The Effect of the Big Five Personality Traits on College Major Choice: Evidence from a Dutch longitudinal youth cohort study.

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Abstract: We present a simple theoretical framework in which we allow individuals to choose a college major based on comparative advantage considerations, but also on the basis of tastes for actions related to college majors and their occupational fields. Using data of a large Dutch longitudinal youth cohort study, we are able to estimate the effect of personality measured at age 12 on college major choice six years later, circumventing the endogeneity problem of contemporaneous personality measures. We examine how the probability of choosing a certain college major category varies with personality traits captured by the Five-Factor Personality Inventory – extraversion, agreeableness, conscientiousness, emotional stability and autonomy. We find that extraversion, conscientiousness, emotional stability and autonomy indeed matter for college major choice, and that the associated effect sizes are comparable to and in some cases larger than those of cognitive skills such as math ability, verbal ability and information processing ability. We discuss which implications these findings have for policies aimed at managing individuals' college major choices.

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Introduction

The decision which college major to pursue is one of the farthest reaching decisions for individuals intending to enroll in higher education. The choice of college major to a large extent determines the occupational field the individual will work in in the future and career opportunities and risks associated with it. What is more, choosing a college major narrows down the kind of actions the individual will be doing for large parts of the day, for large parts of their lives. One can assume that high school graduates do not take this decision lightheartedly.

Earlier studies on sorting into college majors found cognitive skills, such as math and verbal ability, to be related to college major choice (Turner and Bowen, 1999). Math ability increases the odds of choosing math intensive college majors such as Economics, Math-Physical Sciences and Engineering over Humanities, while verbal ability has the opposite effect.

Besides cognitive skills, expected life time earnings have been shown to be an important driver of college major choice (Berger, 1988; Flyer, 1997). More recently, Saks and Shore (2005) that family wealth affects sorting into college majors as it mediates the earnings risk associated with them.

These studies, however, ignore the role of personality traits in college major choice. Personality traits can be conceptualized as directly determining individuals' comparative advantage and productivity in tasks (Heckman, Stixrud and Urzua, 2006). An intuitive and often brought forward example is that extroverts perform better in sales jobs than introverts (Barrick and Mount, 1991). Assuming that individuals choose the college major and related occupational career that maximizes their expected life-time utility, leaving personality traits out of the equation potentially overemphasizes the impact of cognitive skills, life-time earnings and other background variables on college major choice.

Yet, personality traits may not only affect utility via comparative advantages alone. Personality traits may be related to preferences for certain styles of behavior (Almlund, Duckworth, Heckman and Kautz, 2011) or subject matters. They therefore determine what individuals like and enjoy and what kind of jobs they can imagine themselves doing for the rest of their work-lives. Especially in developed countries, preferences for subject matters, next to cognitive skills, play an important role in college major choice (Arciadacono, 2004) and personality traits have the potential of capturing this impact.

In recent years, studies on occupational sorting have presented evidence that occupational choice depends on personality traits (Cobb-Clark and Tan, 2011). Our paper suggests that this sorting process does not only start at the time of entering the labor market but already with college major choice.

We present a simple theoretical framework in which we allow individuals to choose a college major based on comparative advantage considerations, but also on the basis of tastes for actions related to college majors and their occupational fields. We then examine how the probability of choosing a certain college major category varies with personality traits captured by the Five-Factor Personality Inventory – extraversion, agreeableness, conscientiousness, emotional stability and autonomy (FFPI; Hendriks, Hofstee, and De Raad, 1999).

We find that extraversion, conscientiousness, emotional stability and autonomy indeed matter, and that their effect size is comparable to and in some cases larger than that of cognitive skills such as math ability.

Our results represent an important contribution to the literature as we are able to estimate the effect of personality measured at age 12 on college major choice six years later, circumventing the endogeneity problem of contemporaneous personality measures. In addition, we here exploit the unique Dutch setting where college major choice is not influenced by the costs of studying or by similar credit constraints.

The paper is structured as follows. First, in our conceptual framework, we briefly lay out why we think personality traits should influence college major choice. We then present the data and the method used. Consequently, we present and discuss the result and formulate our conclusions.

Conceptual framework

In recent years, there has been a growing interest in the impact of personality traits on individuals' educational outcomes. Personality traits have been shown to affect individuals' probability of finishing secondary school, attending college, and obtaining a college degree (Heckman, Stixrud, Urzua, 2006; Cunha and Heckman, 2007; Borghans, Duckworth, Heckman, ter Weel, 2008; Baron Cobb-Clark, 2010).

Although there is a growing body of literature on the effect of personality traits on educational outcomes, there are, to our knowledge, no studies relating personality traits to the choice of college major. Naturally, entering higher education can be seen as a major achievement and investment in itself. Yet the choice of college major is also an important part of the schooling decision process as it largely determines the future track of economic activity with all the risks and opportunities but also work environment and working conditions associated with it. For example, choosing an education major is the first step of becoming a teacher and of working in a job which involves large amounts of social interaction and managing groups of young individuals. It is important to see the college major decision as a weighing of considerations about expected comparative advantages as well as tastes for certain subject matters and actions.

We present a simple theoretical framework of college major choice based on Almlund, Duckworth, Heckman and Kautz's (2011) approach to incorporate personality traits into economic models. We adapt their model to fit the specific context of college major choice.

The decision which college major to enroll in is comparable to the problem of picking a task to perform. A college major is related to performing a particular kind of (occupational) task during college and, after successful completion, in the labor market. The task related to a particular college major can be accomplished by a variety of actions. [2] Almlund et al. (2011:36) define actions as "*styles* of behavior that affect *how* tasks are accomplished". For example, an applied economist might try to fix a programming error by himself by looking through all the manuals and online portals available, or she might ask a more experienced colleague for help. Many different actions are possible to perform the task related to a particular college major. The individual's productivity in the task related to a college major is a function of the actions taken in that task. The actions themselves depend on personality traits and other productive factors. Some actions might be more productive in the task than others. Let's consider the task of a person working in marketing. Giving presentations and talking to potential customers directly after workshops might be a more effective way to promote products or services than sending long technical e-mails. Giving presentations and chatting away with potential customers might be an easy action to do for extroverted persons but it would cost introverted persons a lot of effort.[3] Introverted persons will therefore be more likely to opt for the e-mail option to accomplish the same task. This might prove less effective than approaching customers directly. Thus, depending on the task to perform, there will be comparative advantages and productivity differentials for people with different personality traits. Evidence pointing in this direction comes from the vocational psychology as well as the economic literature. For example, and much in line with

[2] We do not make a distinction between tasks related to college major and tasks related to the future occupational field as it is a plausible assumption that both are highly correlated.

[3] Effort can substitute for personality traits or complement them.

intuition, extraversion has been found to be associated with higher job performance in management and sales occupations (Barrick and Mount, 1991). Cattan (2010) shows that sociability, a trait related to extraversion, is rewarded in some occupations and penalized in others. Controlling for selection, she finds that a standard deviation increase in sociability leads to a 6% increase in the wages of managers, a 4% increase in the wages of sales workers, a 2% increase in the wages of clerical workers, but leads to a 2% decrease in the wages of professionals. Emotional stability and agreeableness have been found to be particularly important in jobs involving large amounts of teamwork and dyadic customer interaction (Mount, Barrick and Steward, 1998).

In approaches based entirely on comparative advantages college major choice would be the result of maximizing final consumption resulting from multiplying productivity P_j with the reward to a unit of productivity R_j. The effect of personality traits on college major choice would run through the choice of actions taken to perform the task related to a college major and their effect on productivity.

In this paper, we deliberately choose a more general approach which allows the individual to attach utility to some actions even if they do not contribute to productivity in task *j*. We think that this is an important channel through which personality traits determine college major choice as personality traits are related to tastes for certain behaviors and subject matters. For example, it is quite obvious that extroverts enjoy actions involving social contact and persuading others. Staying with our marketing example, even if chatting away with potential customers after presentations was not the optimal way to sell products and services, extroverts might nevertheless opt for this action as they directly derive utility from it and because this utility might compensate for a loss in income. Krueger and Schkade (2008) show that indeed extroverted persons sort into jobs which provide them with the opportunity for social contact. Arcadiacono (2004) suggests that tastes for certain subject matters drive sorting across college majors to a large extent. In our theoretical framework, individuals choose the college major (and the associated labor market career) which maximizes their expected utility derived from life time consumption as well as actions associated with future labor market activity. This general formulation allows the individual to attach value to some actions which do not have influence on productivity.

Our work is very exploratory and we do not derive specific prediction for the effect of the individual Big Five personality traits on the probability to choose college major *j*. Our simple theoretical framework unfolds two main channels through which personality traits might affect college major choice. Personality traits determine college major choice a) through the value they attach to the actions related to task associated with a particular college major and b) through their contribution to productivity. Empirically, we will not be able to disentangle these two channels. Although tastes and preferences for certain professions and subject matters are distinct from comparative advantages at first sight, a good fit between a person's occupational interests and realized occupational choice has been shown to lead to higher job performance (Neumann, Olitsky, Robbins, 2010). Hence, choosing one's major according to taste for certain actions or because one is aware of one's comparative advantage leads to much the same outcome: earnings and productivity differences across individuals with similar occupations. Whenever individuals select their college major on the basis of comparative advantages or taste for actions associated with them, we will see an effect of personality traits on college major choice.

The VOCL'99 data and methodology

We use data of a large longitudinal Dutch youth survey of 19395 individuals who entered secondary education and were around the age of 12 in 1999. Students stem from a random selection of 126 Dutch schools (Van Berkel, 1999). The cohort has been shown to be a representative sample of 12-year old

students in the Netherlands (Kuyper and Van der Werf, 2003). By annually matching the cohort to the national educational register, individuals' educational pathways have been followed until 2008. We limit the sample to individuals who were 12, 13 or 14 in 1999 and then focus on individuals who – from 2004 on – entered university education. We define college major choice as the college major individuals enrolled in their first year of university education. We do not incorporate university of applied sciences (HBO) in our study as this type of education is distinct from university education. We convert the detailed information on college major choice available in the data into four larger categories 1) Humanities and Social Sciences, 2) Business, Economics and Law, 3) Mathematics, Natural Sciences, Engineering and other technical studies, and 4) Medical studies. The detailed mapping table is available in the Appendix. As Agricultural Studies and Environment only contains 37 individuals in our sample we omit this category in our regressions.[4] The distribution across major categories as follows:

Table 1: Sample distribution of individuals across college major categories

College major category	**Number of observations**
Humanities and Social Sciences	955
Business, Economics, Law	654
Mathematics, Natural Sciences, Engineering/other technical studies	502
Medical Studies	309
Total	2420

In the second year of the study, in February 2001, students were administered the Five-Factor Personality Inventory (FFPI; Hendriks, Hofstee, & De Raad, 1999) which assesses the Big Five personality dimensions extraversion, agreeableness, conscientiousness, emotional stability and autonomy. Their definition is presented in Table 2. The questionnaire contained 100 items on a five-point scale ranging from 1 (not at all accurate) to 5 (fully accurate). Each personality dimension was assessed using 10 positively and 10 negatively formulated items. The VOCL'99 data set contains the factor scores computed by the FFPI scoring program (Hofstee and Hendriks, 1998). The constructed Big-Five factors are uncorrelated. The internal consistency reliability (stratified-alpha) of extraversion is a = 0.841, of agreeableness a = 0.82, of conscientiousness a = 0.84, of emotional stability a = 0.83, and of autonomy a = 0.72.

In January 2000, four months after entering secondary education, all students were administered a subset of the traditional Dutch Cito test used to sort students across secondary education tracks. This test is comparable to the SAT and assesses math ability, verbal ability and information processing ability. Each ability is assessed using a battery of 20 multiple choice items. This provides us with an excellent measure of these cognitive skills. We standardize all measures of personality traits and cognitive ability to have a mean of zero and a standard deviation of one.

Table 2: Personality traits and their hypothesized relationship with vocational interest types

Personality trait	Definition
Extraversion	Preference for human contact, attention and the wish to inspire other people; Gregariousness and assertiveness versus reservation and timidity.
Agreeableness	Willingness to help other people and to act in accordance with other people's interests;

[4] This does not affect our outcomes.

	Degree to which an individual is co-operative, warm and agreeable versus cold, disagreeable and antagonistic.
Conscientiousness	Preference for following rules and schedules, for keeping engagements, and the extent to which individuals are hardworking, organized, and dependable, as opposed to lazy, disorganized and unreliable.
Emotional stability	Relaxed versus nervous and independence versus dependence; Degree to which the individual calm, self-confident and cool rather than insecure, anxious, depressed and emotional.
Autonomy	A person's propensity to make his or her own decisions and degree of initiative and control.

Definitions adapted from Nyhus and Pons (2005).

It is important to control for variables which might be related to both personality traits and college major choice. First of all, we control for gender as female students have different personality trait endowments but also make different college major choices.

College major choice is heavily influenced by parental background. Education and occupation of the parents can affect the information set available to the individual on which expectations about utility are founded. Individuals' access to information on job attributes including actions associated with them, rewards to productivity or even the college major choice set vary with parental background. Another important factor in college major choice related to parental background is family wealth. This is highlighted by Saks and Shore (2006) who present evidence that individuals are more likely to sort into risky college majors (in terms of income) when family wealth is higher. They argue that family wealth makes expected consumption more independent from income from productive activity and that income risk is mediated by this external source of income. Sociological studies on the mechanisms through which parental background might influence college major choice pertain to cultural status and upward mobility. Van der Werfhorst et al. (2001) argue that children of higher educated parents are more likely to study Humanities, Social Sciences and Arts in order to maintain their cultural status. Moreover, Van der Werfhorst et al. (2001) argue that children from households with low socio-economic status are more likely to enroll in technical studies as a safe way to upward mobility. It is also very likely that individuals' personality traits are correlated with parental background indicators. Anger (2012) for personality traits and Dohmen, Falk, Huffman and Sunde (2011) for risk preference show that non-cognitive skills are transmitted from parents to children. To avoid our results to be biased, we control for parental education, father's occupational sector as well as net yearly parental household income and the number of children in the household. Unfortunately, the income categories contained in the data set only differentiate well among low income households. 65% of households are in the highest income category (more than 60.000 gulden net yearly income 1999).
Other factors possibly relating to the higher education infrastructure and the information set available and for which we control for are being non-dutch and the province individuals lived in at in 1999. The specification of control variables is shown in detail in the Appendix.

We model the college major decision as a choice between four discrete alternatives and use a multinomial logit framework to examine how the Big Five personality traits as well as math, verbal and information processing ability relate to this choice. The utility individual *i* derives from choosing college major *j* can be expressed as:

$$U_{i,j} = x'_i \beta_j + e_{i,j} \tag{7}$$

Individuals choose the college major which gives them the highest (expected) utility. The multinomial logit model assumes that all $e_{i,j}$ are mutually independent with a log Weibull distribution (also known as a type I extreme value distribution). The probability that individual *i* chooses college major j is

$$\Pr(Y_i = j|x_i) = P_{i,j} = \frac{\exp(x'_i \beta_j)}{1 + \sum_{k=1}^{J} \exp(x'_i \beta_k)}, \; j = 0,1,...,3 \tag{8}$$

where β_0 has been normalized to equal 0.

From

$$\ln\left[\frac{P_{i,j}}{P_{i,k}}\right] = x_i'(\beta_j - \beta_k) = x'_i \beta_j \text{ if k=0} \tag{9}$$

results that β_j can be interpreted as the effect of an incremental change in the independent variable on the log odds ratio, the log of the probability of choosing college major *j* over *k*.

As our research question is less concerned with the effect of personality traits on choosing one college major over an arbitrarily chosen base category *j*=0, we calculate average marginal affects given by:

$$\frac{\partial P_{i,j}}{\partial x_i} = P_{i,j}\left[\beta_j - \sum_{k=0}^{J} P_{i,k}\beta_k\right] \tag{10}$$

The average marginal effect allows us to examine how probability to choose college major *j* would change with a unit change in the independent variable.[5]

Results

Table 3 presents the marginal effects of personality traits and cognitive skills on the probability of choosing the different college major categories. A graphical illustration of these effects can be found in the Appendix. We find that extraversion increases the probability of choosing Business, Economics or Law in college and at the same time decreases the probability of choosing Mathematics, Natural Sciences, Engineering or other technical studies. Controlling for math ability, increasing levels of extraversion shift individuals' choice from Mathematics, Natural Sciences, Engineering or other

[5] Note that the multinomial logit model relies on the Independence of Irrelevant Alternatives (IIA) assumption. A natural alternative which avoids this assumption is the multinomial probit model. The huge disadvantage of this model, however, is its computational complexity which in our case makes it infeasible for the full model. We therefore ran restricted models only including our measures of personality traits and cognitive skills as well as the female dummy for both types of models – the multinomial logit (MNL) and the multinomial probit (MNP) model. If the IIA assumption was a serious problem, the marginal effects calculated from the two models would not be comparable, which is not the case (see Appendix for the table with the two sets of marginal effects). We take this as evidence that the IIA assumption is not a problem in our case and we take the multinomial logit model with the full set of controls to produce our main results.

technical studies to college majors which are similar with regard to the level of structure and rules, the use of data, etc., yet which fit their tastes and expected productivity better in terms of the expected opportunity for social interaction, for persuading others, and for being in the center of attention: Business, Economics and Law. In the words of Sherwin Rosen: "Musicians cannot be tone-deaf; football players tend to be large; while lawyers, and many economists, have a propensity to talk" (Rosen, 2002:9).

Previous studies by Bonin, Dohmen, Falk, Huffman and Sunde (2007), Fouarge, Kriechel and Dohmen (2012) as well as Caner and Otken (2010) suggest that risk preference influences individuals' sorting across occupation. Saks and Shore (2005) identify Business studies as particularly risky in terms of earning variance. If extraversion was related to risk tolerance, the effect we see could be based on the fact that risk tolerant persons sort into Business and Economics college majors. However, Dohmen, Falk, Huffman and Sunde (2010) show that extraversion and risk tolerance are not correlated.

Table 3: Marginal effects of personality traits and cognitive skills on probability of choosing major (average partial effects)

	Humanities and Social Sciences	Business, Economics, Law	Mathematics, Natural Sciences, Engineering/other technical studies	Medical studies
Extraversion	0.001	0.052***	-0.053***	0.000
	(0.011)	(0.010)	(0.008)	(0.007)
Agreeableness	0.013	-0.015	-0.005	0.008
	(0.011)	(0.010)	(0.009)	(0.008)
Conscientiousness	-0.008	-0.007	-0.009	0.024***
	(0.011)	(0.010)	(0.009)	(0.008)
Emotional stability	-0.040***	0.017*	0.023***	-0.001
	(0.010)	(0.010)	(0.009)	(0.008)
Autonomy	-0.000	0.011	0.002	-0.013*
	(0.011)	(0.010)	(0.009)	(0.007)
Math ability	-0.038***	-0.006	0.031***	0.013
	(0.011)	(0.011)	(0.010)	(0.009)
Verbal ability	0.036***	-0.015	-0.025***	0.004
	(0.011)	(0.010)	(0.009)	(0.008)
Information processing ability	-0.020*	-0.021**	0.023**	0.019**
	(0.011)	(0.010)	(0.010)	(0.009)

Note: Average marginal effects from a multinomial logit model of college major choice conditional on personality traits, cognitive skills and controls. *** p<0.01, ** p<0.05 and * p<0.1. Log likelihood full model -2772.994, intercept only -3169.259. Count R2 = 0.503, adj. count R2=18.0. N=2420.

Agreeable individuals are persons who are considered warm and who enjoy helping others. One might therefore expect that agreeable individuals have a comparative advantage and would have a taste for actions related to college majors involving help-giving and care, such as Medical Studies. We find, however, no evidence for this intuition. Agreeableness is not related to any probability of choosing a certain college major.

With regard to conscientiousness and autonomy we have to keep in mind that our sample consists entirely of students in higher education. Conscientious individuals are hardworking and intellectually autonomous individuals are highly motivated to learn new skills. Not surprisingly, conscientiousness and autonomy (similar to openness to experience) are positively related to academic success (O' Connor and Paunonen, 2007) and the probability of entering higher education in general.

Nevertheless, so to speak in addition to this general effect, we find a relationship between these two personality traits and sorting into Medical Studies. Our results show that autonomy is negatively related to choosing Medical Studies in college and that conscientiousness increases the probability of

choosing Medical studies. There are two explanations for the latter finding. Firstly, access to Medical studies is restricted in the Netherlands. Access is granted via a weighted lottery in which high school grades are taken into account. As conscientiousness is related to academic achievement, this could account for the effect we find. In addition, although conscientiousness increases productivity in all occupations, the expected reward to productivity is high for doctors.[6]

Emotional stability – to be calm, self-confident and cool rather than insecure, anxious, depressed and emotional – is positively related to the probability to enroll in Mathematics, Natural Sciences, Engineering or other technical studies as well as Business, Economics and Law. It is negatively linked to the probability of choosing Humanities and Social Sciences. Emotional stability has often been highlighted as a trait which is positively related to performance in all occupations (Mueller and Plug, 2006; Nyhus and Pons, 2005). Mount et al. (1998) argue that emotional stability increases the ability to work efficiently in teams and find this trait to particularly increase job performance in jobs involving teamwork. If our results were the outcome of individuals' comparative advantage considerations, they would indicate that teamwork intensity in occupations related to technical college majors is particularly high. However, in general, teamwork is not a regarded as a feature of a particular occupational field or college major. A potential explanation of this outcome is that emotional stability is positively related to being a conventional vocational interest type (De Fruyt and Mervielde, 1997) which means that emotional stable individuals sort into Mathematics, Natural Sciences, Engineering or other technical studies as well as Business, Economics and Law because they enjoy structured environments and rules and they dislike the seemingly unstructured environment of humanities and social sciences. Following Holland's (1997) description of more artistic work environments and personality types, it may also be that the more disorderly and emotionally charged nature of individuals studying humanities is an important stimulus for their more artistic activities, and might, in the end, represent a comparative advantage in this field.

The results for math ability and verbal ability are in line with sorting on the basis of taste and comparative advantage and are similar to the findings of Turner and Bowen (1999). Math ability and verbal ability work in opposite directions. While math ability increases the probability of choosing Mathematics, Natural Sciences, Engineering and other technical studies and decreases the probability of choosing Humanities and Social Sciences, verbal ability increases the probability of choosing the latter and decreases the probability of choosing the former.

We find that information processing ability increases the probability to enroll in Medical Studies as well as Mathematics, Natural Sciences, Engineering or other technical studies and it decreases the probability of choosing the other two categories. Again, a potential explanation is that the two former college majors are known to involve a tight curriculum which necessitates higher than average information processing ability. Individuals might anticipate this and sort accordingly.

One major advantage of being able to include measures of personality traits and cognitive skills in the same model is the ability to compare effect sizes. As we standardized our measures, we can compare the magnitude of average marginal effects across measures as the effect of a standard deviation increase in the trait or the ability on the probability of choosing a certain college major. In general, we can observe that the magnitude of the marginal effects is similar for personality trait measures and ability measures. This is true for emotional stability, math ability, verbal ability and information processing ability in determining sorting into Humanities and Social sciences as well as Mathematics, Natural Sciences, Engineering and other technical studies. It is also true for the absolute effect size of emotional stability and information processing ability on the probability of choosing

[6] 10 years after leaving university, the average monthly gross earnings of Medical students are 6000 Euro, followed by Business and Economics students (5600 Euro) and Law students (5100 Euro). In contrast, Psychology and Neuroscience students (Humanities and Social Sciences category) earn an average of 3500 Euro gross per month 10 years after leaving university. Source: Graduate survey Maastricht University (UM Scanner), 2011.

Business, Economics and Law, as well as the effects of conscientiousness and information processing ability on the probability of choosing Medical Studies. The large effects of extraversion present an exception. A one standard deviation change in extraversion increases the probability of choosing Business, Economics or Law by 5.2%. This is almost twice the effect size of a standard deviation increase in information processing ability which decreases the probability of choosing college majors in this category by 2.1%.[7] Extraversion also has a strong effect on the probability of choosing Mathematics, Natural Sciences, Engineering or another technical study. A one standard deviation increase in extraversion decreases the probability of choosing this college major group by 5.3%. This effect – in absolute terms, leaving the sign aside – is larger than a standard deviation increase in emotional stability which increases the probability of choosing Mathematics, Natural Sciences, Engineering or another technical study by 2.3% and it even exceeds the effect of a standard deviation change in math ability which increases the probability of choosing this category by 3.1% (difference significant at 10% level). This is a remarkable outcome and underlines the importance of personality traits for the choice of college majors.

Results with regard to control variables

Although we will not go into detail with interpreting the average marginal effects of our control variables, some results deserve mentioning.

First, the highest level of parental education does not seem to be related to the choice of college major. There are two exceptions. Children whose highest parental education is the first step of secondary education have a higher probability of choosing the Business, Economics and Law college major category. Individuals with at least one parent with a doctorate are more likely to choose Mathematics, Natural Sciences, Engineering or another technical study. The latter might be because doctorates are very common in these fields and that the variable might pick up the effect of choosing a college major similar to those of the parents.

Father's occupational sector has significant and very straight forward effects on individuals' college major choice. For example, individuals whose father works in public administration are 10% more likely to choose a college major in Humanities and Social Sciences and 9% less likely to choose Business, Economics and Law than individuals whose father works in construction, industry or agriculture. Individuals with a father working in business services or banking and insurance are more likely to choose Business, Economics or Law than those of children of fathers with more technical occupations. Children of a fathers working in the health and welfare sector have a 7.2% higher probability to enroll in Medical Studies.

Parental income does not play a large role in college major choice. We find significant average marginal effects for the lowest income category which increases the probability of individuals to enroll in Medical Studies while decreasing the probability to enroll in Humanities and Social Science. This might be the result of individuals from low income families trying to secure upward mobility. Stemming from a household in the second lowest income category increases individuals' probability to choose Humanities and Social Sciences.

The minor role of income in the decision which college major to pursue contradicts the findings of Saks and Shore (2006) who argue that family income mediates the risk of studying business. Although our measures of family wealth are less complex, our results suggests that their finding depends on the

[7] The magnitude of the average marginal effects of extraversion and information processing ability are significantly different from each other at the 5% level: $\left(t = \frac{ame_e - ame_i}{\sqrt{\sigma_e + \sigma_i}} = \frac{0.052 - 0.021}{\sqrt{(0.01)^2 + (0.01)^2}} = 2.19 \right)$

particular American context and that in the Dutch context, with the costs of studying being similar for all college majors, family wealth does not have the same effects. The absence of a significant effect of household income on the probability of enrolling in technical studies suggests that policies such reducing or abolishing tuition costs for engineering in order to increase the supply of engineers will most likely not work.

As expected and often observed, female students are more likely than male students to choose Humanities and Social Sciences as well as Medical Studies. They are less likely to enroll in Business, Economics and Law as well as Mathematics, Natural Sciences, Engineering or another technical study. Compared to individuals without a migration background, individuals with a migration background are more likely to choose Business, Economics and Law at the expense of Humanities and Social Sciences.

Table 4: Average marginal effects selected control variables

	Humanities and Social Sciences	Business, Economics, Law	Mathematics, Natural Sciences, Engineering/other technical studies	Medical studies
Highest level parental education				
Low	-0.082	0.071	0.057	-0.045
	(0.061)	(0.052)	(0.050)	(0.044)
1st step secondary ed.	-0.045	0.090**	0.007	-0.052
	(0.051)	(0.042)	(0.039)	(0.039)
2nd step secondary ed.	-0.016	0.022	0.024	-0.031
	(0.025)	(0.024)	(0.021)	(0.019)
1st step university or university of applied science	Ref	Ref	Ref	Ref
2nd step university or post-university of applied science	-0.033	-0.018	0.036	0.016
	(0.027)	(0.026)	(0.022)	(0.018)
Doctorate	-0.053	-0.072	0.099***	0.027
	(0.049)	(0.048)	(0.037)	(0.029)
Father's occupational sector				
Agriculture, Industry or Construction (as technical professions)	Ref	Ref	Ref	Ref
Transportation and Communication	0.016	0.035	-0.003	-0.048
	(0.056)	(0.050)	(0.043)	(0.046)
Banking and Insurance	-0.055	0.009**	-0.071	0.035
	(0.057)	(0.045)	(0.048)	(0.034)
Business services	0.010	0.082**	-0.070**	-0.022
	(0.100)	(0.033)	(0.031)	(0.028)
Hotel, Restaurant, Catering	0.158	-0.025	-0.097	0.014
	(0.050)	(0.090)	(0.084)	(0.060)
Trade	0.158***	-0.104*	-0.057	0.003
	(0.050)	(0.056)	(0.044)	(0.038)
Health and Welfare	0.083**	-0.068*	-0.088**	0.072***
	(0.040)	(0.041)	(0.034)	(0.025)
Education	0.048	0.004	-0.033	-0.019
	(0.042)	(0.040)	(0.033)	(0.030)
Public administration	0.099***	-0.083**	0.029	-0.044
	(0.037)	(0.037)	(0.029)	(0.030)

Culture, Sports, Recreation	0.077 (0.124)	-0.026 (0.115)	0.030 (0.084)	-0.081 (0.113)
Other	0.051 (0.040)	-0.007 (0.037)	-0.037 (0.031)	0.007 (0.029)
Net yearly parental household income (gulden)				
Below 20000	-0.173* (0.093)	-0.034 (0.097)	0.069 (0.079)	0.138*** (0.045)
20000-30000	0.108* (0.059)	-0.028 (0.056)	-0.073 (0.056)	-0.007 (0.048)
30000-40000	-0.017 (0.046)	-0.014 (0.049)	0.037 (0.036)	-0.006 (0.034)
40000-50000	0.035 (0.040)	0.001 (0.038)	-0.005 (0.032)	-0.031 (0.034)
50000-60000	0.026 (0.034)	-0.003 (0.032)	0.006 (0.027)	-0.017 (0.026)
more than 60000	Ref	Ref	ref	Ref
female	0.232*** (0.019)	-0.089*** (0.018)	-0.210*** (0.018)	0.066*** (0.015)
non-dutch	-0.067** (0.029)	0.061** (0.024)	-0.017 (0.023)	0.023 (0.019)

Note: Average marginal effects of selected control variables from a multinomial logit model of college major choice conditional on personality traits, cognitive skills and controls. For average marginal effects of remaining control variables see Appendix. *** p<0.01, ** p<0.05 and * p<0.1.

Conclusions

In this paper we show that personality traits have a significant influence on individuals' college major choice. The effect sizes of personality traits are similar to those of cognitive skills such as math ability, verbal ability and information processing ability. For Mathematics, Natural Sciences, Engineering and other technical studies as well as for Business, Economics and Law, the influence of personality (extraversion) even exceeds the influence of cognitive skills (math and information processing ability). Our findings suggest that increasing students math ability indeed opens up opportunities in Mathematics, Natural Sciences, Engineering and other technical studies for individuals who would otherwise have chosen (or would have had to choose) Humanities and Social Sciences. This is potentially good news for policies targeting the quantity and quality of math ability learned in school in order to increase the supply of students in majors considered crucial for economic development, such as Engineering. However, focusing on math ability alone neglects the influence personality traits have on college major choice. For example, policy makers intending to change individuals' choices from Humanities and Social Sciences to more technical majors have to take individuals' differences in emotional stability into account. Another important finding of our study is that Business, Economics and Law majors and Mathematics, Natural Sciences, Engineering and other technical studies compete for similar students and that individuals' final choice is partly determined by their level of extraversion. Extroverted individuals may consider their personality particular productive in Business, Economics or Law as opposed to Mathematics, Natural Sciences, Engineering and other technical studies. This consideration would affect their expected life time consumption. If college major choice

was to a large extent based on consumption considerations, increasing rewards to a unit of productivity in technical studies would make extroverted individuals increasingly indifferent between the two choices. However, extroverted individuals might prefer Business, Economics or Law over technical studies because they expect more opportunities to live out their assertiveness, dominance and persuasiveness in these occupational fields. If taste and productivity considerations added up, this would have important implications for the wage (reward per unit of productivity) differential which would be necessary to make individuals indifferent about the two choices. Our conceptual framework implies that it will be particularly difficult and costly to influence college major choice of individuals who are prepared to trade a lot of expected life-time consumption for a good match between personality and the actions involved in studying a particular college major or performing an occupation.

It can be argued that the information young individuals possess when making their choices are incomplete at best. To the extent that individuals do not possess adequate information, advising individuals better of the returns per unit productivity or the actions related to particular occupations will affect their choices. However, because in this study we are not able to disentangle the effect of personality traits on college major choice through consumption and taste considerations, and because we do not know what weight individuals attach to each of these considerations, we cannot make precise predictions about the proportion of individuals who would make different choices if one of the parameters in our model would change.

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Appendix

Table 5: Descriptives control variables

Variable	**% in sample**
Female	49.55
Nondutch	16.57
Net yearly parental household income	
Below 20000	1.63
20000-30000	4.14
30000-40000	6.46
40000-50000	9.44
50000-60000	13.80
more than 60000 (ref)	64.53
Highest parental education	
Low	3.33
1st step vo	5.06
2nd step vo	29.38
1st step wo or hbo (ref)	33.69
2nd step wo or post-hbo	23.08
Doctorate	5.46
Father's occupation	
Agriculture, construction, industry (technical)(ref)	22.71
Transport and communication	4.47
Banking and insurance	5.23
Business services	14.16
Hotel, restaurant, catering	1.42
Trade	4.90
Health and Welfare	11.49
Education	10.29
Public administration	13.34
Culture, sports, recreation	0.98
Others	11.00
Missing: 584/2420	
Number of children in parental household	
0	7.44
1	13.18
2	36.65
3	29.83
4	9.17
5 or more	3.72
Provinces	
Groningen	1.47
Friesland	4.26
Drente	4.80
Overijssel	7.16
Flevoland	0.50
Gelderland	9.64
Utrecht	9.06
Noord-Holland	15.40
Zuid-Holland	18.29
Zeeland	0.95
Noord-Brabant	19.16
Limburg	9.06

Own calculations.

Table 6: Comparison average marginal effects restricted multinomial logit model and restricted multinomial probit model

	Humanities and Social Sciences		Business, Economics, Law		Mathematics, Natural Sciences, Engineering/other technical studies		Medical studies	
	MNL	MNP	MNL	MNP	MNL	MNP	MNL	MNP
Extraversion	0.004	0.004	0.055***	0.055***	-0.061***	-0.062***	0.002	0.003
	(0.013)	(0.012	(0.012)	(0.012)	(0.009)	(0.009)	(0.008)	(0.008)
Agreeableness	0.019*	0.020*	-0.020*	-0.021**	-0.007	-0.006	0.008	0.007
	(0.011)	(0.011)	(0.011)	(0.011)	(0.009)	(0.009)	(0.008)	(0.008)
Conscientiousness	-0.011	-0.010	-0.000	-0.000	-0.008	-0.010	0.020***	0.020***
	(0.011)	(0.011)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)	(0.008)
Emotional	-0.041***	-0.041***	0.018	0.017	0.024**	0.025**	-0.001	-0.001
stability	(0.013)	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)	(0.009)	(0.009)
Autonomy	-0.005	-0.005	0.018	0.017	-0.001	-0.000	-0.012	-0.012
	(0.013)	(0.013)	(0.012)	(0.012)	(0.011)	(0.010)	(0.009)	(0.009)
Math ability	-0.015***	-0.015***	-0.003	-0.003	0.014***	0.014***	0.004	0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Verbal ability	0.016***	0.016***	-0.006	-0.005	-0.010***	-0.011***	0.000	0.000
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Information	-0.008*	-0.007*	-0.012***	-0.012***	0.010***	0.010***	0.010***	0.009***
processing ability	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)

Note: Multinomial logit model (MNL) and multinomial probit model (MNP) run without controls and missing dummies. N=1185.

Table 7: Mapping VOCL'99 college major categories to four categories used in multinomial logit framework

Category used in multinomial logit framework	**Dutch VOCL data college majors**	**Cases**
Humanities, Social Sciences and Arts	Theology	5
	Languages (Dutch, French, Spanish, German, English)	160
	Languages - others	144
	History	45
	History of Art/Archeology	7
	Philosophy	9
	Administrative Studies	37
	Physical education	20
	Geography	14
	Anthropology Sociology	19
	Health Sciences	54
	Sociology	19
	Political Sciences	20
	Psychology	171
	Educational Sciences	74
	Social Sciences - others	157
		955
Business, Economics, Law	Business/Economics	318
	Econometrics	15
	Business-others	170
	Law	151
		654
Mathematics, Natural Sciences, Engineering, other technical studies	Mathematics	6
	Physics	3
	Chemistry	13

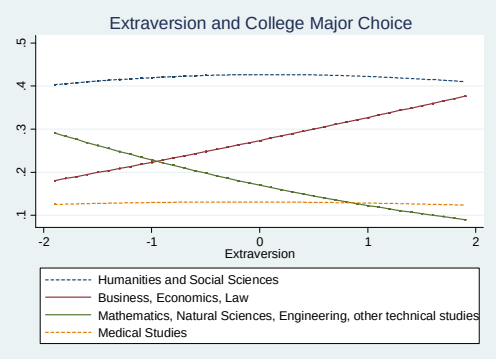
	Biology	40
	Pharmaceutical studies	7
	Mathematics/Natural Sciences -others	92
	Technical Mathematics	6
	Technical Physics	33
	Technical Chemistry	10
	Civil Engineering	29
	Construction	55
	Electrotechnology	19
	Toolmaking	54
	Aerospace	26
	Technical Business studies	27
	Technical studies - others	82
		502
Medical Studies	Medical studies Medicine	196
	Medical studies other	105
	Dentistry	8
		309
		2420

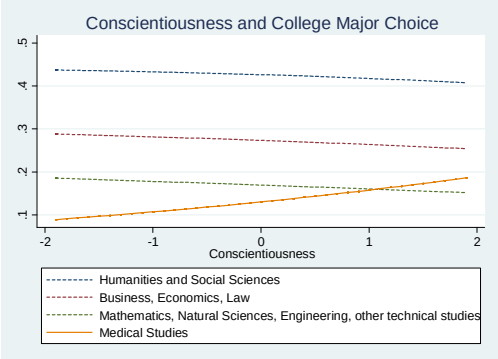
Table 8: Average marginal effects remaining control variables

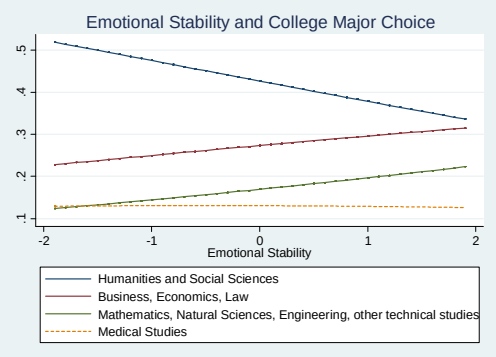
	Humanities and Social Sciences	Business, Economics, Law	Mathematics, Natural Sciences, Engineering/other technical studies	Medical studies
Number of children	-0.007	-0.015	0.029***	-0.007
	(0.010)	(0.010)	(0.008)	(0.008)
Groningen	-0.086	0.008	0.119*	-0.041
	(0.095)	(0.085)	(0.062)	(0.060)
Friesland	-0.0144***	0.076	0.061	0.008
	(0.053)	(0.053)	(0.044)	(0.039)
Drente	-0.097*	0.124**	0.021	-0.048
	(0.050)	(0.049)	(0.046)	(0.041)
Overijssel	-0.069	0.078*	-0.001	-0.008
	(0.046)	(0.046)	(0.040)	(0.033)
Flevoland	1.324***	-2.664***	0.885***	0.455***
	(0.141)	(0.102)	(0.124)	(0 .083)
Gelderland	-0.098**	0.100**	0.018	-0.020
	(0.042)	(0.042)	(0.037)	(0.032)
Utrecht	-0.109**	0.076*	0.029	0.004
	(0.044)	(0.044)	(0.038)	(0.032)
Noord-Holland	-0.113***	0.082**	0.022	0.009
	(0.039)	(0.040)	(0.034)	(0.028)
Zuid-Holland	-0.069*	0.072*	0.016	-0.019
	(0.038)	(0.039)	(0.033)	(0.028)
Zeeland	0.097	-0.202	0.058	0.048
	(0.098)	(0.138)	(0.079)	(0.074)
Noord-Brabant	-0.124***	0.058	0.059*	0.007
	(0.036)	(0.038)	(0.032)	(0.026)
Limburg	Ref	Ref	Ref	Ref
Extraversion	-0.155	0.111	0.028	0.016
missing	(0.109)	(0.098)	(0.070)	(0.050)
Agreeableness	0.072	0.061	0.020	-0.153**
missing	(0.075)	(0.069)	(0.056)	(0.070)
Conscientiousness	0.081	-0.126	0.017	0.028
missing	(0.113)	(0.104)	(0.090)	(0.067)
Emotional stability	-0.043	0.039	-0.017	0.021
missing	(0.122)	(0.119)	(0.087)	(0.078)
Autonomy missing	0.056	-0.126	-0.019	0.089
	(0.103)	(0.102)	(0.069)	(0.062)
Math ability	-0.353	0.342*	-0.207*	0.218
missing	(0.264)	(0.187)	(0.117)	(0.158)
Verbal ability	0.168	-0.180	0.143*	-0.131

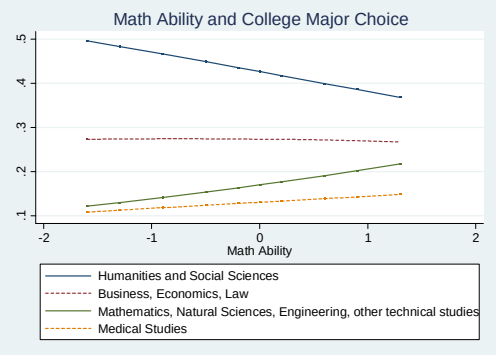
missing	(0.224)	(0.173)	(0.085)	(0.130)
Information	0.125	-0.114	0.098	-0.108
processing ability	(0.106)	(0.101)	(0.084)	(0.123)
missing				
Net Yearly	-0.028	0.024	-0.025	0.029
household income	(0.026)	(0.024)	(0.021)	(0.018)
missing				
Highest parental	-0.137*	0.115*	0.074	-0.052
education missing	(0.076)	(0.065)	(0.069)	(0.041)
Father's	0.069**	-0.038	-0.015	-0.016
occupational sector	(0.032)	(0.031)	(0.026)	(0.024)
missing				

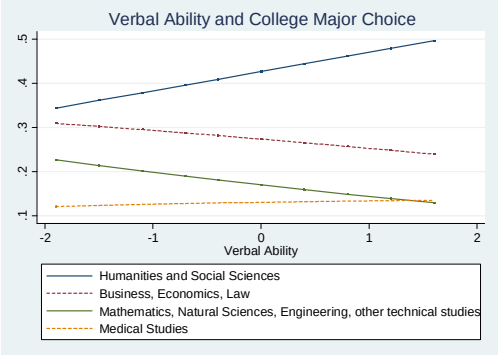
Figure 1-7: Personality Traits, Cognitive Skills and College Major Choice Probabilities

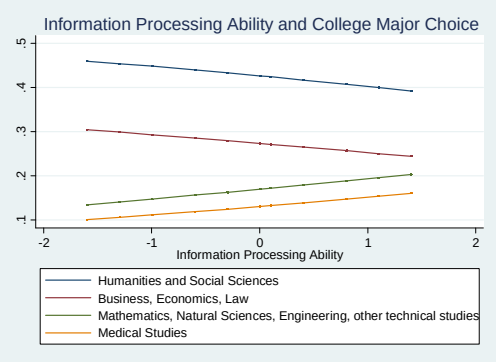












Note: Predicted college major choice probabilities evaluated at different levels of personality traits and cognitive skills (one at a time) and the means of all other covariates. Short-dashed lines represent insignificant changes in choice probabilities.