseline results

Table 2 presents our baseline estimates of the effect of personality traits on the log of total earnings (Column (1)). The Big Five personality traits are jointly significant, and the individual scores are largely consistent with our hypotheses. As in previous literature using survey data and our hypothesis H1, more neurotic subjects tend to perform significantly worse in our task: an increase of a standard deviation in the level of neuroticism is associated with a decrease in performance of about 2.9%, which translates into a 0.1 standard deviation in our distribution of payoffs. Thus, our results support the idea that neuroticism contributes to differences in wages through productivity.

Our hypothesis regarding conscientiousness (H2) is also confirmed. We find a positive and significant effect of this trait on performance, in line with results obtained in both the Economics

and the Psychology literatures. An increase of a standard deviation in the level of conscientiousness is correlated with an increase of 2.6% in total payoff. On the other hand, we find no evidence that the level of extraversion of an individual may be correlated with performance in the task. However, coefficients of agreeableness and openness are, although insignificant, negative and of sizeable magnitude.[18] We expected that negative effect of openness given the repetitive nature of the task which can make the novelty of the experience vanish quite rapidly (H3). The result on agreeableness is in line with the one found in the survey literature. In our setup, it suggests that more agreeable subjects might worry in excess about performing well. Unfortunately, our data does not allow to estimate precisely non-linear effects which could help to substantiate this conjecture.

Taking advantage of the set-up of our experiment, we also check whether the relationship between personality traits and performance changes as subjects get more familiar, tired or bored with the task. In columns (2) and (3) of Table 2, we estimate a separate regression for the main outcome (log of payoffs) in each round of the task. We do not find evidence of the impact of personality traits varying in magnitude as the task evolves. However, we gain some precision, with the negative effects for agreeableness and openness becoming significant for some rounds.

Table 2 also reports two additional measures of performance available from our experiment: the number of correct items in Column (4) and the total number of items answered in Column (5). While the task at hand should be relatively simple for a university student, it is time-limited and wrong answers entail a penalty. Therefore, there is a trade-off between the number of sums answered and the time spent per item, which, conditional on cognitive ability, should increase the probability of answering correctly. The relationship between personality traits and these two measures of performance is very similar to the one with total payoffs. Therefore, we will restrict our attention to the this outcome for the rest of the analysis.

As a further robustness check of the representativeness of our sample, we make use of the information provided in the questionnaire and estimate the relation between personality traits and grades for all individuals and wages for those in the labour force at the time of the experiment. While this estimation (not shown) is severely affected by selection, we find consistent results with prior literature (Fletcher 2013), with more conscientious individuals reporting higher grades and hourly wages.

[18] We do not observe subjects with very low scores in either of these traits. This is to be expected, given that subjects needed to volunteer to participate in the experiment and that requires a certain level of empathy and openness to new experiences.

5.2 Heterogeneous effects

We now turn our attention to the possibility that personality traits may be correlated with productivity differently by subsamples. In particular, we are interested in whether individuals of different gender, major of study (as a proxy for occupation), and family background present differential effects of personality traits on productivity.

As expected, because the task chosen has been shown to be gender neutral (Niederle and Vesterlund 2007), we do not find in our previous estimation any evidence that women and men differ in performance for any of our measures. However, there are significant gender differences in the distribution of two personality traits. Figure 1 and statistical tests confirm that, in our sample, women tend to be more agreeable (two sample t-test, $t = 2.171$, $p = 0.015$) and neurotic ($t = 3.878$, $p < 0.001$) than males. This is consistent with a number of studies on gender differences in personality traits (Costa Jr, Terracciano and McCrae 2001, Schmitt, Realo, Voracek and Allik 2008). Thus, we explore whether the relationship between personality and performance differs for men and women.

Table 3 presents our first set of heterogeneous effects. Column (1) includes the baseline results for ease of comparison. Column (2) allows the effect to vary between men and women. Interestingly, traits that vary in their distribution by gender (agreeableness and neuroticism) do not appear to impact differently male and female productivity. However, other traits seem to affect productivity differentially by gender. In particular, increases in the level of extraversion are positively correlated with productivity for men and negatively correlated for women. A rise of one standard deviation in extraversion increases earnings by 4% for men and decreases them by 3.5% (point estimate for women -0.035 (0.021)) for women. The differential effect of extraversion by gender is in line with the results obtained by Heineck and Anger (2010) using survey data, who find a wage penalty of 4% for women and a wage premium of 3% for men. Similarly, Fletcher (2013) obtains a wage premium of extraversion for men. The extraversion factor includes facets that might be correlated with productivity differently, and that are more or less salient in men and women. For instance, Costa Jr et al. (2001) report that men show larger scores in the facets of extraversion associated with ambition (assertiveness and activity) whereas women score higher in the facets associated with sociability (warmth, gregariousness and positive emotions), which may have different effects on productivity. By looking at the specific items of the Big Five Inventory related to extraversion, we find that men report themselves as more assertive than women ($t = 1.681$, $p = 0.047$). This difference in assertiveness might be driving the heterogeneous effect of extraversion. Unfortunately,

our sample size does not allow for a more detailed investigation of the source of this result.

Female participants who score highly in openness to experience obtain a significantly lower payoff (point estimate for women -0.059 (0.020)). We observe no difference for men with a higher score in this trait. Although we do not observe any significant differences in the distribution of openness, women score higher in items measuring how much individuals value artistic and aesthetic experiences ($t = 3.334$, $p < 0.001$) and the sophistication of their taste in arts and literature ($t = 3.183$, $p < 0.001$). Hence, more open women may find our experimental task to be specially boring and uninteresting, leading them to score worse than more open men.[19]

Next, we explore an additional source of student heterogeneity, major of study. When the entire sample is considered, individuals enrolled in scientific majors perform significantly better, which is not surprising given the nature of the task. Similarly to occupational choice, there might be unobservable characteristics that determine self-selection into a particular major. These unobservables could condition how personality traits influence performance even after controlling for family background and our proxy for ability. Therefore, the major of specialization might be capturing an array of individual characteristics. In addition, there are some significant differences in the distribution of traits by major. As suggested by Figure 2, we find that individuals enrolled in majors offered by the Australian School of Business (Business majors hereafter) or in Fine Arts majors score higher in extraversion (two sample t-test, $t = 2.063$, $p = 0.019$) and neuroticism ($t = 1.937$, $p = 0.026$). These differences are consistent with those observed in the literature (see, for example, De Fruyt and Mervielde (1996) and Rubinstein (2005)).[20]

Column (3) of Table 3 presents the results when the effects are allowed to vary by major. The omitted category corresponds to students majoring in a scientific discipline. Neuroticism is correlated with lower performance for Science majors, while the net effect is negligible for non-Science majors (point estimate for non-Science majors -0.002 (0.017)). We find no differential effects of extraversion, agreeableness or conscientiousness by major of study. As in the case of female subjects, we do find that higher levels of openness are correlated with lower performance for non-Science majors (point estimate -0.063 (0.017)), with a smaller beneficial effect for Science majors.

While all regressions control for gender and major, it may be the case that some of the differences are driven by the gender composition of the samples of Science and non-Science majors. About

[19] Müller and Schwieren (2012) find a negative correlation between openness and earnings in a similar experimental setting, although they do not disaggregate their results by gender.

[20] Only 37 subjects reported an major in fine arts, preventing a more detailed analysis in this sample.

60% of Science majors are men while the percentage goes down to 35% for Business and Fine Arts majors. Hence, it might be that the heterogeneous effect of openness by major is actually driven by the differential effect of openness by gender. The specification presented in Column (4) shows that this is not the case. The effect of openness is different across gender and majors. An increase of one standard deviation in the openness score for a man who chooses a scientific major is correlated with an increase in productivity of 5%, while this effect is negligible for women in science (point estimate -0.0005 (0.025)), and negative by almost 9% for women enrolled in Business and Fine Arts (point estimate -0.087 (0.020)). This suggests that the detrimental effect of openness on productivity is not only driven by the gender composition of majors.

As in the case of gender, we find differences by major in one important item: Science majors report themselves to be more inventive than Business and Fine Arts majors (t = 2.174, p-value = 0.015). Being inventive might be helpful in our task since more inventive individuals will find more efficient ways of adding arrays of two digits numbers. Interestingly, male participants also report themselves to be more inventive than female participants (t = 2.455, p-value = 0.007). Hence, it seems that being more open makes salient different aspects of this trait by gender and major. An increase in openness for women and participants in Business and Fine Arts majors implies a higher increase in artistic inclination and a lower increase of inventiveness than for men or participants in Scientific majors. As discussed, these two aspects have plausible opposite effects on performance. Therefore, differences in inventiveness and in the taste for aesthetic and artistic experiences might be responsible for the differential impact of openness on performance in our task.

We now turn our attention briefly to family characteristics that could influence the link between personality traits and outcomes. Figure 3 presents the density functions for the subsamples of subjects by parental income and education. Individuals who classify their family income as high are more extroverted (t = -2.178, p-value = 0.030) and less neurotic (t = 1.983, p-value = 0.048) than the rest. However, we do not find any consistent evidence that individuals with high family income experience a different relation between personality traits and productivity (Column (2) of Table 4).

Individuals from families with at least one college educated parent score lower in conscientiousness (t = 1.790, p-value = 0.074, and graphic evidence from Figure 4). Column (3) of Table 4 explores the possibility that parental education may affect the relationship between personality and productivity. Individuals from low education families present a positive correlation between conscientiousness and productivity which is absent in individuals from families with high education (point estimate 0.017 (0.018)). Finally, Column (4) presents the results including interactions with both

proxies for family background. Our results still show that individuals from more disadvantaged educational backgrounds benefit more from conscientiousness than those from more advantaged ones. As a matter of fact, individuals who report their parental education to be low (both parents without any college education) score higher in this trait than subjects from more favourable backgrounds ($t = 1.790$, p-value $= 0.037$). Because we are only considering university students, this difference suggests that higher conscientiousness is instrumental for educational attainment when parental education is not high. The differential effect of this trait might be capturing that earnings in the experiment are more substantial for subjects who come from less favourable backgrounds (the average payoff in the experiment of AU$ 28.8 is 1.8 times the minimum hourly wage in Australia). These subjects may have higher incentives to perform well and conscientiousness is a useful trait to attain this goal.

6 Discussion

In this paper, we perform the first lab experiment on the link between individual productivity and personality traits. Our aim is to unbundle the channels behind the correlations between personality and labour market outcomes reported using survey data. The controlled environment of the lab allows us to disentangle whether previous results are due to productivity or to other factors such as occupational choice, wage bargaining or personal interactions in the work place.

As conjectured in Section 4, we find a robust negative correlation between neuroticism and performance (H1), and some evidence supporting a positive correlation between conscientiousness and productivity (H2). Similar effects are present in most of the studies on personality and labour market outcomes. Our results thus support the hypothesis that at least part of the effect of neuroticism and conscientiousness on earnings operates through productivity. On the other hand, we found only a very weak negative effect of openness to experience (H3) and agreeableness on performance. This suggests that the strong negative correlation between these traits and labour market outcomes observed in survey data is mostly driven by occupational choices, wage bargaining, or by cooperative behaviour being penalized in the labour market.

When looking at the interaction between personality traits and personal characteristics, we find noticeable heterogeneous effects. Increases in traits are correlated with productivity differently for men and women, even in our setting, where we can abstract from many factors affecting labour market relations. More extroverted women, for instance, exhibit lower performance, while more extroverted men earn a higher payoff than their less extroverted counterparts. We report some

heterogeneous effects by major, reinforcing the idea that our experimental setting can alleviate the problem of selection bias by occupation present in survey studies. Finally, we do not find consistent evidence that family background is shaping the impact of personality traits, suggesting that policies designed to alter non-cognitive skills may be effective across the entire income distribution.

One last remark is in order: performance in the task chosen should also be influenced by cognitive ability. Cognitive and non-cognitive abilities have been shown to interact with each other (Borghans et al. 2008). Therefore, our findings could be merely reflecting that individuals with higher cognitive abilities score higher in certain personality traits like openness and conscientiousness (Almlund et al. 2011). However, all the results shown are robust to including our best available control for cognitive ability, i.e., average coursework grade and indicators for whether subjects are honour students, masters or Ph.D. students. While these coefficients are highly significant, their inclusion in all the specifications does not affect the coefficient or the precision of our estimates of interest, suggesting that our results do not only reflect differences in cognitive abilities.[21]

Finally, the reader may argue that our results are contingent on the payment scheme we employ. However, we believe that piece rate in the most reasonable payment scheme. Even in real workplaces where wages are fixed, a good performance may lead to better promotion opportunities, better outside options and higher wages in general.

An increasing body of literature explores the relationship between personality traits and a wide variety of economic outcomes, such as educational attainment and labour income. Among these traits, the Big Five factor model has attained a prominent role. We contribute to this literature by illustrating how the Big Five factors correlate with productivity. However, further research is needed to achieve a comprehensive understanding of the role played by personality traits in labour market outcomes in general and in productivity in particular. As with any branch of the literature of recent development, measures are sometimes unsatisfactory, encompassing too much or too little information on the underlying characteristics that drive the relations reported. For instance, openness to experience and extraversion seem to encompass facets with very different economic implications, while facets across different factors may have similar economic effects. We are aware that the consensus on the validity and usefulness of the Big Five factor model is not universal among psychologists (see Almlund et al. (2011) for references). While we can not contribute to this debate, economists should learn more about the link between personality and economic outcomes

[21] While in an ideal setting we would have a perfect measure of cognitive ability, in addition to budget and time constraints of the experimental setting, IQ tests have been shown to be the result of cognitive and non-cognitive abilities (Almlund et al. 2011).

by looking inside each trait for the facets of personality relevant to their specific research question. Any policy intervention designed to affect non-cognitive skills requires a deeper understanding of their potential impact on productivity across different populations.

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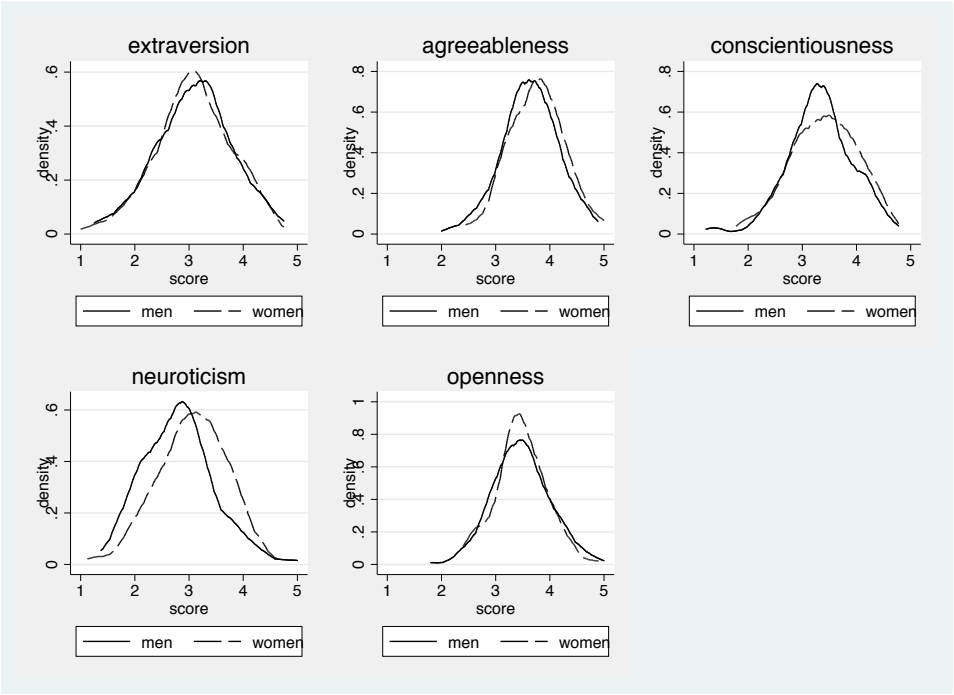

Figure 1: Personality traits density distribution by gender

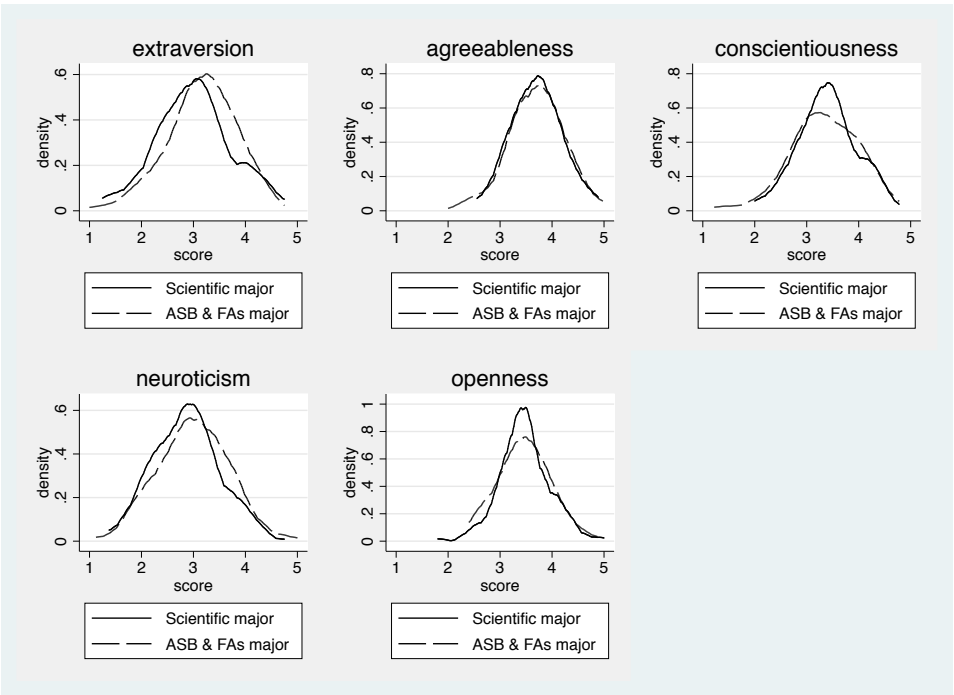

Figure 2: Personality traits density distribution by major

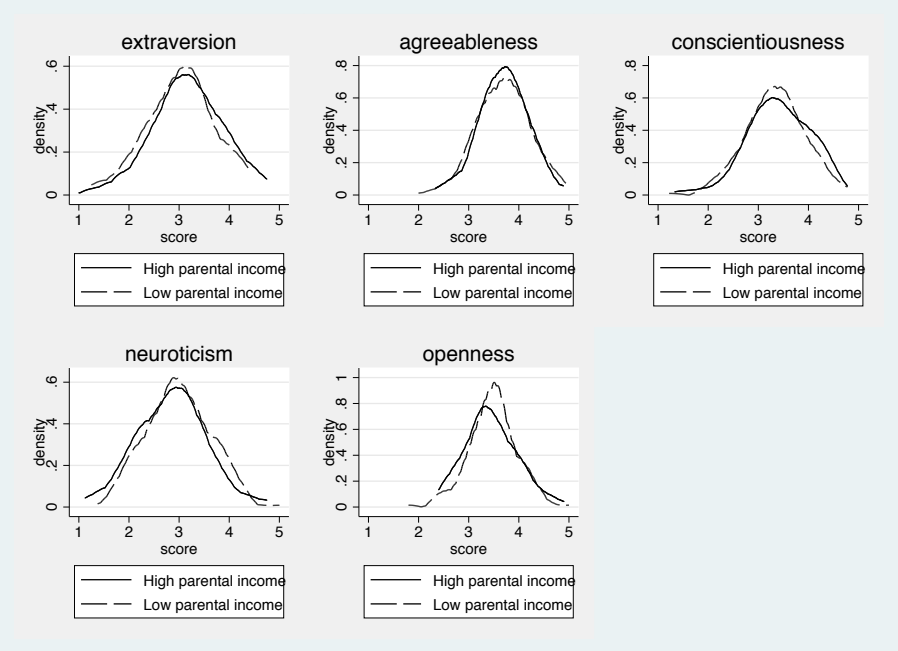

Figure 3: Personality traits density distribution by family income

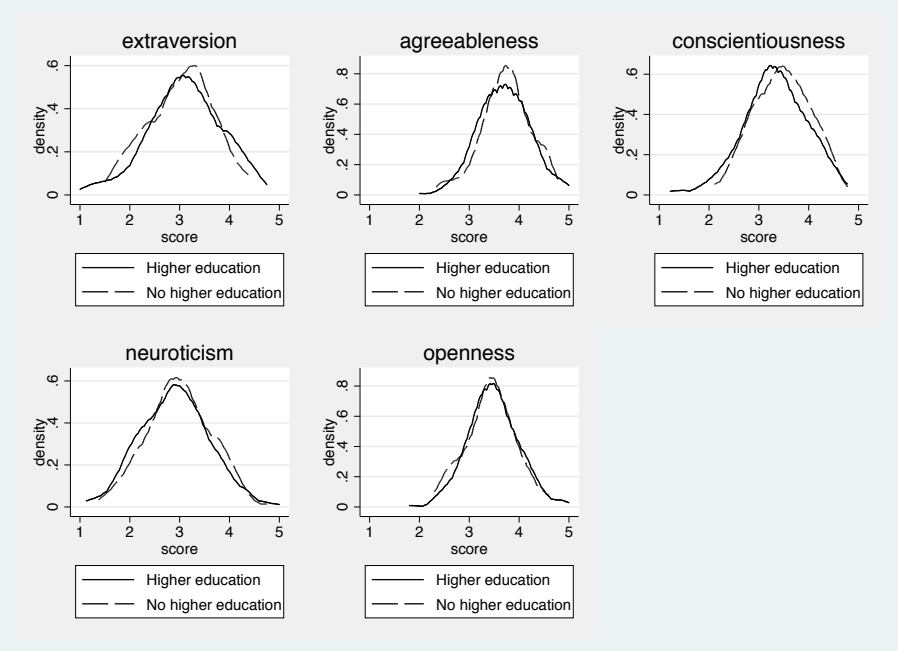

Figure 4: Personality traits density distribution by parental education

Table 1: Summary statistics

Variable	Mean	Std. Dev.	N
Individual characteristics			
Female	0.501	0.501	359
Age	22.08	3.25	359
Science major	0.482	0.5	359
Honour, Master or PhD student	0.301	0.459	359
High family income	0.432	0.496	359
Father education: less than college	0.339	0.474	342
Mother education: less than college	0.503	0.501	342
Family size	2.29	1.091	359
Big Five personality traits			
Extraversion	3.089	0.706	359
Agreeableness	3.698	0.518	359
Conscientiousness	3.371	0.619	359
Neuroticism	2.928	0.665	359
Openness	3.468	0.501	359
Average grade			
Fail (FL)	0.003	0.053	359
Pass Conceded (PC)	0.003	0.053	359
Pass (PS)	0.114	0.319	359
Credit (CR)	0.501	0.501	359
Distinction (DN)	0.295	0.457	359
High Distinction (HD)	0.084	0.277	359
Labour force status			
Working	0.474	0.5	359
Unemployed	0.061	0.24	359
Out of labour force	0.465	0.499	359
Hourly wage (if working)	22.19	10.28	169
Task outcomes			
Total payoff received (AUD)	22.864	5.803	359
Total correct answers	45.421	14.555	359
Total items answered	50.485	15.41	359

Table 2: Big Five personality traits and productivity (OLS)

	ln payment			*Total correct*	*Total items*
	Total	Round 1	Round 2	*answers*	*answered*
	(1)	(2)	(3)	(4)	(5)
Extraversion	0.002	0.005	-0.002	0.317	0.268
	(0.016)	(0.022)	(0.023)	(0.882)	(0.934)
Agreeableness	-0.025	-0.023	-0.052**	-1.047	-1.018
	(0.016)	(0.024)	(0.024)	(0.874)	(0.929)
Conscientiousness	0.026*	0.032	0.044*	1.275	1.257
	(0.015)	(0.021)	(0.023)	(0.819)	(0.866)
Neuroticism	-0.029**	-0.041**	-0.036	-1.616**	-1.554*
	(0.014)	(0.019)	(0.023)	(0.743)	(0.812)
Openness	-0.018	-0.037*	-0.022	-0.638	-0.994
	(0.015)	(0.020)	(0.021)	(0.846)	(0.856)
N	359	359	359	359	359
F-stat (Big Five)	2.70	2.63	2.49	2.33	1.97
F-stat	1.873	1.686	1.762	1.646	1.294
R^2	0.053	0.046	0.063	0.046	0.038

Robust standard errors are reported in parentheses. *** denotes significance at 1%, ** at 5% and * at 10%. All specifications control for session characteristics, gender and age of the subject, whether the student is a science major or a honour, masters or Ph.D. student. Our explanatory variables of interest have been standardized to have a mean zero and a standard deviation of one.

Table 3: Big Five personality traits and productivity: gender and major of specialization (OLS)

y=ln(total payment)	(1)	(2)	(3)	(4)
Extraversion	0.002	0.043*	0.005	0.034
	(0.016)	(0.022)	(0.022)	(0.024)
Extraversion*female		-0.078**		-0.079**
		(0.031)		(0.034)
Extraversion*business & arts major			-0.008	0.021
			(0.030)	(0.033)
Agreeableness	-0.025	-0.018	-0.023	-0.018
	(0.016)	(0.020)	(0.027)	(0.029)
Agreeableness*female		-0.005		-0.007
		(0.032)		(0.031)
Agreeableness*business & arts major			-0.007	-0.001
			(0.032)	(0.032)
Conscientiousness	0.026*	-0.004	0.006	-0.008
	(0.015)	(0.020)	(0.021)	(0.027)
Conscientiousness*female		0.032		0.015
		(0.026)		(0.025)
Conscientiousness*business & arts major			0.034	0.026
			(0.027)	(0.025)
Neuroticism	-0.029**	-0.040**	-0.067***	-0.071***
	(0.014)	(0.018)	(0.020)	(0.021)
Neuroticism*female		0.022		0.002
		(0.026)		(0.028)
Neuroticism*business & arts major			0.065**	0.076***
			(0.027)	(0.028)
Openness	-0.018	0.015	0.036*	0.051**
	(0.015)	(0.019)	(0.019)	(0.022)
Openness*female		-0.073***		-0.050*
		(0.027)		(0.026)
Openness*business & arts major			-0.098***	-0.088***
			(0.026)	(0.026)
N	359	359	359	359
F-stat	1.873	2.516	2.125	2.589
R^2	0.053	0.113	0.116	0.161

Robust standard errors are reported in parentheses. *** denotes significance at 1%, ** at 5% and * at 10%. All specifications control for session characteristics, gender and age of the subject, whether the student is a science major or a honour, masters or Ph.D. student. The omitted category are scientific majors.

Table 4: Big Five personality traits and productivity: family background (OLS)

y=ln(total payment)	(1)	(2)	(3)	(4)
Extraversion	0.004	0.015	-0.008	0.001
	(0.016)	(0.020)	(0.025)	(0.027)
Extraversion*high family income		-0.018		-0.018
		(0.032)		(0.032)
Extraversion*high parental education			0.017	0.018
			(0.031)	(0.032)
Agreeableness	-0.024	-0.012	0.005	0.011
	(0.016)	(0.021)	(0.020)	(0.023)
Agreeableness*high family income		-0.035		-0.035
		(0.032)		(0.033)
Agreeableness*high parental education			-0.040	-0.032
			(0.029)	(0.031)
Conscientiousness	0.024	0.013	0.042*	0.039*
	(0.015)	(0.017)	(0.022)	(0.023)
Conscientiousness*high family income		0.011		0.017
		(0.027)		(0.027)
Conscientiousness*high parental education			-0.025	-0.039
			(0.028)	(0.027)
Neuroticism	-0.026*	-0.052***	-0.024	-0.043*
	(0.014)	(0.018)	(0.020)	(0.023)
Neuroticism*high family income		0.043		0.044
		(0.027)		(0.029)
Neuroticism*high parental education			-0.003	-0.014
			(0.026)	(0.027)
Openness	-0.018	0.004	-0.008	0.009
	(0.015)	(0.020)	(0.024)	(0.026)
Openness*high family income		-0.044		-0.046
		(0.028)		(0.030)
Openness*high parental education			-0.014	-0.007
			(0.031)	(0.030)
N	344	344	344	344
F-stat	1.615	1.438	1.375	1.284
R^2	0.058	0.087	0.067	0.096

Robust standard errors are reported in parentheses. *** denotes significance at 1%, ** at 5% and * at 10%. All specifications control for session characteristics, age and gender of the subject, parental education, family composition and income, whether the student is a science major or a honour, masters or Ph.D. student, and average grade. A family is considered to be of high income if the subject reported 4 or higher in a 7 step classification of income. A parent is consider to have high education if he/she has at least some college education.