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Tjaša Logaj
Sašo Polanec

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† Institute for Economic Research and Faculty of Economics, Ljubljana, Slovenia; email: logajt@ier.si

‡ University of Ljubljana, Faculty of Economics, Slovenia; email: saso.polanec@ef.uni-lj.si

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1. Polanec, Sašo

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Abstract

The choice of college major is one of the most important decisions students make. In this paper we study the impact of ability on college major choice, using a data set for full-time students enrolled in four-year business and economics programs offered by the Faculty of Economics, University of Ljubljana. We distinguish between general and major-specific ability, which measure different dimensions of cognitive ability. We show that both measures are important in explaining individual decisions and that misleading results can follow from observing only commonly employed general ability. We also find important gender differences as males are more likely to base their major choice on the ability to complete the coursework, while females are more likely to decide according to unobserved preferences.

Keywords: College Majors, Ability, Gender Differences

JEL Classification: I23

1 Introduction

One of the most important economic decisions students make is the choice of college major. These decisions do not only determine future job opportunities faced by graduates (see e.g. Daymont and Andrisani, 1984; Brown and Corcoran, 1997), but also have important implications for the structure of labor force and labor market outcomes, such as equilibrium wages and unemployment rates. Understanding how these choices are made and which factors determine them enable policy makers to set appropriate incentives for the adjustment of labor supply according to the needs of the labor market and other development goals. It also helps universities and their faculties understand why some majors are crowded and why others are struggling for students.

An empirical and theoretical research has identified several factors that influence the choice of college major. The most important include gender, ability, peer effects and expected future income. While authors agree on the effects of gender and expected future income, mixed evidence is found regarding the impact of ability on major choice. In this paper we focus on the impact of ability on choices of college major by Slovenian students and argue that the mixed evidence may be due to inability to distinguish between different types of ability. For this purpose, we use data for a set of full-time economics and business students enrolled in undergraduate programs at the Faculty of Economics, University of Ljubljana. Unlike the existing studies that use limited information on student ability, proxied by some measure of general ability (e.g. score of SAT/GRE tests), our data allow us to distinguish between two measures of ability. The first is a measure of 'general' ability that is approximated with a high school average grade and points achieved at a standardized national exam at the end of high school (matura examination). The second measure of ability is major-specific, approximated by the average grade achieved in courses relevant for a specific major. We construct these two variables, because we believe that they measure different aspects of cognitive ability. While commonly employed general ability measures more or less only abilities such as language and problem solving, the major specific ability is a proxy for a broader mixture of abilities

needed for a specific major. Since we include the general and the major specific ability, we provide a more thorough estimation of the influence of cognitive ability on college major choice.

By estimating the mixed logit model and the nested logit model, we show that major-specific ability is important for the choice of college major. By controlling for a set of relevant explanatory variables, we find that GPA for each major has a significant positive marginal effect on choosing that major and a negative marginal effect on choosing any other major. Hence our evidence suggests that results based on empirical models that include only a measure of general ability and not also measures of major-specific ability, are missing an important factor that influences major choice and are thereby making incorrect conclusions.

By looking at gender-specific marginal effects of distinct measures of ability, we also contribute to the literature that studies the gender differences in decision-making. Several authors suggested that males and females differ both in their preferences and expectations (see e.g. Zafar, 2009; Turner and Bowen, 1999; Montmarquette, Cannings and Mahseredjian, 2002). We add to these findings by documenting significant differences in how major-specific ability affects choices of males and females. Namely, we show that males are more conditioned by major-specific ability than females, suggesting that the former are more concentrated on their ability to complete the coursework in particular major.

The rest of the paper is organized in the following way. In Section 2, we review the existing literature that studies the college major choice. We describe the institutional framework that is essential for understanding the empirical analysis in Section 3. We summarize the data in Section 4 and present the results in Section 5. In the last section we conclude with a discussion of the main results.

2 Literature Review

The choice of college major has been a subject of research for quite some time. Literature has focused on the importance of personal characteristics, such as ability and gender, expected future earnings and peer effects. While we expect that higher major specific ability should increase the likelihood of choosing it, the effect of gender is not so obvious. While some authors argue that there are 'female' and 'male' majors, a more fundamental question is, what makes some majors more attractive to females and other majors more attractive to males.

The existing evidence suggests that gender differences in college major choices may be attributed to differences in both preferences and ability. Turner and Bowen (1999) find that differences in pre-collegiate preparation only partly explain gender gaps in choice of major. The main part of the gap is explained by the differences in preferences, expectations and gender-specific effects of college experience. In a more recent study that uses survey information on subjective expectations about choice-specific outcomes of students at Northwestern University, Zafar (2009) attempts to distinguish between the effects of preferences and beliefs on differences in college major choice between genders. The author confirms the role of preferences and finds that differences in beliefs play only a minor role. She shows that females care more about non-pecuniary outcomes, such as gaining approval of parents and enjoying work, while males are more concentrated on pecuniary outcomes, like the social status of the job, the likelihood of finding a job and the earnings associated with the job.

The effects of future earnings have also been extensively studied. Berger (1988) and Boudarbat (2008) find that students are more likely to choose majors with higher streams of future earnings. Similarly, Montmarquette et al. (2002) confirm the importance of expected earnings on major choice and report significant differences in the marginal effects of this variable by gender and race. In addition, Arcidiacono, Hotz and Kang (2010) propose that a substantial share of students would choose a different major if they made no error in their forecast of future earnings.

The influence of peer effects on major choice has recently been examined by DeGiorgi, Pellizzari and Redaelli (2009). They show that if many peers choose a particular major, a student is more likely to choose the same major. In fact, a student may choose a major that is not consistent with their relative ability advantage when this is a less popular choice. Contrary, Sacerdote (2001) does not find significant peer effects among college roommates in the choice of college major.

Student's relative ability has also been widely recognized as an important predictor of major choice. Fiorito and Dauffenbach (1982) identify ability as one of the most important nonmarket factors on a curriculum choice. Paglin and Rufolo (1990) find that mathematical ability has a great influence on field choice. The study by Arcidiacono et al. (2010) and early study by Arcidiacono (2004) also added to this literature by surveying students on their relative abilities at chosen and all other possible majors. Their results suggest that choice of major is influenced by ability to perform coursework in particular major. However, all authors fail to accurately measure major specific ability. With the exception of Arcidiacono et al. (2010) ability is usually measured with verbal and/or mathematics scores at SAT/GRE tests that do not sufficiently differentiate students' ability to perform in specific majors. Arcidiacono et al. (2010) partially solve the problem by asking students on their relative ability in specific majors, but are exposed to potential bias related to the discrepancy between their actual and stated ability.

From methodological point of view, data availability and computational capability are the two main problems with which researchers are dealing. Due to these obstacles, earlier literature in major choice field mostly used multinomial logit models and only recently some researchers used methods that do not rely on the independence of irrelevant alternatives (IIA) assumprion, such as the random parameters logit (e.g. Zafar, 2009) or the heteroscedastic extreme value model and the multinomial probit model (e.g. Montmarquette et.al., 2002). However, some of these less restrictive models are widely used in other research fields. For example, the nested logit model is common in applied literature on transportation (e.g. Dis-

sanayake and Morikawa, 2010; Hensher, 1998), marketing (e.g. Richards, 2007; Guadagni and Little, 1998) and in different fields of economics (e.g. Dubin, 2007; Rasciute and Pentecost, 2010).

3 The Institutional Framework

In this paper we study the college major choice of business and economics students at the Faculty of Economics, University of Ljubljana. The faculty enrolls around 8 thousand full and part-time undergraduate and graduate students. It is part of the largest Slovenian university, located in the national capital, Ljubljana. The university consists of 26 faculties and academies and enrolls around 63 thousand full and part-time students. Like the majority of Slovenian higher education organizations, it is public organization and does not charge tuition fees to full-time undergraduate students with domestic residence.[1]

Before the Bologna reform of tertiary education system in 2007, which is the relevant period for our analysis, a high-school graduate could enroll in programs at the Faculty of Economics after completing any general or technical four-year high school program. The applicants were ranked nationally according to a weighted index, calculated from the grade percentage averages in the third and fourth years of high school study and a national exam called matura (similar to SAT in the U.S.; see http(1) for details), and only the top 650 students are enrolled in the four-year business and economics programs.[2] For the period of analysis (1994-2004), the entry quota was binding for all cohorts. Since we use these averages as measures of general ability, it is important to note that the high-school grading system distinguishes between five marks, ranging between 1 (insufficient) and 5 (excellent), and 2 as the minimum pass grade. The matura examination is the same for all high-school students

[1] See Slovenian Law on Higher Education (http(3)). At the Faculty of Economics, part-time students pay tuition fee that amounts to 2,500 EUR per academic year.

[2] Although the Faculty of Economics also enrolls students in 2-year programmes in business, these are not considered in our analysis.

and consists of three compulsory (Slovene language, Mathematics and one foreign language - usually English) and two elective subjects (e.g. Biology, History, Physics etc.).

In contrast to the typical distinction between business (Harvard Business School, MIT Sloan School of Management, Yale School of Management, London Business School) and economics program (The University of Chicago Department of Economics, Harvard University Department of Economics, LSE Economics Department), the Faculty of Economics offers both. Moreover, all undergraduate students at the Faculty of Economics attended the same set of courses during their first two years, regardless of their subsequent choice of the major. Hence, students enrolled in economics program attended business courses as well and vice versa. For example, a student that obtains her diploma in Banking and Finance followed courses in Management, Entrepreneurship, Commercial Law and Business Information Systems. Likewise, a student majoring in Management has taken courses in Microeconomics, Macroeconomics and Political Economy, in addition to rigorous courses in Mathematics. Details of curiculum are given in Appendix (Table A1). The structure of the program enables students to make an informed choice between 3 majors in economics (National Economy (NE), Banking and Finance (BF), International Economics (IE)) and 5 majors in business (Marketing (Mrk), Finance (Fin), Accounting and Auditing (Acc), Organization and Management (Mng), Business Informatics (BI)) before the start of the third year. The two programs differ in the stress they put on economic theory and econometric tools. The economics program is designed for students who intend to continue their studies in graduate programs in the fields of economics and work either in academia or government organizations, whereas the business program aims to attract students who wish to start working in companies after graduation and thus puts emphasis on the acquistion of practical skills (see third and fourth year curicula in Tables A2 and A3 in Appendix). From Table A2 is evident greater similarity between the majors in economics program than the majors in business program, as the former have a common third year of the program.

The expected time to complete any four-year program at the Faculty of Economics is 5

years, which includes an additional year for completion of final thesis (diploma), although the actual time typically varies between 4 and 6 years and can extend to more than 10 years. The grading scheme for undergraduate studies operates on a ten point scale with 10 as the highest and 1 as the lowest grade. A minimum requirement to pass an exam is 6, which usually corresponds to at least 60 points out of 100. Students who failed an exam were allowed to retake it with no limit on the total number of attempts, although the number of exam dates for each course is limited to 3 per academic year. To progress to the next year of study, students must achieve a passing grade in all but one course.

4 Data and Summary Statistics

The data set contains records for all students enrolled in the four-year undergraduate programs at the Faculty of Economics in the period 1994-2004 and studied until academic year 2008/2009. In empirical modelling of the college major choice we use personal characteristics of students (age, gender, home address, high school average grades, high school), and grades and dates of exams while studying. To capture the labor market conditions, we use information on the distance between home address and Ljubljana. Since Slovenia is a monocentric country, we construct a step variable for five regions: 0 for the distance below 10 km, 1 for the distance between 10 and 40 km, 2 for the distance between 40 and 70 km, 3 for the distance between 70 and 110 km and 4 for the distance above 110 km.

One of the most important determinants of the choice of major is the student's background knowledge, which we interpret as a measure of general ability. In order to measure it, we use both the average grade achieved at the matura examination and the average grade in the last two years of high school. The matura examination is a national test and as such an objective measure of background knowledge, while the latter reflects study results over a longer time span. In order to obtain a measure that reflects both an objective measurement of background knowledge and a persistence of study results, we construct a new variable

High school GPA, which is an unweighted average of the two averaged grades. The combined measure reduces the specific problems related to either of the two measures. Namely, the external examination is a one-off test, which may be influenced by idiosyncratic events ('the bad day effect'), while the high school average grade may not be entirely comparable due to variations in grading policies between high schools.

A unique feature of our data set is the possibility to construct a measure of GPA for each major using the data on student performance before actually making the choice of major (henceforth GPA). This measure attempts to capture the major-specific ability of student.[3] We are able to construct this measure because undergraduate students of business and economics at the Faculty of Economics attend the same courses during the first two years of study, regardless of their subsequent choice. Before the start of their third year, students choose between 8 majors that belong to: Economics program: National Economy (NE),

[3]Cognitive ability describes 9 different processes: memory (m), association (ass), concept formation (cf), language (l), attention (att), perception (p), action (act), problem solving (ps) and mental imagery (im). Each major requires different mixture of these abilities. The ability required for a certain major can then be written as:

$$A_j = \begin{bmatrix} \beta_j^m & \beta_j^{ass} & \beta_j^{cf} & \beta_j^l & \beta_j^{att} & \beta_j^p & \beta_j^{act} & \beta_j^{ps} & \beta_j^{im} \end{bmatrix}^T, j = 1, ..., m \tag{1}$$

where m is the number of majors offered and β_i^k are the levels of different abilities required for a specific major. Major j gives to a student i a utility:

$$u_{ij} = u(x_{ij}, \frac{a_i^m}{\beta_j^m}, \frac{a_i^{ass}}{\beta_j^{ass}}, ..., \frac{a_i^{im}}{\beta_j^{im}})$$

where a_i^k is a student's level of a particular ability and x_{ij} are all other factors that influence the degree of utility student gets from a major. The higher is the quotient of the student's and the required ability, the higher is utility. A student chooses the major that gives him the highest utility.

Banking and Finance (BF), International Economics (IE); and Business program: Marketing (Mrk), Finance (Fin), Accounting and Auditing (Acc), Organization and Management (Mng), Business Informatics (BI). The GPA for each major is calculated from student's grades in relevant courses during the first two years. For example, GPA BI is calculated as an average grade of courses Business Information Systems 1 and Business Information Systems 2. Courses used to calculate major-specific GPAs are presented in Table 1.[4]

Table 1: Major-specific Courses

Major	GPA of courses (first two years)
NE	Introduction to National Economy, Microeconomics, Macroeconomics Statistics 1 and 2, Economic Statistics
BF	Microeconomics, Macroeconomics, Statistics 1 and 2, Economic Statistics Mathematics 1 and 2
IE	Microeconomics, Macroeconomics, Statistics 1 and 2, Economic Statistics
Mrk	Entrepreneurship
Fin	Mathematics 1 and 2
Acc	Accounting, Mathematics 1 and 2
Mng	Organization of Enterprise, Entrepreneurship, Management
BI	Business Information Systems 1 and 2

Table 2 shows the enrolment statistics for the full-time students enrolled in the four-year programs. For both males and females the business program is more frequent choice, among which the majors in Marketing and Finance are the most popular.[5] Among the economics majors students are most likely to choose Banking and Finance major. Although there is high correlation between male and female choices, there are some important differences between genders. On one hand females are more likely to choose majors in business program, and in comparison to males they are more likely to choose the majors in Marketing and Accounting. On the other hand males are more likely to choose majors in Organization and Management and Business Informatics (business program) and Banking and Finance (economics program).

[4]The response of choice of college major to GPA may be sensitive to construction of major-specific courses. We have considered alternative specifications (dropping Mathematics 2 from major specific measure of ability for Accounting), and obtained qualitatively similar results.

[5]Note that these are also the fields in which students achieved the highest and the lowest grade during their first two years.

Table 2: Number of Students by Program and Major

Program / Major	Males		Females		All	
	Freq.	Share	Freq.	Share	Freq.	Share
Economics	432	0.171	465	0.137	897	0.152
National Economy	62	0.025	54	0.016	116	0.020
Banking and Finance	257	0.102	232	0.683	489	0.083
International Economics	113	0.448	179	0.527	292	0.049
Business	2,088	0.829	2,932	0.863	5,020	0.848
Marketing	424	0.168	894	0.263	1,318	0.223
Finance	714	0.283	1061	0.312	1,775	0.300
Accounting	148	0.587	404	0.119	552	0.933
Organization and Management	417	0.166	472	0.139	889	0.150
Business Informatics	385	0.153	101	0.030	486	0.082
Total	2,520	1.000	3,397	1.000	5,917	1.000

Source: Faculty of Economics and own calculations.
Notes: The cohorts of students enrolled between 1994 and 2004 are considered. The shares are given in percent of respective column total.

Next, Table 3 shows the relationship between the choice of major and three case specific variables separately for males and females. It suggests that the choice of major varies systematically with region of residence (or distance to Ljubljana) and general ability (measured with high school GPA), but not with age of students. In particular, students who major in National Economy, Accounting and Marketing have permanent residence further away from Ljubljana, while students who major in Organization and Management and International Economics have permanent address closer to the capital. The mean of variable region does not differ between genders, with exception of majors in Finance and in Business Informatics. The mean is higher for females majoring in Finance than males in this major, yet the opposite can be observed for Business Informatics or Banking and Finance major. The highest general ability is observed for students of economics program. Among specific majors, students choosing Banking and Finance and International Economics have the highest average GPA and students selecting Marketing, Organization and Management, and Business Informatics have the lowest GPA. With exception of National Economy and Banking and Finance major, females have a higher high school GPA in all majors.

Looking at the major-specific measure of ability (major-specific GPA) in relation to the chosen major in Table 4, we can observe that these coincide in some majors (e.g. Marketing), although students that major in a particular field do not necessarily have the highest GPA in that field. However, the tendency of choosing the major at which students are proficient can still be observed. Comparison of average major-specific GPAs shows that apart from Marketing and Management, males have a higher GPA in majors they chose than females. With only few exceptions, males have a higher GPA in Banking and Finance, Finance, Accounting and Business Informatics regardless of which major they actually select afterwards. However, females appear to be more proficient in Marketing and Management.

Finally, Table 5 gives information on major choices of siblings. On the basis of the student's home adress, surname and birth date, we create a dummy variable *Sibling,* which is equal to 1 if student has a sibling (older or of the same age) who is/has been enrolled in a four-year undergraduate program at the Faculty of Economics and 0 otherwise.[6] The variable *Major sibling* indicates whether a student's sibling had the same major. In the table we report the means of these two variables and their ratio, which shows that siblings are highly likely to choose the same majors.

[6]If there are two siblings of the same age, dummy variable is equal to 1 for one of them.

Table 3: Summary Statistics for Case-specific Regressors by Major and Gender

Major	Males		Females	
	Mean	St. Dev.	Mean	St. Dev.
A. REGION[(a)]				
National Economy	1.629	1.370	1.611	1.280
Banking and Finance	1.401	1.334	1.582	1.326
International Economics	1.345	1.266	1.380	1.250
Marketing	1.517	1.339	1.548	1.290
Finance	1.443	1.274	1.566	1.215
Accounting	1.642	1.256	1.671	1.209
Organization and Management	1.348	1.300	1.341	1.233
Business Informatics	1.418	1.309	1.277	1.184
B. HIGH SCHOOL GPA[(b)]				
National Economy	4.032	0.768	3.717	0.717
Banking and Finance	4.125	0.676	4.091	0.714
International Economics	4.053	0.642	4.112	0.632
Marketing	3.626	3.705	3.767	0.675
Finance	3.705	0.677	3.846	0.667
Accounting	3.713	0.583	3.837	0.638
Organization and Management	3.659	0.651	3.721	0.685
Business Informatics	3.610	0.671	3.718	0.618
C. AGE				
National Economy	18.984	0.914	19.185	0.754
Banking and Finance	18.981	0.698	18.978	0.577
International Economics	18.823	0.571	18.933	0.536
Marketing	19.085	0.566	18.927	0.525
Finance	18.968	0.674	18.943	0.544
Accounting	19.054	0.604	18.988	0.640
Organization and Management	19.012	0.606	18.947	0.677
Business Informatics	19.016	0.520	18.911	0.492

Source: Faculty of Economics and own calculations.

Notes: [(a)] There are five regions based on the distance between student's home address and Faculty of Economics in Ljubljana. Student is in region 0 if the distance is less than 10 km, in region 1 if the distance is at least 10 km, but less than 40 km, in region 2 if the distance is at least 40 km, but less than 70 km, in region 3 if the distance is at least 70 km, but less than 110 km and in region 4 otherwise.

[(b)] High school GPA is calculated as an average of the matura examination results and the high school average grade.

Table 4: Field GPA by Major

Major	GPA NE[(a)]	GPA BF	GPA IE	GPA Mrk	GPA Fin	GPA Acc	GPA Mng	GPA BI
				Males				
NE	7.260	7.013	7.156	7.803	6.637	6.767	7.660	7.538
BF	7.556	7.308	7.464	8.191	6.914	7.048	7.899	7.905
IE	7.403	7.117	7.297	8.167	6.657	6.718	7.886	7.752
Mrk	6.976	6.809	6.913	7.853	6.544	6.567	7.479	7.343
Fin	7.121	6.925	7.028	7.908	6.654	6.723	7.523	7.517
Acc	7.177	6.955	7.086	8.109	6.641	6.789	7.556	7.715
Mng	6.910	6.721	6.824	7.870	6.460	6.497	7.464	7.422
BI	6.899	6.736	6.838	8.025	6.479	6.511	7.319	7.652
				Females				
NE	7.201	6.949	7.101	7.991	6.565	6.682	7.848	7.654
BF	7.432	7.203	7.381	8.207	6.763	6.879	7.941	7.771
IE	7.200	7.002	7.143	8.097	6.651	6.699	7.776	7.601
Mrk	6.979	6.799	6.925	7.925	6.483	6.520	7.634	7.338
Fin	7.173	6.977	7.129	8.072	6.592	6.653	7.737	7.558
Acc	7.145	6.946	7.100	8.112	6.565	6.712	7.737	7.544
Mng	6.965	6.795	6.929	7.998	6.444	6.465	7.673	7.339
BI	6.852	6.704	6.804	8.010	6.455	6.477	7.439	7.525

Source: Faculty of Economics and own calculations.

Notes: [(a)] GPA for each major is based on grades student achieved at relevant courses in first two years. The columns contain the mean values of students' GPAs.

Table 5: Sibling's Major

Major	Mean(Major sibling) [a]	Mean(sibling) [b]	Ratio [c]
NE	0.000	0.000	-
BF	0.004	0.020	0.200
IE	0.003	0.010	0.300
Mrk	0.011	0.024	0.458
Fin	0.011	0.020	0.550
Acc	0.000	0.014	0.000
Mng	0.009	0.016	0.526
BI	0.004	0.025	0.160

Source: Faculty of Economics and own calculations.
Notes: [a] Variable major sibling is equal to 1 if student's sibling has/had the same major.
[b] Variable sibling is equal to 1 if student has a sibling (older or of the same age) who is/has been studying at university program of Faculty of Economics.
[c] The variable ratio is a ratio between columns (1) and (2).

5 Empirical Analysis

Let us now turn to econometric modelling of the college major choices of economics and business students. We assume that individuals choose majors by comparing the utility levels related to each of m alternatives. Each major gives her a different utility and these utilities vary between students. In particular, student i choosing major j enjoys the following utility:

$$u_{ij} = \mathbf{z}'_{ij}\alpha_j + \mathbf{w}'_i\gamma_j + \varepsilon_{ij}, \qquad j = 1, 2, ..., m, \tag{2}$$

where $\mathbf{z}_{ij}$ are alternative-varying regressors, $\mathbf{w}_i$ are alternative-invariant or case-specific regressors and ε_{ij} is the random component of utility. As students are assumed to be rational, α_j is the same for all majors ($\alpha_j = \alpha$). Student chooses the major with the highest utility, so the probability that student i chooses major j is (for simplicity let $\mathbf{x}_{ij}$ contain alternative

variant and invariant regressors):

$$\begin{aligned}\Pr[y_i = j|\mathbf{x}_{i1}, ..., \mathbf{x}_{im}] &= \Pr[u_{ij} \geq u_{ik}, \text{ for all k}] \\ &= \Pr[u_{ik} - u_{ij} \leq 0, \text{for all k}] \\ &= \Pr[\varepsilon_{ik} - \varepsilon_{ij} \leq (\mathbf{x}_{ij} - \mathbf{x}_{ik})'\beta, \text{ for all k}].\end{aligned} \tag{3}$$

Different assumptions regarding the joint distribution of the error terms are associated with different multinomial models. While there are both ordered and unordered choice models, we cannot find an ordering of college majors, except if we ask students on their personal ordering of given majors (see Arcidiacono et al., 2010). Since this is not the case for our data, we apply unordered multinomial models. The dependent variable y is equal to j if major j is taken ($j = 1, 2, ..., m$). Thus, the probability that major j is chosen by student i, conditional on the regressors $\mathbf{x}_i$, is defined as

$$p_{ij} = \Pr[y_i = j] = F_j(\mathbf{x}_i, \beta) \quad j = 1, ..., m, \quad i = 1, ..., N. \tag{4}$$

By introducing m indicator variables $y_1, y_2, ..., y_m$, so that y_j is equal to 1 if major j is chosen and 0 otherwise, the multinomial density for student i can be written as

$$f(y_i) = p_{i1}^{y_{i1}} \cdot p_{i2}^{y_{i2}} \cdot ... \cdot p_{im}^{y_{im}} = \prod_{j=1}^{m} p_{ij}^{y_{ij}}, \tag{5}$$

where functional form $F_j(.)$ corresponds to specific multinomial model. The maximum likelihood estimator (MLE), which is used for the multinomial models, maximizes the log-likelihood function $\mathcal{L} = \sum_{i=1}^{N}\sum_{j=1}^{m} y_{ij} \ln p_{ij}$, that follows from multinomial density defined in (5).

In what follows, we estimate two econometric models for college major choices of Slovenian business and economics students. The first is the mixed logit model with restrictive assumption of independence of irrelevant alternatives (IIA) and the second is the nested logit model that relaxes this assumption.

5.1 The Mixed Logit Model

For the mixed logit model,[7] the probability that student i selects major j is:

$$p_{ij} = \frac{e^{\mathbf{z}'_{ij}\alpha + \mathbf{w}'_i\gamma_j}}{\sum_{l=1}^{m} e^{\mathbf{z}'_{il}\alpha + \mathbf{w}'_i\gamma_l}}, \qquad j = 1, ..., m. \tag{6}$$

The error term ε_{ij} is assumed to be identically and independently distributed according to the Type I extreme value distribution with density $f(\varepsilon_{ij}) = e^{-\varepsilon_{ij}} \exp(-e^{-\varepsilon_{ij}})$, which ensures that choice probability in (3) has a closed form presented in equation above. In the estimation, the case- or individual-specific regressors are dummy for females, high school GPA, age, and dummies for regions (a dummy for region = 0 is omitted to avoid multicollinearity), while the two alternative-specific regressors are major-specific GPA and a dummy variable *major sibling*. In all estimations, the National Economy major is used as a base alternative and all the coefficients should be interpreted with respect to this major.

Since the estimated coefficients of the mixed logit model can not be interpreted as the marginal effects and the signs of the two may not coincide, we show the marginal effects in the tables of the main text (see Tables 6, 7 and 8) and summarize the estimated coefficients and specification tests in the Appendix (see first two columns in Table A4). It is important to note that while some coefficients are statistically insignificant, the Wald test for inclusion of all variables are statistically significant with an exception of the variable major sibling. The key variable of interest is the major-specific GPA, for which the marginal effects at the mean are shown separately for males (Table 6) and females (Table 7). We find that an increase in the major-specific GPA increases the probability of choosing that major (the marginal effects on the diagonal are positive) and decreases the probability of choosing other majors

[7] The term mixed logit model is used here to refer to the model that is a combination of the multinomial and the condition logit model and should not be confused with the random parameters logit model. See McFadden and Train (2000) for extended discussion of the mixed logit model.

- the 'substitution effects' (the marginal effects off the diagonal are negative). However, the absolute values of marginal effects are higher and statistically more significant for males than for females, which suggests that males base their decisions on measures of ability to a greater extent than females. Thus, for example, an increase in Marketing GPA increases the probability of majoring in Marketing by 2.9 percentage points for males, while the same probability increases only by 1.4 percentage points for females. Similar differences can also be observed for other majors. The second major-specific variable, which is introduced to capture the peer effects (*major sibling*), is not statistically significant. In spite of this, all the marginal effects on the diagonal and some marginal effects off the diagonal are significant, and imply that having a sibling in one major increases the probability of choosing that particular major and decreases the probability of taking any of the other majors (Table 9).

Next, the marginal effects at the mean for the case-specific variables are shown in Table 8. These suggest that being a female increases the probability of choosing a major in Marketing, Finance, Accounting and International Economics and decreases the probability of choosing a major in National Economy, Banking and Finance, Management and Business Informatics. We also find that an increase in the general ability increases the probability of choosing any of the majors in economics program and Finance, while the contrary can be observed for other business program majors. In line with results for major-specific GPA, we find that the marginal effects for males are higher in absolute values and statistically significant for higher number of majors. As expected, the marginal effect of age is not statistically significant. However, the variable measuring the distance of home address from the capital, which aims to capture difference in socio-economic background of students and employment opportunities in different regions, seems to have some effect on major choice. For example, students from regions outside Ljubljana are more likely to choose majors such as Marketing and Accounting compared to students with permanent address in Ljubljana, while students living outside capital are less likely to major in Banking and Finance or Management.

Table 6: Mixed Logit: Marginal Effects at the Mean for GPA, Males

	Change in GPA$^{(a)}$ of							
	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Change in Pr[NE]	0.004∗	−0.000	−0.000	−0.001∗	−0.001∗∗∗	−0.000	−0.001	−0.001
Pr[choice = NE] = 0.022	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Change in Pr[BF]	−0.000	0.017∗	−0.001	−0.003∗	−0.005∗∗∗	−0.001	−0.003	−0.003
Pr[choice = BF] = 0.088	(0.000)	(0.009)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Change in Pr[IE]	−0.000	−0.001	0.008∗	−0.001∗	−0.002∗∗∗	−0.000	−0.001	−0.001
Pr[choice = IE] = 0.040	(0.000)	(0.001)	(0.004)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Change in Pr[Mrk]	−0.001∗	−0.003∗	−0.001∗	0.029∗∗∗	−0.010∗	−0.002∗	−0.006∗∗∗	−0.005∗∗∗
Pr[choice = Mrk] = 0.167	(0.000)	(0.002)	(0.001)	(0.005)	(0.006)	(0.001)	(0.001)	(0.001)
Change in Pr[Fin]	−0.001∗∗∗	−0.005∗∗∗	−0.002∗∗∗	−0.010∗	0.043∗∗∗	−0.004∗∗∗	−0.010 ∗ ∗	−0.010∗∗∗
Pr[choice = Fin] = 0.299	(0.000)	(0.001)	(0.000)	(0.006)	(0.015)	(0.001)	(0.005)	(0.003)
Change in Pr[Acc]	−0.000	−0.001	−0.000	−0.002∗	−0.004∗∗∗	0.011∗	−0.002	−0.002
Pr[choice = Acc] = 0.059	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)	(0.001)	(0.002)
Change in Pr[Mng]	−0.001	−0.003	−0.001	−0.006∗∗∗	−0.010 ∗ ∗	−0.002	0.029∗∗∗	−0.005∗∗∗
Pr[choice = Mng] = 0.169	(0.001)	(0.002)	(0.001)	(0.001)	(0.005)	(0.001)	(0.005)	(0.002)
Change in Pr[BI]	−0.001	−0.003	−0.001	−0.005∗∗∗	−0.010∗∗∗	−0.002	−0.005∗∗∗	0.027∗∗∗
Pr[choice = Mng] = 0.156	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.007)

Notes: $^{(a)}$ GPA for each major is based on grades student achieved at relevant courses in the first two years.
*** p-value<0.01, ** p-value<0.05, * p-value<0.1. Standard errors are reported in parentheses.

Table 7: Mixed Logit: Marginal Effects at the Mean for GPA, Females

	Change in GPA$^{(a)}$ of							
	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Change in Pr[NE]	0.001	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
Pr[choice = NE] = 0.014	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[BF]	−0.000	0.004	−0.000	−0.001	−0.001 ∗∗	−0.001	−0.001	−0.000
Pr[choice = BF] = 0.062	(0.000)	(0.006)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.000)
Change in Pr[IE]	−0.000	−0.000	0.003	−0.001	−0.001∗	−0.000	−0.000	−0.000
Pr[choice = IE] = 0.047	(0.000)	(0.001)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Change in Pr[Mrk]	−0.000	−0.001	−0.001	0.014∗	−0.006	−0.002	−0.003 ∗∗	−0.001
Pr[choice = Mrk] = 0.270	(0.000)	(0.001)	(0.001)	(0.008)	(0.011)	(0.003)	(0.001)	(0.001)
Change in Pr[Fin]	−0.000	−0.001 ∗∗	−0.001∗	−0.006	0.015	−0.003	−0.003	−0.001
Pr[choice = Fin] = 0.325	(0.000)	(0.001)	(0.001)	(0.011)	(0.012)	(0.002)	(0.002)	(0.000)
Change in Pr[Acc]	−0.000	−0.001	−0.000	−0.002	−0.003	0.007	−0.001	−0.000
Pr[choice = Acc] = 0.116	(0.000)	(0.002)	(0.001)	(0.003)	(0.002)	(0.012)	(0.003)	(0.001)
Change in Pr[Mng]	−0.000	−0.001	−0.000	−0.003 ∗∗	−0.003	−0.001	0.008	−0.000
Pr[choice = Mng] = 0.137	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.006)	(0.001)
Change in Pr[BI]	−0.000	−0.000	−0.000	−0.001	−0.001	−0.000	−0.000	0.002
Pr[choice = Mng] = 0.029	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.004)

Notes: $^{(a)}$ GPA for each major is based on grades student achieved at relevant courses in the first two years.
*** p-value<0.01, ** p-value<0.05, * p-value<0.1. Standard errors are reported in parentheses.

Table 8: Mixed Logit: Marginal Effects at the Mean, Case-specific Variables

	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Female	−0.009	−0.036	0.004	0.101***	0.025	0.058	−0.025	−0.119
	(0.008)	(0.023)	(0.012)	(0.011)	(0.026)	(0.079)	(0.018)	(0.097)
High school GPA[(a)]	0.005	0.057	0.030	−0.042***	0.002	−0.000	−0.033	−0.018
	(0.005)	(0.050)	(0.029)	(0.010)	(0.027)	(0.009)	(0.024)	(0.023)
-Males	0.016*	0.083 **	0.028 **	−0.042***	−0.012	−0.003	−0.023	−0.046*
	(0.008)	(0.040)	(0.014)	(0.014)	(0.019)	(0.009)	(0.017)	(0.024)
-Females	−0.003	0.039	0.031	−0.040***	0.015	0.003	−0.036	−0.008
	(0.007)	(0.050)	(0.047)	(0.012)	(0.043)	(0.009)	(0.034)	(0.017)
Age	0.006	0.011	−0.006	−0.013	−0.016	0.015	−0.000	0.002
	(0.007)	(0.009)	(0.010)	(0.013)	(0.011)	(0.014)	(0.011)	(0.005)
Region 1[(b)]	0.004	−0.021	−0.005	−0.002	0.025	0.031	−0.027 **	−0.004
	(0.007)	(0.021)	(0.008)	(0.016)	(0.024)	(0.041)	(0.014)	(0.008)
Region 2[(b)]	−0.005	−0.018	−0.014	−0.011	0.043	0.055	−0.037 **	−0.013
	(0.007)	(0.017)	(0.015)	(0.020)	(0.033)	(0.070)	(0.015)	(0.013)
Region 3[(b)]	0.008	−0.015	−0.012	0.004	0.032	0.027	−0.035 **	−0.008
	(0.012)	(0.014)	(0.013)	(0.018)	(0.025)	(0.037)	(0.014)	(0.009)
Region 4[(b)]	0.004	−0.011	−0.017	0.071*	−0.033	0.052	−0.053 **	−0.013
	(0.010)	(0.017)	(0.021)	(0.037)	(0.038)	(0.063)	(0.026)	(0.017)

Notes: [(a)] High school GPA is calculated as an average of the matura examination results and the high school average grade.

[(b)] There are five regions that are based on the distance between student's home address and Faculty of Economics in Ljubljana. Student is in region 0 if the distance is less than 10 km, in region 1 if the distance is at least 10 km, but less than 40 km, in region 2 if the distance is at least 40 km, but less than 70 km, in region 3 if the distance is at least 70 km, but less than 110 km and in region 4 otherwise.

*** p-value<0.01, ** p-value<0.05, * p-value<0.1. Standard errors are reported in parentheses.

Table 9: Mixed logit: Marginal Effects at the Mean for Major Sibling

	Sibling in major							
	NE[(a)]	BF	IE	Mrk	Fin	Acc	Mng	BI
Change in Pr[NE]	0.981***	−0.019	−0.019	−0.019	−0.019*	−0.019	−0.019	−0.019
Pr[choice = NE] = 0.019	(0.023)	(0.022)	(0.022)	(0.016)	(0.010)	(0.022)	(0.020)	(0.022)
Change in Pr[BF]	−0.074	0.926***	−0.074	−0.075	−0.076***	−0.074	−0.075	−0.074
Pr[choice = BF] = 0.074	(0.072)	(0.085)	(0.071)	(0.048)	(0.023)	(0.072)	(0.063)	(0.071)
Change in Pr[IE]	−0.046	−0.046	0.954***	−0.046	−0.047**	−0.046	−0.046	−0.046
Pr[choice = IE] = 0.046	(0.049)	(0.048)	(0.053)	(0.034)	(0.019)	(0.049)	(0.043)	(0.048)
Change in Pr[Mrk]	−0.228***	−0.229***	−0.228***	0.779***	−0.233	−0.228***	−0.229**	−0.229***
Pr[choice = Mrk] = 0.228	(0.065)	(0.069)	(0.066)	(0.187)	(0.221)	(0.065)	(0.094)	(0.068)
Change in Pr[Fin]	−0.325	−0.325	−0.325	−0.328	0.688***	−0.325	−0.326	−0.325
Pr[choice = Fin] = 0.325	(0.295)	(0.300)	(0.297)	(0.404)	(0.157)	(0.295)	(0.337)	(0.299)
Change in Pr[Acc]	−0.090	−0.090	−0.090	−0.091	−0.092**	0.910***	−0.090	−0.090
Pr[choice = Acc] = 0.090	(0.105)	(0.104)	(0.105)	(0.077)	(0.046)	(0.105)	(0.094)	(0.104)
Change in Pr[Mng]	−0.155***	−0.155***	−0.155***	−0.157***	−0.158***	−0.155***	0.848***	−0.155***
Pr[choice = Mng] = 0.155	(0.053)	(0.050)	(0.052)	(0.006)	(0.052)	(0.053)	(0.159)	(0.051)
Change in Pr[BI]	−0.062	−0.062	−0.062	−0.063	−0.063***	−0.062	−0.062	0.938***
Pr[choice = BI] = 0.062	(0.060)	(0.059)	(0.060)	(0.040)	(0.019)	(0.060)	(0.052)	(0.072)

Notes: [(a)] GPA for each major is based on grades student achieved at relevant courses in the first two years.
*** p-value<0.01, ** p-value<0.05, * p-value<0.1. Standard errors are reported in parentheses.

5.2 The Nested Logit Model

The mixed logit model relies on a restrictive assumption of independence of irrelevant alternatives (IIA). This assumption is relaxed in the nested logit model (NL) that breaks alternatives into groups (nests) and allows errors to be correlated within the nests, but not between the nests. This model is convenient for the major choice of students at the Faculty of Economics, as the economics and business programs represent the natural nests as the majors that belong to these programs share a large number of courses and are comparably demanding in terms of required knowledge of theory, mathematics and statistics. It is therefore reasonable to assume that the addition of a new major in, say, economics program will affect the probability of choosing other majors in this program, while there will be little influence on majors in the business program. Applying the NL to our data permits the correlation of errors within economics and within business program, but not between them. Denoting the nests with B_k $(k = 1, 2)$ and using the same notation as above, we can write the assumed generalized extreme value joint cumulative distribution function for the errors:

$$F(\boldsymbol{\varepsilon}) = \exp\left(-\sum_{k=1}^{K}\left(\sum_{j\in B_k} e^{-\varepsilon_{ij}/\tau_k}\right)^{\tau_k}\right), \tag{7}$$

where τ_k stands for the scaling parameter equal to $\sqrt{1 - corr(\varepsilon_{ij}, \varepsilon_{il})}$ and $j, l \in k$. Again, we assume that an individual chooses the nest that gives her the highest utility. This utility is called an inclusive value and is defined as:

$$I_{ik} = \ln\left(\sum_{j\in B_k} e^{\mathbf{x}'_{ij}\boldsymbol{\beta}/\tau_k}\right), \tag{8}$$

where $\mathbf{x}_{ij}$ denotes (for simplicity) the set of alternative-specific variables, although it is straightforward to extend this model to case-specific variables. By denoting the nest specific

variables with $\mathbf{q}_{ik}$, the probability of choosing nest k, can be written as:

$$p_{ik} = \frac{\exp(\mathbf{q}'_{ik}\delta + \tau_k I_{ik})}{\sum_{k'=1}^{K} \exp(\mathbf{q}'_{ik'}\delta + \tau_{k'} I_{ik'})}, \tag{9}$$

and the probability of choosing alternative j conditional on deciding for nest k as:

$$p_{ij|k} = \frac{\exp(\mathbf{x}'_{ij}\beta/\tau_k)}{\sum_{j' \in B_k} \exp(\mathbf{x}'_{ij'}\beta/\tau_k)}. \tag{10}$$

The probability of choosing alternative j from nest k is then a product of equations in (9) and (10). The estimates of the NL can obtained by applying the full information maximum likelihood (FIML) estimator that maximizes log likelihood based on a sample of observations from density (for one observation):

$$f(y_i) = \prod_{k=1}^{K} \left((p_{ik})^{1\{y_i \in B_k\}} \prod_{j \in B_k} (p_{ij|k})^{1\{y_i = j\}} \right), \tag{11}$$

where $1\{y_i \in B_k)$ denotes an indicator function that assumes 1 if student chooses major that belongs to nest B_k, and $1\{y_i = j\}$ is an indicator that assumes 1 if student chooses major j.

The estimation results for the program and major choice of economics and business students are shown in the Appendix (the last two columns of Table A4). As above, the National Economy major is used as the base alternative. The coefficients differ considerably in comparison with the mixed logit model. For example, the coefficient for major-specific GPA has increased from 0.128 in the mixed logit model to 0.317 in the nested logit model. Changes are apparent in coefficients for case-specific variables as well. For instance, high school GPA coefficient for Banking and Finance major has changed from 0.505 with p-value less than 1% to an insignificant value 8.022. The log-likelihood has increased and the likelihood ratio statistic that $\tau_{economics}$ and $\tau_{business}$ are both equal to 1 is 18.63, therefore rejecting the null hypothesis that the NL model reduces to the conditional logit model.[8]

[8]The results of Hausman and McFadden test shows that the IIA is not violated. The

Still, both scaling parameters are larger than 1, indicating that the model is not consistent with the additive random utility model, but it is nevertheless mathematically correct.

The marginal effects for the GPA (see Table 10) do not change much if compared with the mixed logit model. For the sake of brevity, we do not distinguish between the marginal effects of major-specific GPA for males and females.[9] Since average marginal effects and the marginal effects at the mean are not the same for the model considered here, the comparisons between the two models are based on the average marginal effects. For this purpose we present also the average marginal effects for the mixed logit model (see Table 12 and 13). Overall, the results of the two models coicide as an increase in the major-specific GPA increases the probability of choosing that major and decreases the probability of choosing other majors. However, there is an important difference as for the nested logit an increase in GPA of any of the three majors increases the probability of majoring in all three majors in economics program. For example, an increase in Banking and Finance GPA by 1 unit is associated with changes of 0.003, 0.012 and 0.006 in, respectively, the probabilities of majoring in National Economy, Banking and Finance and International Economics.

Average marginal effects for the case-specific variables are shown in Table 11. Note that there are no major differences when compared to average marginal effects of the mixed logit model in Table 13. Similarly to the results shown above, the estimations suggest that females are more likely to major in Marketing and Accounting and less likely to major in Business Informatics. In addition, an increase in high school GPA increases the probability of choosing any major of the economics program, while the opposite holds for the business program. More precisely, one unit increase in high school GPA increases the probability of majoring in National Economy, Banking and Finance and International Economics by 0.006, 0.062 and 0.029, respectively. On the other hand, the same change in high school

contradicting results are in line with the findings of other authors, who suggest that this and other choice set partitioning tests of the IIA can be unreliable (see e.g. Cheng and Long, 2007; Fry and Harris, 1996).

[9] Due to software limitations, we only calculated the average marginal effects.

GPA decreases the probability of majoring in Marketing, Finance, Accounting, Management and Business Informatics by 0.040, 0.001, 0.001, 0.031 and 0.024, respectively. Age decreases probability of majoring in Marketing and Finance. Finally, geographical characteristics seem to have an important effect on the choice of major here as well.

6 Discussion and Conclusions

The results of both presented models show the importance of correctly measuring student's abilities. On one hand, ability measured with high school GPA shows that there exists sorting in majors on the basis of this variable. Presented evidence is in line with existing research which suggests that (mathematical) ability is an important factor in explaining program and field choice for college students. To complement the existing studies, our results show that students with higher high school GPA are more likely to study economics than business. On the other hand, major-specific ability has also proven to be very important in deciding about one's major. Controlling for high school GPA and other relevant variables, we find that GPA for each major has a significant positive effect on choosing that major and a negative effect on choosing any other major. The exceptions are only majors in the economics program, where an increase in GPA in any of the three majors, increases probability of majoring in all majors in the economics program. This is not surprising because all three programs share a large set of courses and any of these programs offers sufficient knowledge to continue studies in graduate programs. Consequently, the choice of major is not as important for determining student's future as it is for individuals in business program.

Our evidence suggests that authors who rely only on a measure of 'general ability', and not major-specific ability, are missing an important factor that influences major choice. Namely, by observing only high school GPA, the conclusion of this analysis would be that students with lower ability choose to major in e.g. Marketing. On the contrary, by including also major specific ability, the evidence is found that, although it is true that students with

lower high school GPA are more likely to choose Marketing, it is also true that their relative ability is higher in this field. As a result, the reason for their choice is not only their lacking in general ability, but also their higher relative ability in a specific major.

In line with existing studies, gender differences in major choice were shown to matter as well. For example, controlling for all other variables, females are more likely to major in Marketing. Moreover, the effect of major-specific ability on major choice is different for males and females. The results show that males are more conditioned by it than females. Similar conclusions can be made also after looking at gender specific marginal effects of the general ability. This suggests that males are more concentrated on their ability to complete the coursework in a particular major, while females are more influenced by other (unobserved) dimensions of their preferences. Furthermore, summary statistics by gender suggest that the reason for 'female' and 'male' majors cannot be ability. E.g. in the major with the highest percentage of females, Accounting, males have a higher average GPA than females. Also, in the major with the lowest fraction of females, Business Informatics, the difference in major specific ability is small. These conclusions are in line with the findings of other authors who document important differences in preferences and expectations between genders (Zafar, 2009; Turner and Bowen, 1999; Montmarquette et al., 2002).

Our data confirm also peer effects as siblings are more likely to choose the same major. Further, the marginal effects on regions suggest that geographical factors matter as well. Especially, majoring in Management is less likely for those living outside Ljubljana. This is not unexpected, since urban regions provide more possibilities for employing such labor force. An alternative interpretation for this result may be the competition of other management schools that are further away from the capital. Thus, some of the students interested in management and living in more distant regions might be studying there. In the same way, it is reasonable that students from the most distant regions are more likely to major in Marketing, given that these regions have tourism as one of the major industries and hence have a greater demand for such workforce.

A potential concern with our data set is in the absence of an estimator of expected future earnings that some authors find to be important (e.g. Arcidiacono et al., 2010; Berger, 1988, Boudarbat, 2008). However, there are at least four reasons why we believe this is a minor limitation for the decisions of economics and business students. Firstly, due to no publicly available data the differences in expected earnings between different majors may be difficult to estimate. Moreover, students might rely on poor economic models for predicting their future incomes. Secondly, the differences in earnings between majors are small. For example, in 2003 the average gross annual income of graduates in the first year after obtaining a diploma were 8.078 €, 7.011 €, 8.219 €, 6.737 €, 6.799 €, 7.339 €, 6.380 € and 7.414 € for Accounting, Banking and Finance, Business Informatics, Finance, International Economics, Management, Marketing and National Economy, respectively. Thirdly, students are prone to myopic thinking. This leads us to believe that individuals are selecting majors by comparing the difficulty of coursework across majors and their abilities to do the coursework, rather than future incomes. And lastly, the results of an empirical model that includes also the average earnings in the first year after graduation by major, shows that inclusion of this variable does not change coefficients and significance of other variables. Furthermore, the coefficient for this new variable turns out to be negative, suggesting that the higher the expected pay for a certain major, the lower the probability of selecting that major is. The explanation for such results lies in cause-and-effect relationship of difficulty of study and relative supply of labor. For example, Marketing is relatively easier to study, so a larger portion of students is capable to graduate in this major. This leads to a higher supply of this type of labor and consequently to lower wage premiums. Thus, the choice of major is not influenced by future earnings, but rather the other way around - the wage premiums are effected by the choice of major, which depends on the difficulty of the coursework.

From methodological point of view of the paper, the findings of authors (e.g. Cheng and Long, 2007; Fry and Harris, 1996) that Hausman and McFadden test may be unreliable in some cases, again proved to be true. While mentioned test does not reject the assumption

of independence of irrelevant alternatives, the model based likelihood ratio test does so. Therefore, (again) providing evidence that it is better to estimate also the less restrictive model and then check whether the more restrictive one provides accurate results.

While most of the authors use the multinomial and conditional logit model, estimations of the nested logit model are presented as well. The results support the use of the nested logit model and imply the first two mentioned models to be too restrictive. Clearly, our finding is specific to the data in question: we use data set on choices among quite similar majors and consequently the correlation of errors among alternatives is high.

To conclude, this study showed that appropriate measurement of ability is important for understanding student choices. The variables such as points achieved at GRE/SAT test, which measure only general ability, are missing an important factor behind the choice of college major. The future research should put more emphasis on obtaining good measures of major-specific ability for different fields of education and ensure that the econometric models are not too restrictive.

Table 10: Nested Logit: Average Marginal Effects, GPA

	Change in GPA$^{(a)}$ of							
	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Change in Pr[NE]	0.001***	0.003***	0.002***	−0.001***	−0.002***	−0.001***	−0.001***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[BF]	0.003***	0.012***	0.006***	−0.005***	−0.008***	−0.002***	−0.004***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[IE]	0.002***	0.006***	0.005***	−0.003***	−0.005***	−0.001***	−0.002***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[Mrk]	−0.001***	−0.005***	−0.003***	0.019***	−0.005***	−0.002***	−0.002***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[Fin]	−0.002***	−0.008***	−0.005***	−0.005***	0.025***	−0.002***	−0.003***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[Acc]	−0.001***	−0.002***	−0.001***	−0.002***	−0.002***	0.009***	−0.001***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[Mng]	−0.001***	−0.004***	−0.002***	−0.002***	−0.003***	−0.001***	0.014***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in Pr[BI]	−0.001***	−0.002***	−0.001***	−0.001***	−0.002***	−0.000***	−0.001***	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: $^{(a)}$ GPA for each major is based on grades student achieved at relevant courses in the first two years.
*** p-value<0.01, ** p-value<0.05, * p-value<0.1. Bootstrap standard errors in parentheses.

Table 11: Nested Logit: Average Marginal Effects, Case-specific Variables

	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Female	−0.004	−0.036	0.013	0.092***	0.019	0.057***	−0.021	−0.120***
	(0.039)	(0.077)	(0.053)	(0.030)	(0.045)	(0.016)	(0.022)	(0.018)
High school GPA[(a)]	0.006***	0.062***	0.029***	−0.040***	−0.001	−0.001***	−0.031***	−0.024***
	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Age	0.003***	0.004***	0.003***	−0.013***	−0.017***	0.015***	−0.000	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Region 1[(b)]	0.001	−0.021	−0.004	−0.002	0.024	0.030*	−0.026	−0.002
	(0.045)	(0.090)	(0.062)	(0.035)	(0.052)	(0.018)	(0.026)	(0.020)
Region 2[(b)]	−0.002***	−0.021***	−0.013***	−0.008***	0.043***	0.049***	−0.034***	−0.014***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Region 3[(b)]	0.004***	−0.022***	−0.009***	0.006***	0.033***	0.026***	−0.032***	−0.007***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Region 4[(b)]	−0.003***	−0.018***	−0.002***	0.064***	−0.021***	0.045***	−0.054***	−0.010***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)

Notes: [(a)] High school GPA is calculated as an average of the matura examination results and the high school average grade.

[(b)] There are five regions based on the distance between student's home address and Faculty of Economics in Ljubljana. Student is in region 0 if the distance is less than 10 km, in region 1 if the distance is at least 10 km, but less than 40 km, in region 2 if the distance is at least 40 km, but less than 70 km, in region 3 if the distance is at least 70 km, but less than 110 km and in region 4 otherwise.

*** p-value<0.01, ** p-value<0.05, * p-value<0.1. Bootstrap standard errors in parentheses.

Table 12: Mixed Logit: Average Marginal Effects, GPA

	Change in GPA$^{(a)}$ of							
	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Change in Pr[NE]	0.002	−0.000	−0.000	−0.001	−0.001	−0.000	−0.000	−0.000
Change in Pr[BF]	−0.000	0.009	−0.001	−0.002	−0.003	−0.001	−0.002	−0.001
Change in Pr[IE]	−0.000	−0.001	0.006	−0.001	−0.002	−0.001	−0.001	−0.000
Change in Pr[Mrk]	−0.001	−0.002	−0.001	0.021	−0.008	−0.003	−0.004	−0.002
Change in Pr[Fin]	−0.001	−0.003	−0.002	−0.008	0.026	−0.004	−0.006	−0.003
Change in Pr[Acc]	−0.000	−0.001	−0.001	−0.003	−0.004	0.011	−0.002	−0.001
Change in Pr[Mng]	−0.000	−0.002	−0.001	−0.004	−0.006	−0.002	0.016	−0.002
Change in Pr[BI]	−0.000	−0.001	−0.001	−0.002	−0.003	−0.001	−0.002	0.009

Note: $^{(a)}$ GPA for each major is based on grades student achieved at relevant courses in the first two years.

Table 13: Mixed Logit: Average Marginal Effects, Case-specific Variables

	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Female	−0.008	−0.036	0.005	0.097	0.024	0.061	−0.021	−0.122
High school GPA$^{(a)}$	0.005	0.060	0.031	−0.040	−0.000	−0.001	−0.031	−0.024
Age	0.006	0.012	−0.007	−0.013	−0.015	0.015	−0.001	0.003
Region 1$^{(b)}$	0.004	−0.024	−0.005	−0.001	0.025	0.030	−0.026	−0.003
Region 2$^{(b)}$	−0.005	−0.018	−0.016	−0.007	0.044	0.049	−0.034	−0.014
Region 3$^{(b)}$	0.008	−0.016	−0.013	0.005	0.032	0.026	−0.034	−0.009
Region 4$^{(b)}$	0.005	−0.008	−0.020	0.066	−0.021	0.046	−0.054	−0.013

Notes: $^{(a)}$ High school GPA is calculated as an average of matura examination results and high school average grade.

$^{(b)}$ There are five regions based on the distance between student's home address and Faculty of Economics in Ljubljana. Student is in region 0 if the distance is less than 10 km, in region 1 if the distance is at least 10 km, but less than 40 km, in region 2 if the distance is at least 40 km, but less than 70 km, in region 3 if the distance is at least 70 km, but less than 110 km and in region 4 otherwise.

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A Appendix

Table A1: 1st and 2nd Year Courses

1st year	2nd year
Accounting	Business Information Systems 2
Business Information Systems 1	Economic Statistics
Commercial Law	Entrepreneurship
Enterprise Economics	Foreign Language 1
Introduction to National Economy	Political Economy
Mathematics 1	Management
Organization of the Enterprise	Mathematics 2
Introductory Microeconomics	Intermediate Microeconomics
Introductory Macroeconomics	Intermediate Macroeconomics
Statistics 1	Statistics 2

Table A2: 3rd Year Courses

	Economics Program			Business Program				
	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
History of Economic Thought	x	x	x					
International Economics	x	x	x					
Monetary Economy	x	x	x	x	x	x	x	x
Industrial Organization	x	x	x					
Econometrics	x	x	x					
Theory of Economic Policy	x	x	x					
Public Finance	x	x	x		x	x		
Foreign Language 2	x	x	x	x	x	x	x	x
Principles of Marketing				x	x	x	x	x
Corporate Finance				x	x	x	x	x
Organization of Production				x	x	x	x	x
Management Accounting				x			x	
Methods of Marketing Research				x				
Consumer Behaviour				x				
Banking					x	x		
Financial Accounting					x			
Cost Accounting						x		
Principles of Management							x	
Human Resources and Management							x	
Decision Support Technology								x
Information Systems in the Economy								x
Databases								x
Elective				x			x	

Table A3: 4th Year Courses by Major

	Economics program			Business program				
	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Development Economics	x	x	x					
Economics of European Union	x	x	x					
Corporate Finance	x		x					
Labor Economics	x							
Regional Economics	x							
National Accounting	x							
Philosophy of Economics	x							
Financial Economy		x						
Theory of Corporate Finance		x						
International Finance		x	x		x	x		
Financial Markets		x			x			
Banking		x						
Economics of Public Enterprises		x						
Economics and Politics of international Trade			x					
International Business			x	x			x	
International Marketing			x	x			x	
International Commercial Law			x	x				
Foreign Language 3			x					
International Economics				x	x	x	x	x
Strategic Management				x	x	x	x	x
Business Environment				x	x	x	x	x
Marketing Channels				x				
Marketing Communications				x				
Insurance					x			
Management Accounting					x	x		
Auditing						x		
Economics and Organization of Information Systemy						x		
Orgranization Theory							x	

Table A3: 4th Year Courses by Major

	Economics program			Business program				
	NE	BF	IE	Mrk	Fin	Acc	Mng	BI
Analysis and Design of Organization							x	
Analysis and Planning of Organization							x	
Information Systems Development								x
Cost Accounting or Management Accounting								x
Object-oriented Methodology								x
Organizing and Decision Making								x
Elective	x	x	x	x	x	x	x	x
Elective	x			x				

Table A4: Estimation Results: Mixed Logit and Nested Logit Model

			Mixed		NL	
Regressor	Type		Coeff.	St. Error	Coeff.	St. Error
GPA[(a)]	Specific		0.128***	(0.023)	0.317***	(0.070)
Major sibling[(b)]	Specific		18.123	(600.911)	184.877	(823.209)
Intercept	Invariant	NE	0.000	-	0.000	-
		BF	3.294	(2.956)	43.131	(52.979)
		IE	8.283 **	(3.359)	27.310	(29.202)
		Mrk	11.015***	(2.772)	57.928	(53.572)
		Fin	10.831***	(2.719)	57.595	(54.140)
		Acc	5.021*	(2.915)	40.283	(53.428)
		Mng	10.289***	(2.819)	55.438	(54.314)
		BI	9.744***	(2.960)	52.895	(55.598)
Female	Invariant	NE	0.000	-	0.000	-
		BF	−0.028	(0.210)	−3.340	(3.622)
		IE	0.543 **	(0.225)	10.532	(18.432)
		Mrk	0.924***	(0.199)	3.194	(5.966)
		Fin	0.532***	(0.195)	1.992	(5.920)
		Acc	1.145***	(0.212)	3.829	(6.013)
		Mng	0.289	(0.201)	1.302	(5.918)
		BI	−1.138***	(0.220)	−3.015	(6.072)
High school GPA[(c)]	Invariant	NE	0.000	-	0.000	-
		BF	0.505***	(0.158)	8.022	(6.004)
		IE	0.398 **	(0.168)	5.425	(4.737)
		Mrk	−0.449***	(0.148)	5.088	(4.776)
		Fin	−0.258*	(0.146)	5.678	(4.794)
		Acc	−0.267*	(0.155)	5.618	(4.786)
		Mng	−0.478***	(0.150)	5.039	(4.781)
		BI	−0.559***	(0.158)	4.810	(4.790)
Age	Invariant	NE	0.000	-	0.000	-
		BF	−0.187	(0.147)	−2.048	(1.832)
		IE	−0.472***	(0.169)	−1.703	(1.367)
		Mrk	−0.392***	(0.138)	−1.892*	(1.111)
		Fin	−0.384***	(0.135)	−1.887*	(1.130)
		Acc	−0.17	(0.145)	−1.245	(1.093)
		Mng	−0.336 **	(0.140)	−1.718	(1.128)
		BI	−0.299 **	(0.147)	−1.560	(1.167)
Region 1[(d)]	Invariant	NE	0.000	-	0.000	-
		BF	−0.489*	(0.291)	−5.283	(4.425)
		IE	−0.286	(0.305)	−2.535	(4.313)
		Mrk	−0.188	(0.273)	−3.577	(3.776)
		Fin	−0.103	(0.270)	−3.339	(3.785)
		Acc	0.14	(0.291)	−2.570	(3.815)
		Mng	−0.363	(0.277)	−4.115	(3.770)

Table A4: Estimation Results: Mixed Logit and Nested Logit Model

			Mixed		NL	
Regressor	Type		Coeff.	St. Error	Coeff.	St. Error
		BI	−0.239	(0.289)	−3.741	(3.765)
Region 2[(d)]	Invariant	NE	0.000	-	0.000	-
		BF	0.038	(0.344)	−2.497	(4.414)
		IE	−0.048	(0.363)	−2.313	(4.244)
		Mrk	0.247	(0.329)	−2.043	(3.728)
		Fin	0.426	(0.325)	−1.503	(3.754)
		Acc	0.814 ∗ ∗	(0.342)	−0.350	(3.820)
		Mng	0.041	(0.332)	−2.643	(3.719)
		BI	0.078	(0.346)	−2.488	(3.717)
Region 3[(d)]	Invariant	NE	0.000	-	0.000	-
		BF	−0.599 ∗ ∗	(0.286)	−8.643	(6.514)
		IE	−0.673 ∗ ∗	(0.307)	−6.997	(4.908)
		Mrk	−0.372	(0.268)	−6.738	(5.031)
		Fin	−0.293	(0.265)	−6.516	(5.053)
		Acc	−0.115	(0.288)	−5.98	(5.056)
		Mng	−0.633 ∗ ∗	(0.273)	−7.511	(5.045)
		BI	−0.521∗	(0.287)	−7.133	(5.079)
Region 4[(d)]	Invariant	NE	0.000	-	0.000	-
		BF	−0.347	(0.443)	−0.618	(6.689)
		IE	−0.651	(0.493)	2.736	(8.196)
		Mrk	0.085	(0.417)	1.616	(6.396)
		Fin	−0.297	(0.417)	0.480	(6.358)
		Acc	0.274	(0.442)	2.197	(6.465)
		Mng	−0.597	(0.433)	−0.423	(6.317)
		BI	−0.416	(0.452)	0.174	(6.231)
Log-likelihood			-10209		-10199	
τ (economics)					21.572	(27.576)
τ (business)					3.006	(0.952)

Notes: [(a)] GPA for each major is based on grades student achieved at relevant courses in the first two years of study.
[(b)] Variable major sibling is equal to 1 if student's sibling has/had the same major.
[(c)] High school GPA is calculated as an average of the matura examination and high school average grade.
[(d)] There are five regions that are based on the distance between student's home address and Faculty of Economics in Ljubljana. Student is in region 0 if the distance is less than 10 km, in region 1 if the distance is at least 10 km, but less than 40 km, in region 2 if the distance is at least 40 km, but less than 70 km, in region 3 if the distance is at least 70 km, but less than 110 km and in region 4 otherwise.
*** p-value<0.01, ** p-value<0.05, * p-value<0.1

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