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Abstract

In the first chapter, we study financial aid policies in developing countries that support students' education abroad. We collect a unique data-set on government-funded scholarship and loan programs and establish stylized facts for developing countries. We find that scholarship programs select students based on merit criteria, target graduate and postgraduate studies, and require recipients to return after graduation more frequently than loan programs do. We build a two-country student migration model that qualitatively accounts for the observed patterns. In the model, government intervention is justified for two reasons. First, students from a developing country are assumed to be financially constrained and cannot afford education abroad. Second, the government values the productivity of "returnees" more highly than the market does. We argue that when students are uncertain about their future productivity and may fail in their studies, scholarship programs can insure them against potential default. Consequently, if students differ in their expected ability, under certain conditions, a government with a tight budget will prioritize ex-ante high-ability students and support them with scholarships with return requirement, and support ex-ante low-ability students with loans without return requirement.

In the second chapter, we focus on host developed country policies tailored to international students arriving from developing countries. Using the data on the EU countries, we find that a higher university ranking is associated with a higher GDP per capita and higher tuition fees. However, six countries with highly ranked universities (Austria, Belgium, France, Germany, Italy, Luxembourg) are exceptions to this rule and charge one of the lowest tuition fees in Europe. We also find that there is no strong association between university rankings and immigration policies. We build a model with two developed countries, in which international students are heterogeneous in their ability, wealth, and preferences towards studying in one country or another. The model suggests two equally plausible socio-political explanations for the existence of these high-ranking-low-fee countries. First, historically, tuition fees in these countries may be institutionally set at a low level. Second, the universities in these countries could be more selective due to unfavorable views towards international students.

In the third chapter, we study the effects of information provision on student's intended and actual college major choices. We conduct an experiment on secondary school students in Georgia and find that students systematically overestimated the earnings and unemployment rates of college graduates. We also find that 10 percent more students

who received information on actual earnings and unemployment changed their college majors than those with no information. The changes in their majors are partly driven by differences in the perceived and actual unemployment rates, whereas the earning differences do not appear to play a role. We also estimate spillover effects on students who do not receive information directly, and show that they matter, but only for older students who are closer to high school graduation. Importantly, we find that the immediate changes in the intended choices are not linked to the final major choices, suggesting that measuring the effects of information on immediately expressed intentions may not be sufficient to understand how information affects actual real-life decisions. We find that both direct and indirect information provision have sizable effects on student college major choices.

Abstrakt

V první kapitole se zabýváme politikou finanční pomoci v rozvojových zemích, které podporují vzdělávání studentů v zahraničí. Zatímco některé země poskytují finanční podporu studentům ve formě grantů a stipendií, jiné se spíše přiklání k metodě studentských půjček. Tato práce používá informace z nového souboru dat, který popisuje charakteristiky vládních programů z celého světa, které se zaměřují na studentská stipendia a půjčky, které slouží jako prostředek pro finanční pomoc studentům při studiu v zahraničí. Tato data nám umožňují identifikovat jedinečná fakta o těchto politických programech v rozvojových zemích. Výsledky ukazují, že v porovnání s metodou studentských půjček, jsou do stipendijních programů mnohem častěji vybírání studenti na základě svých dovedností. Zároveň se stipendijní programy zaměřují více na bakalářské a magisterské studium, a také po studentech častěji požadují návrat do domovské země. Ve své práci jsme zkonstruovali studentsko-migrační model pro dvě země s vládními zásahy, který kvalitativně bere v úvahu zákonitosti, které jsme vypozorovali v datech. V našem modelu jsou zásahy vlády oprávněné a to ze dvou důvodů. Zaprvé, studenti z rozvojových zemí jsou finančně omezeni a nemohou si tedy dovolit vzdělání v zahraničí. Za druhé, stát si váží produktivity svých pracovníků jež se vrátili ze svých studií v zahraničí mnohem více než trh. Ve své práci argumentujeme, že v prostředí, ve kterém si studenti nejsou jisti svou budoucí produktivitou a čelí riziku neúspěchu při svých studiích, mohou stipendia sloužit jako nástroj pro pojištění se proti potenciálnímu krachu. Z analýzy vyplývá, že v případě, kdy je očekávaná kvalita studentů proměnlivá, bude stát s malým rozpočtem v určitých případech poskytovat stipendia studentům s vyšší očekávanou kvalitou, přičemž od nich bude po ukončení studií požadovat návrat do domovské země a půjčky studentům s nižší očekávanou kvalitou. Po studentech, kterým poskytne stát půjčku, nebude vyžadovat návrat na domovské země.

Ve druhé kapitole se zaměřujeme na politiku hostitelských vyspělých zemí šitou na míru zahraničním studentům přijíždějícím z rozvojových zemí. Na základě údajů o zemích EU zjišťujeme, že vyšší hodnocení univerzit je spojeno s vyšším HDP na hlavu a vyšším školným. Šest zemí s vysoce hodnocenými univerzitami (Rakousko, Belgie, Francie, Německo, Itálie, Lucembursko) však tvoří výjimku z tohoto pravidla a účtují jedna z nejnižších školných v Evropě. Zjišťujeme také, že neexistuje žádná silná souvislost mezi hodnocením univerzit a imigrační politikou. Vytváříme model se dvěma vyspělými zeměmi, ve kterých jsou zahraniční studenti heterogenní ve svých schop-

nostech, bohatství a preferencích ke studiu v té či oné zemi. Model navrhuje dvě stejně věrohodná sociálně-politická vysvětlení existence těchto vysoce hodnocených zemí s nízkým školným. Za prvé, z historického hlediska lze školné v těchto zemích institucionálně stanovit na nízké úrovni. Za druhé, univerzity v těchto zemích by mohly být selektivnější kvůli nepříznivým názorům na zahraniční studenty.

Ve třetí kapitole studujeme dopady poskytování informací na zamýšlené a provedené volby studentů ohledně studia na vysoké škole. Studenti mohou mít při rozhodování o vzdělání nepřesné představy o budoucích výdělcích a uplatnění. Tento článek zkoumá vliv informování na zamýšlenou a výslednou volbu studijního oboru v Gruzii. Středoškolští studenti v našem experimentu systematicky nadhodnocují příjmy a nezaměstnanost vysokoškolských absolventů. Zjišťujeme, že o 10% více studentů, kteří byli informováni o skutečných příjmech a nezaměstnanosti, změnilo svou volbu studijního oboru oproti studentům, kteří informováni nebyli. Změny ve volbě studijního oboru jsou částečně dány rozdílem mezi přibližnou představou o nezaměstnanosti a skutečnou nezaměstnaností. Naproti tomu se zdá, že rozdíly v příjmech nehrají roli. Také odhadujeme a nacházíme vliv na studenty, kteří informaci nezískali přímo. Nepřímý vliv se projevuje pouze u starších studentů, kteří jsou blíže ukončení střední školy. Zjišťujeme, že okamžité změny v zamýšlené volbě oboru nejsou propojeny s konečnou volbou oboru, což naznačuje, že měření vlivu informace na bezprostřední úmysly nemusí být postačující k pochopení, jak informace ovlivní skutečné životní volby. Zjišťujeme, že informování má značný přímý i nepřímý vliv na volbu univerzitního oboru.

Chapter 1

Financing Education Abroad: A Developing Country Perspective

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1.1 Introduction

Governments in developing countries often play a critical role in supporting university education abroad for their citizens by using financial aid programs. Economic literature emphasizes two possible reasons that can motivate governments in developing countries to promote education abroad. First, poor individuals from the developing world do not always have access to credit markets (Banerjee 2003; Dustmann and Okatenko 2014). Second, governments might expect a positive externality ("multiplier effect") from study abroad alumni who return to their home countries (DAAD and British Council, 2014). External economic and non-economic benefits for the sending countries might include R&D spillovers (Le 2010), fostered democracy in the home country (Spilimbergo 2009), human rights development (Atkinson 2010), and better inter-cultural understanding (Edelstein and Douglass 2012). According to standard economic theory, for these two reasons the level of foreign education attainment in the source country will be lower than the socially optimal one and thus government intervention is needed.

Two major financial aid programs promoting higher education abroad have been prevalent: international scholarships and loan programs. International scholarship programs have existed since the early 20th century, when several countries created programs to train the administrative elite of their colonies. Until the 1990s, generally only developed countries operated and funded international scholarship programs (Varghese, 2008). Since then, however, former Soviet countries have been offering more opportunities for their citizens' education abroad. In addition, over the last five years, a new wave of international scholarship programs have emerged in Latin America and Asia that are continuously expanding (Perna et al. 2014). At the same time, large-scale

loan programs have been operating in several developed countries for many years (e.g. Bafog in Germany). Some developing countries have also administered loan programs that send students abroad. One well-established example is a government-sponsored student loan scheme in Mauritius (UNESCO, 2006).

This paper makes two contributions to the literature. First, via Internet search, we collect a novel data-set on government-funded scholarship and loan programs that send students abroad. In total, we document 76 government-funded programs that promote education abroad in middle- and low-income countries,[1] of which 51 are scholarship programs and 25 are loan programs.

These programs provide financing to citizens of the sending country for studying abroad. The destination can be restricted to a specific geographical region, specific schools abroad, specific degree levels, and/or specific fields. According to the data, the financing of the programs amounts to 0.4% of the total budget of tertiary education of the sending countries. In addition, nearly 17 students per million population of a sending country receive either a scholarship or a loan in the middle- and low-income countries annually.[2]

The collected data-set has an advantage over all previously available data because it allows us to identify unique stylized facts for scholarship and loan programs for middle- and low-income countries. In particular, we find that the scholarship programs more frequently have an academic merit requirement, target graduate/postgraduate education, and require recipients to return to their home country than the loan programs do.[3]

Second, we build a two-country student migration model with government intervention to qualitatively explain the observed patterns. We analyze the model in which students from a developing country cannot finance their education abroad and the government expects a positive externality from study abroad graduates who return to the sending country upon graduation. Within this environment, we show that uncertainty about individual ability and the possibility that students may fail at their studies are crucial factors that generate the stylized facts. Specifically, when making education decisions, students cannot perfectly evaluate their own ability and risk failure in university studies. The students learn about their ability, and thus their productivity, only when they graduate and become employed. Consequently, when the degree of

[1] See Appendix in Section 1.8 for definitions of middle- and low-income countries, in addition to other key terms used throughout the paper. We use term "middle- and low-income country" to refer to a developing country.

[2] These are median figures based on Tables 1.8 and 1.9.

[3] There are possible alternative approaches to using the data in the research. Firstly, one can empirically investigate what the characteristics of countries that administer loans or scholarships are. Such an analysis might provide insight into the determinants of a government's choice to opt for one type of financial aid over another. Secondly, the data can be complemented by policies from developed countries. Such a combination can provide a more general picture of the market of "international talent," in which developed countries lay down policies to attract international students from developing countries and developing countries promote their citizens' education abroad.

uncertainty is sufficiently high, the likelihood of loan default becomes large and students will never accept loans. We demonstrate an example with two ex-ante ability groups of students where the government prioritizes ex-ante high-ability students and supports them with scholarships with the return requirement, and supports ex-ante low-ability students with loans without the return requirement. Our described theoretical environment in which students are uncertain about their own ability is novel in the migration literature.

The rest of the paper is organized as follows. Section 1.2 reviews the related literature. Section 1.3 discusses the methodology of the data collection and establishes stylized facts. Sections 1.4 builds the model to qualitatively account for the stylized facts. Section 1.5 concludes and points out further directions of the research.

1.2 Related Literature

Few studies analyze government-funded financial aid programs designed to promote education abroad for developing countries. Limited insights about the features of programs financing education abroad can be gleaned from OECD, UNESCO, and the World Bank reports, as well as several case studies, e.g. Woodhall (1992), Salmi (2003), The International Comparative Higher Education Finance and Accessibility Project (2009), Devesa and Blom (2007), Shen and Ziderman (2009), Ziderman (2013). However, these studies either only consider programs that support domestic university studies or provide a comparison of programs in selected countries.

Nevertheless, recent studies by DAAD[4] and British Council (2014) and Perna et al. (2014) are relevant. DAAD and British Council (2014) analyze scholarship programs in 11 selected countries (including both developed and developing countries). The study finds that scholarship programs tend to support graduate studies and are likely to have some merit criteria in the selection of recipients.

Perna et al. (2014) provide a typology summarizing programmatic indicators of active government-funded scholarship programs over the world. The report uses data collected via Internet search in 2014 and classifies scholarship programs with respect to degree, priority fields, types of expenses covered (full or partial), destination restriction, and return obligation. The study finds that of government-funded programs promoting education abroad, 63% promote graduate/postgraduate degrees and 25% oblige recipients to return after studies.

Although these studies describe various characteristics of scholarship programs, neither provides sufficient information on loan programs nor allows to carry out a comparative analysis of the types of financial aid programs. Our novel data-set fills this gap in the literature as it documents characteristics of both types of financial aid programs: loans and scholarships. Furthermore, the data-set allows us to establish unique stylized facts for middle- and low-income countries that were not available before.

[4]DAAD is the German Academic Exchange Service.

With regard to the theoretical literature, the only study that explicitly examines the optimal financial aid policy promoting education abroad is by Franck and Owen (2015). They investigate the performance of different types of grants in a two-country model with an education quality differential, endogenous probability of migration, and students' heterogeneity in ability. The government maximizes aggregate welfare generated only by the citizens of the country subject to the exogenous budget constraint. Their paper compares three types of grant schemes: unconditional grants, conditional grants with return requirement, and grants with operating return.[5] As Franck and Owen (2015) find, the optimal financial aid policy for a government with a tight budget is the grant with operating return. The authors also conjecture that when ability is the students' private information and not observed by the government, loans with the return requirement will be an optimal policy. This prediction follows from their model in which students perfectly know their own ability, and consequently, their future wages. In such a case, highly able students would know that they will earn enough to repay the loan after their studies. Therefore, only these students will be willing to accept loans and the government with a limited budget will maximize its expected welfare.

Other studies investigate different aspects of student migration. Rosenzweig (2008) and Driouchi (2014) analyze a two-country student migration model and find that education quality and skill premium differentials might be the most influential factors inducing the outmigration of students from lower income countries. Haupt et al. (2010) find that the positive probability of permanent migration, when this probability is sufficiently moderate, raises the aggregate human capital of a sending country.

Our model differs from the above models in various dimensions. First, neither of these models imposes any market imperfection, while we analyze a model in which students cannot finance their education abroad and there is a positive externality coming from returnees. Second, all these models assume that individual ability is the private information of students, while we introduce uncertainty about own ability and the stochastic return to education abroad (with the possibility of failure). Third, these models assume that the return migration decisions of students are exogenous, while we allow for endogenous decision on return migration. Therefore, our model is significantly richer compared to the existing models.

Our study is also related to Kwok and Leland (1982), Lien (1993), and Dai et al. (2015), who investigate the effect of return subsidies on the welfare (or the average productivity of workers) of a source country. These models assume that students decide to pursue education abroad and to return upon graduation based on a cost-benefit analysis. In addition, these models allow for information asymmetry such that the firms do not perfectly recognize the true productivity of workers. Still, neither of these papers explicitly examines the optimal financing policy for sending students

[5]Unconditional grants do not oblige the grant recipients to return to the home country after their studies abroad; conditional grants with return requirement require recipients to return after studies; and grants with operating return allow recipients to stay abroad if they repay the amount of the grant to the government.

abroad. In addition, the information asymmetry presented in our paper differs from the above authors' specifications. In particular, we assume that both students and government are uncertain about individual ability at the initial stage, while their models assume that ability is the private information of a student.

Our work is also related to Vidal (1998) and Stark and Zakharenko (2012), who analyze migration from developing countries with externality related to education attainment, and to Dustmann and Okatenko (2014), who consider financial constraints as obstacles to outmigration.

Lastly, our model is part of the large strand of "brain drain" literature extensively developed since Bhagwati and Hamada's (1974) seminal paper. The conventional assumption in this particular literature is that the government of a sending country maximizes the welfare (or average or aggregate productivity) of citizens that permanently reside in the source country, e.g. Stark et al. (1997, 1998), Stark and Wang (2002), Docquier and Rapoport (2008), Eggert et al. (2010). Our model diverges from this specification and provides a more general form of the government objective that potentially includes the welfare of permanent migrants.

1.3 The Data

1.3.1 Methodology

The methodology of the data collection is adopted from Perna et al. (2014). During January-May, 2015, we used a systematic Internet search to identify federal or government scholarship and loan programs supporting postsecondary education abroad. We limited the population to education loan and scholarship programs that are (fully or partially) financed by the national or federal governments in 196 independent states identified by the U.S. Department of State (Bureau of Intelligence and Research 2014).

To collect the data, we first searched through the English versions of government websites (government, ministry of higher education) for each country. Second, we investigated several reports and case-studies to glean information about existing programs (i.e. UNESCO (2011), the World Bank (2010), Mapping European Union Member States Higher Education External Cooperation Programmes and Policies (2010), The International Comparative and Higher Education Project (2009), National Student Fee and Support Systems in European Higher Education (2011-2015), Celik (2009), Lam and Oste (2014)). Third, we conducted web-searches in English and the national language of the country for several key-word combinations containing country name and variation(s) of words referring to financial aid.[6] National languages were identified from the U.S. Central Intelligence Agency (2013). Google Translate was used if necessary.

Whenever we identified a web source containing information regarding education fi-

[6] See Appendix in Section 1.7 for a full description of the key-word combinations.

nancial aid, we saved the web-address and analyzed the information. We restricted our focus to only scholarship and loan programs that target higher education abroad. These programs consist of scholarships and loans that exclusively promote education abroad, as well as programs that encourage tertiary education both locally and abroad. Programs that promote higher education only domestically were excluded. In addition, we only focused on programs that are fully or partially funded by national public resources, i.e. financed by a government authority. As for loan programs, in addition to programs fully administered and financed by a government (Federal Direct Subsidized Stafford Loans, Ministry of Education and Scientific Research loan in Mauritius), we included private loans subsidized or secured by a government (Government Supported Education Loans in Russia, Padho Pardesh in India). Loan or scholarship programs that operate using only private resources or funds established on the basis of intra-governmental agreements were excluded from our analysis.

To check whether a program satisfied the above criteria, we explored whether the program was mentioned on government websites and if either "government" or "public fund" was primarily stated in the source. We also checked whether it was clearly stated that financial aid can be used for education abroad.

For each program we recorded several available characteristics. Variables were systematically organized in Excel and filled in manually from the websites. A full list of the variables is presented in Section 1.8 of the Appendix. The full data-set is available upon request.

It is important to note that the collected data might not represent the whole population of policies. First, the population of programs might be at risk of selection bias, as it only documents financial aid programs that were available through the Internet January-May, 2015. Second, the data may not include full information on the characteristics of each program, as in some cases a limited number of indicators were available on the Internet.

Despite these limitations, the current data-set represents the best available data-set on the characteristics of financing programs supporting education abroad. The full list of countries with scholarship and loan programs is presented in Tables 1.3-1.5 in Appendix in Section 1.9.

1.3.2 Data Analysis and Stylized Facts for Middle- and Low-Income Countries

In total, we document 76 government-funded programs that promote education abroad in middle- and low-income countries, of which 51 are scholarship programs and 25 are loan programs. To establish stylized facts, we count scholarship and loan programs that have merit criteria, are targeted towards graduate/postgraduate studies, and require recipients to return after completion of studies. The facts about government-financed programs promoting higher education abroad are the following:

Table 1.1: Stylized Facts on Financial Aid Programs for Middle- and Low-Income Countries.

Fact 1	Scholarship programs *more frequently* select students based on *merit criteria* than loan programs do.
Fact 2	Scholarship programs are *more likely* to promote *graduate/postgraduate studies* than loan programs.
Fact 3	Scholarship programs are *more likely* to *require recipients to return* after completion of studies than loan programs.

Fact 1: In middle- and low-income countries 64.71% of scholarship programs and 48.00% of loan programs select recipients based on merit criteria.

Fact 2: In middle- and low-income countries 56.86% of scholarship programs and 20.00% of loan programs target graduate/postgraduate education.

Fact 3: In middle- and low-income countries 54.9% of scholarship programs and 8.00% of loan programs require recipients to return after completion of studies.

The findings are also presented in Table 1.10 in section 1.9 of the Appendix.

The established facts imply that scholarship programs more frequently have academic merit requirements, target graduate/postgraduate studies, and require recipients to return after graduation. Conversely, loan programs are more flexible with respect to the return obligation and less selective regarding academic merit and study level. The stylized facts are summarized in Table 1.1.

The presented stylized facts contradict some of the theoretical predictions and conventional assumptions of the migration literature. First, the stylized facts counter the theoretical prediction of Franck and Owen (2015) that loans with the return requirement should be an optimal financing policy for a government with a tight budget. The reasoning of their model is that higher-ability students are those who are likely to earn higher wages after studies and to be able to repay the loan amount. Therefore, even if the government does not observe the ability of students, only high-ability people will be willing to accept loans and to repay them upon graduation. Hence, a government with a tight budget would prefer to economize and to finance more students with loans with the return requirement. However, according to the stylized facts, countries rarely use loans with the return requirement. In addition, according to stylized facts 1 and 2, loan programs seem to be more flexible and less oriented towards "high-ability" students than conjectured by Franck and Owen (2015).

Second, our findings suggest that in reality government's objective is at variance with the conventional "brain-drain" objective. According to the traditional "brain-drain" approach, government's objective contains only the welfare/productivity of the residents. Consequently, government considers permanent migrants a waste of its human capital. If the "brain-drain" model were true, one should expect that countries frequently require their citizens to return after studies. However, according to Table

1.10 in Section 1.9 of the Appendix, nearly 60% of total policies in middle- and low-income countries do not require recipients to return after completion of studies. This can imply that government's objective in reality is flexible with regard to the post-study residence of students.

One of the shortcomings of our interpretation of the stylized facts is that our descriptive analysis simply counts existing programs and does not weigh them based on the expenditure or the size of programs. Thus, the large scholarship programs, e.g., Brazil's, is treated as equivalent to small programs, e.g. the loan program in Mauritius. We omit the dimension of size because of the large number of missing observations on the program budgets. Omitting the size of programs could create a potential problem, particularly if the size of the program is correlated with the type of program (scholarship vs. loan). Nevertheless, throughout the paper we assume no correlation between the size and the type of a program.

In addition, we abstract from interpreting the financial aid policies in middle- and low-income countries as being a response to developed country policies promoting incoming student mobility from developing countries. Although such an interpretation is quite realistic, this chapter starts with the simplest scenario and studies only a sending country dimension in which the receiving country is inactive. Future research could aim to investigate a more general picture where both developed and developing countries play actively in the "market" for international students.

The presented stylized facts serve as the motivation to build a student migration model that can qualitatively account for these stylized facts. Section 1.4 develops the framework for the model.

1.4 The Model

We develop a model which can qualitatively account for the stylized facts. The assumption we impose is that the stylized facts are the result of the government maximization problem of aggregate social welfare. First, we develop a basic model of student migration. Next, we extend the basic model and identify the ranges for the parameter values that generate stylized facts.

1.4.1 The Basic Model Without Government Intervention

There are two countries: home and foreign. The home country is a developing country and the foreign country is a developed country. The home country is populated with a mass of students who have an initial level of endowment $I \geq 0$. Acquiring education is only possible in the foreign country and the cost of education attainment is $c > 0$ for all students. The education cost encompasses all types of economic and psychological fixed costs related to studying abroad, which in general can be higher than pure tuition fees.

Students in the home country are characterized with an initial level of ability, productivity, or human capital (θ). The value of θ is randomly drawn from a uniform distribution with an expected value $\mathbb{E}(\theta)$ and the degree of uncertainty or the spread of distribution $\phi = \frac{\overline{\theta}}{\underline{\theta}} - 1$ where $\overline{\theta}$ and $\underline{\theta}$ stand for the upper and lower bounds of the distribution, respectively.[7] Initially, the students cannot perfectly evaluate their own ability and only know the values of $\mathbb{E}(\theta)$ and ϕ that are public information and the same for all students.[8] The productivity is revealed only after all migration decisions are settled (details about the timing are described below).[9]

Students are also described with parameter x that stands for disutility from loan default. Specifically, if a student accepts a loan and defaults, she experiences x amount of disutility. There is γ_x fraction of students with $x = 0$ and $(1-\gamma_x)$ fraction of students with $x = \overline{x} > c$. The value of x is a student's private information.

The model without government intervention is as follows. There are two periods in the model. In the first period, persons in the home country decide between acquiring education in the foreign country or staying in the home country. The education enhances the human capital by factor μ and the expected ability becomes $\mu\mathbb{E}(\theta)$. Factor μ is a random variable and

$$\mu = \begin{cases} \overline{\mu} & \text{with probability} \quad (1-\pi) \\ 1 & \text{with probability} \quad \pi \end{cases} \tag{1.1}$$

where $\overline{\mu} > 1$ and $\pi \in (0, 1]$. Alternatively, with probability π a student fails during her studies and ends up with the initial level of her (expected) human capital. When deciding upon education, students only know about the distribution of μ.

At the beginning of the second period, after studies are over, the value μ is revealed. If a student fails during her studies ($\mu = 1$), she has to return to the home country and work there. If a student successfully graduates ($\mu = \overline{\mu}$), she decides to migrate home or to stay abroad. If this graduate returns to the home country, the human capital is depreciated by β ($\beta < 1$ and $\beta\overline{\mu} > 1$) and the expected productivity becomes $\beta\overline{\mu}\mathbb{E}(\theta)$.[10] If this student decides to remain in the foreign country, she has to pay a

[7] Note that given uniform distribution, $\mathbb{E}(\theta)$ and ϕ determine the values of $\overline{\theta}$ and $\underline{\theta}$ as follows: $\underline{\theta} = \frac{2\mathbb{E}(\theta)}{\phi+2}$ and $\overline{\theta} = \frac{2\mathbb{E}(\theta)(\phi+1)}{\phi+2}$. That is, when $\phi = 0$, it holds that $\overline{\theta} = \underline{\theta} = \mathbb{E}(\theta)$, and when $\phi \to \infty$, it holds that $\overline{\theta} = 2\mathbb{E}(\theta)$ and $\underline{\theta} = 0$.

[8] According to our specifications, given ϕ a higher expected value of ability $\mathbb{E}(\theta)$ implies a higher range of the distribution of θ in absolute terms. That is $\overline{\theta} - \underline{\theta} = \frac{2\mathbb{E}(\theta)\phi}{\phi+2}$ which is increasing in $\mathbb{E}(\theta)$. This assumption can be motivated such that high-ability students have a larger range of opportunities in employment than the low-ability ones - starting from average-paid qualifications to top managers, CEO, etc. Low-ability students usually have comparably limited prospects on the labor market and a smaller range of available earnings.

[9] In other words, students are ex-ante homogeneous in their expected productivity. However, they are ex-post heterogeneous once the value of θ is revealed. The scenario in which students are also ex-ante heterogeneous is analyzed in Section 1.4.4.

[10] This is a commonly used approach in the migration literature to model the wage differential between developed and developing countries.

living cost abroad, which can be considered an opportunity cost of the time spent to socialize with family and friends who remain in the home country.[11] The living cost abroad of a student is assumed to be m fraction of her earnings where $m > 0$.

Once decisions on return migration are settled, the ability θ becomes publicly observable. Labor markets in both countries are perfectly competitive. As soon as θ is revealed, employment occurs at the place of a student's residence. Since the uncertainty about ability is resolved, firms can perfectly observe the human capital of workers and offer them wages equal to their revealed productivity.

Therefore, from the firms' point of view, there is no uncertainty about workers' productivity whatsoever.

Given the environment, we assume two types of market imperfection that justify government intervention.

Assumption 1.1. *Students are financially constrained ($I < c$) and unable to borrow.*

Since the home country is from the developing world, it is natural to assume that poor individuals have neither sufficient finances to afford education abroad nor perfect access to credit markets. In the model, we assume an extreme situation in which students are unable to borrow.

Assumption 1.2. *The social value of returnees' productivity is $\chi > 1$ times the corresponding market value.*

Assumption 2 implies that returnees create a positive externality for the domestic economy. The motivation of assumption 2 is that once graduates from foreign studies return to the home country, the production spillovers occur and are evenly distributed across all sectors of the economy. Since we do not model the production side of the sending country economy, we assume that the government values the productivity of returnees higher than the market does. The parameter χ can be interpreted as the social value of the productivity of returnees.

Finally, we assume no time-discounting and risk-neutral preferences.

1.4.1.1 The Market Outcome Without Government Intervention

In the first period, subject to the individual budget constraint, students decide to migrate or to stay in the home country. If students were not financially constrained, they would decide whether to migrate by comparing the expected utility from acquiring education abroad to the expected utility from staying in the home country.

Furthermore, under no financial constraints, students could be classified into three groups:

[11] The living cost abroad in the model should not be attributed to the differences in living conditions between developing and developed countries. Such differences are already captured by wages since the model assumes the wages in real terms. Instead, the living cost abroad is an opportunity cost that occurs only during permanent migration and captures an opportunity cost of home-sickness.

1. Students for whom it is ex-ante optimal to stay at home (H).
2. Students for whom it is ex-ante optimal to study abroad and return (R).
3. Students for whom it is ex-ante optimal to study and work abroad (F).

Due to the risk-neutral preferences, the corresponding expected utility for each group would be:

$$U^H = I + \mathbb{E}(\theta), \tag{1.2}$$

$$U^R = I - c + ((1-\pi)\beta\overline{\mu} + \pi)\mathbb{E}(\theta), \tag{1.3}$$

and

$$U^F = I - c + ((1-\pi)(1-m)\overline{\mu} + \pi)\mathbb{E}(\theta), \tag{1.4}$$

respectively. Clearly, under no financial constraints a student would choose the population group that would generate the highest expected utility. Specifically, a student would opt to study abroad and return, or choose R, if both her expected ability and the living cost abroad were sufficiently high, that is

$$\mathbb{E}(\theta) \geq \frac{c}{(1-\pi)(\beta\overline{\mu}-1)} := \hat{e}_1 \;\; \& \;\; m \geq 1-\beta := \hat{m}. \tag{1.5}$$

A student would opt to study and remain abroad, or choose F, if her expected ability were sufficiently high and the living cost abroad were sufficiently low, that is

$$\mathbb{E}(\theta) \geq \frac{c}{(1-\pi)((1-m)\overline{\mu}-1)} := \hat{e}_2 \;\; \& \;\; m < \hat{m}. \tag{1.6}$$

Finally, a student would never go abroad, or choose H, if her expected ability were not sufficiently high, that is

$$\mathbb{E}(\theta) < min(\hat{e}_1, \hat{e}_2). \tag{1.7}$$

The privately optimal outcome with no financial constraints for different values of $\mathbb{E}(\theta)$ and m is also illustrated in Figure 1.1(a).

However, as $I < c$ students stay in the home country and receive U^H.

1.4.2 The Social Optimum

This section introduces the notion of social welfare for the developing home country. We assume that the aggregate social welfare of the home country includes the welfare of all citizens irrespective of the place of their residence after studies abroad. This welfare structure is different from the traditional "brain drain" structure. Conventionally, permanent migrants are considered a skill waste for a sending country.

Alternatively, the "brain-drain" interpretation of the government objective function is that welfare should include only the welfare of the sending country residents. The reason we model the government objective is two-fold. First, our motivation is driven by the data on government-funded financial aid policies. According to Table 1.10 in Section 1.9 of the Appendix, nearly 60% of financial aid policies in middle- and low-income countries do not oblige recipients to return after their studies. This implies that in reality governments' objective might be closer to the social welfare definition presented in this paper. Second, our model is more general than the traditional one. In particular, when $\chi\beta > 1$ our model is equivalent to the "brain-drain" model.

The social planner does not observe students' ability θ; rather, it knows only the expected value $\mathbb{E}(\theta)$ and the spread of the distribution ϕ. The social planner also does not observe the cost of loan default x that is the private information of a student. According to assumption 2, the social productivity of returnees is χ times their market productivity. Therefore, the expected welfare for each population group, from the social point of view, is the following:

$$W^H = I + \mathbb{E}(\theta) = U^H, \tag{1.8}$$

$$W^R = I - c + ((1-\pi)\chi\beta\overline{\mu} + \pi)\mathbb{E}(\theta) > U^H, \tag{1.9}$$

and

$$W^F = I - c + ((1-\pi)(1-m)\overline{\mu} + \pi)\mathbb{E}(\theta) = U^F. \tag{1.10}$$

The social welfare from returnees is higher than the expected utility (under no financial constraints) of returnee students by $(\chi-1)(1-\pi)\beta\overline{\mu}\mathbb{E}(\theta)$ due to externality. Groups H and F do not create any externality and the social welfare coincides with the expected utility (under no financial constraints) from these population groups.

The social planner can simply direct students to one of the groups H, R, F to maximize the aggregate social welfare. The social planner maximizes the aggregate social welfare:

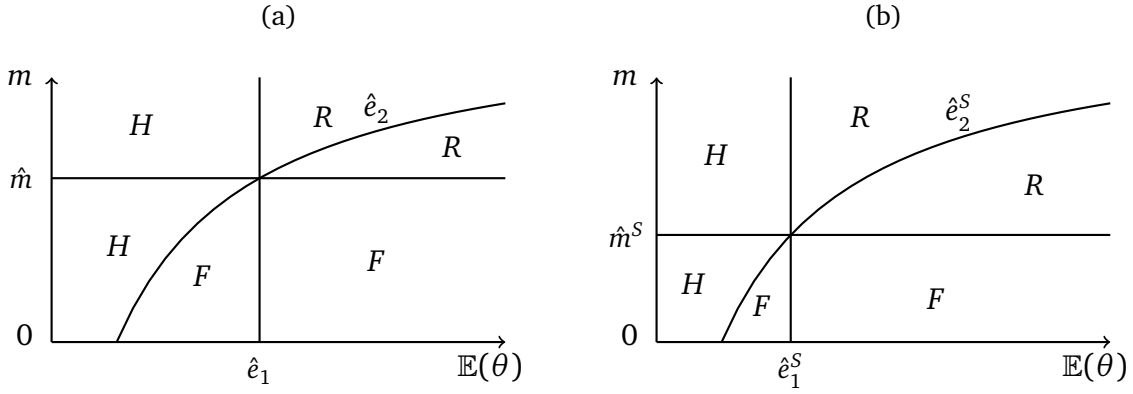
$$\underset{\{D\}}{\text{Max}}\, SW\big(D\big) = W^D \tag{1.11}$$

where $SW(.)$ stands for the aggregate social welfare and D stands for the population group ($D \in \{\{H\}\{R\}\{F\}\}$). The welfare W^D is determined according to equations (1.8)-(1.10).

The socially optimal outcome depends on values that $\mathbb{E}(\theta)$ and m can take on. In particular, the socially optimal outcome is population group R, if, from the social perspective, both the expected ability and the living cost abroad are sufficiently high, that is

$$\mathbb{E}(\theta) \geq \frac{c}{(1-\pi)(\chi\beta\overline{\mu}-1)} := \hat{e}_1^S \;\;\&\;\; m \geq 1-\chi\beta := \hat{m}^S. \tag{1.12}$$

Figure 1.1: (a) The Privately Optimal Outcome (under no financial constraints); (b) The Socially Optimal Outcome when $\chi \in (1, \frac{1}{\beta})$. It holds that $\hat{m} > \hat{m}^S$, $\hat{e}_1 > \hat{e}_1^S$, and $\hat{e}_2 = \hat{e}_2^S$.



The socially optimal outcome is population group F, if, from the social perspective, students' expected ability is sufficiently high and the living cost abroad is sufficiently low, that is

$$\mathbb{E}(\theta) \geq \frac{c}{(1-\pi)((1-m)\overline{\mu}-1)} := \hat{e}_2^S \;\; \& \;\; m < \hat{m}^S. \tag{1.13}$$

Finally, the socially optimal outcome is population group H, if, from the social perspective, students' expected ability is not sufficiently high, that is

$$\mathbb{E}(\theta) < min(\hat{e}_1^S, \hat{e}_2^S). \tag{1.14}$$

The socially optimal outcome for different values of $\mathbb{E}(\theta)$ and m is also illustrated in Figure 1.1(b).

It is clear that $\hat{e}_1^S < \hat{e}_1$, $\hat{m}^S < \hat{m}$, and $\hat{e}_2^S = \hat{e}_2$. The result is intuitive because the government expects a positive externality from the returnee students ($\chi > 1$). Therefore, the parameter range for which R is the socially optimal group is larger than that for which R is the privately optimal group (with no financial constraints). Specificaly, there is a range of parameters for which it is privately optimal (under no financial constraints) to remain at home (H), whereas due to externality, the socially optimal outcome is R ($\mathbb{E}(\theta) \in [\hat{e}_1^S, \hat{e}_1)$ & $m \geq \hat{m}$). Additionally, there is a range of parameters for which the privately optimal outcome (without financial constraints) is to study and remain abroad (F), whereas due to externality, the socially optimal outcome is R ($\mathbb{E}(\theta) \geq \hat{e}_1^S$ & $m \in [\hat{m}^S, \hat{m})$). For the rest of the cases, the privately (without financial constraints) and the socially optimal outcomes coincide.

1.4.3 The Government

The government does not observe a student's productivity and only knows about the expected value $\mathbb{E}(\theta)$ and the spread of the distribution ϕ. The government also does not observe the cost of loan default that is a student's private information.

The government is constrained by an upper limit of the budget, denoted by B ($B > 0$).[12] Subject to the budget constraint, the government sets the policy that maximizes the expected aggregate welfare of the society.

Government Policy. The government determines the financial aid policy at the beginning of the first period, before any individual decisions whether to migrate are made. The government policy is comprised of the type of financial aid ($\mathbf{P}$), the return requirement ($\mathbf{r}$), the amount of aid ($\mathbf{a}$), the fraction of applicants receiving aid (α), and the lump-sum transfers distributed at the end of the second period ($\mathbf{G}$). Below we discuss the characteristics of each tool in detail.

The type of policy ($\mathbf{P}$). The government is restricted to choose only one type of policy at once ($\mathbf{P} \in \{\mathbf{P_0}, \mathbf{P_s}, \mathbf{P_l}\}$). The government can either offer a scholarship ($\mathbf{P_s}$), a loan ($\mathbf{P_l}$), or no financial aid at all ($\mathbf{P_0}$).

Scholarships do not require recipients to repay the amount of aid. A loan is aid that should be repaid in the second period after employment occurs (the detailed timing of the model is described below). If a person does not repay the loan, she experiences the disutility in the amount of x, the value of which is the private information of a student.

The return requirement ($\mathbf{r}$). The government also decides whether to oblige recipients to return to the home country ($\mathbf{r} = 1$) or not to oblige them to return ($\mathbf{r} = 0$). If a student accepts aid with the return requirement, the student has to return after completion of studies abroad and cannot extricate him/herself from the obligation.[13]

The amount of aid ($\mathbf{a}$). The government also determines the amount of aid ($\mathbf{a} \in [0, c]$). The amount of aid cannot be larger than the cost of the education, because the government may find it difficult to politically justify extremely high expenditure on higher education abroad to taxpayers.

The fraction of applicants receiving aid (α). The government also determines the fraction $\alpha \in [0, 1]$ of applicants who will receive aid. The applicants are the students who, given the government policy, decide to apply for aid at the beginning of the first period. In general, the mass of applicants can be different from the total mass of students. The rule of the aid provision is that the amount $\mathbf{a}$ is randomly distributed to α share of students who applied for the aid.

The lump-sum transfers ($\mathbf{G}$). The government determines the amount of lump sum

[12] Our assumption regarding the exogenous budget level is quite realistic. According to the data, the budget of financial aid programs is usually a tiny fraction of the total budget on higher education (refer to Tables 1.6 and 1.7 in Section 1.9 of the Appendix). Therefore, this can indicate that these financial aid programs, in reality, are an insignificant burden on taxpayers.

[13] It is important to note that the evidence on the avoidance of the return obligation is mixed. Turkey experienced a significantly large number of recipients who did not return after studies although they were obliged to (Gungor and Tansel 2008), whereas in the Philippines the non-return rate was negligible (DAAD and British Council 2014). Our interpretation of this assumption is that the government in principle might be able to place legal restrictions on students intending to stay abroad after their studies (e.g. suspending visa in the host country) and effectively force them to return.

transfers ($\mathbf{G} \in [0, B]$). The transfers are equally distributed among students at the end of the second period after loan repayment. We assume that if the government is indifferent as to providing financial aid and distributing transfers, the government always chooses the latter option over the former. The availability of transfers incorporates an opportunity cost of providing financial aid for the government. Instead of administering educational aid programs, the government can always spend resources on public goods provision and make the whole society better off.[14]

Timing of the Model with Government Intervention. The timing of the model with government intervention is as follows. At the beginning of the first period, the government decides on the policy $(\mathbf{P}, \mathbf{r}, \mathbf{a}, \alpha, \mathbf{G})$. Given the government policy, students decide whether to apply for financial aid. The government distributes aid randomly to α fraction of students who applied for the aid. After the aid is distributed, all persons who received the aid study abroad; all other students remain in the home country. In the second period, when studies are over, the students learn about their failure. Those who failed during their studies and those who receive the aid obliging return in the first period return to their home country; the graduates who obtained the aid without the return requirement and successfully graduated from studies decide between returning home and remaining abroad. Once all decisions on return migration are settled, the productivity of students is publicly revealed and employment occurs at the place of a person's residence. If the students receive loans in the first period, they decide on the loan repayment after employment is settled. Once loan repayment decisions are made, the government distributes the lump-sum transfers **G** to everyone.

The full timing of the model is illustrated in Figure 1.3.

Decision on Default. Scholarship recipients are never required to repay the amount of the aid. Loan recipients with no disutility from default ($x = 0$) will never repay loans. Loan recipients with a positive disutility from default ($x = \overline{x}$) will default if they do not earn sufficiently high income after both their failure and their ability are revealed. This occurs when $\theta < c - I$ for $\mu = 1$ and $\theta < \tilde{\theta}^j$ for $\mu = \overline{\mu}$ where

$$\tilde{\theta}^j = \begin{cases} \frac{c-I}{\beta\overline{\mu}} & \text{if} \quad \text{j=R} \\ \frac{c-I}{(1-m)\overline{\mu}} & \text{if} \quad \text{j=F.} \end{cases} \tag{1.15}$$

In other words, if a student successfully graduates from studies, the threshold ability level for default depends on the population group.

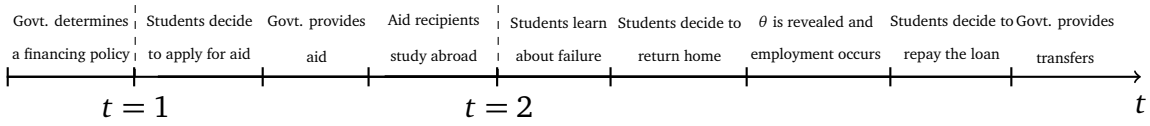
Students with $x = \overline{x}$ anticipate the probability of loan default that is

$$\nu^j = (1-\pi)Prob(\theta < \tilde{\theta}^j) + \pi Prob(\theta < c - I) \tag{1.16}$$

where ν^j stands for the probability of loan default for $x = \overline{x}$ students who end up in the population group $j \in \{\{R\}\{F\}\}$. Clearly, the higher the degree of uncertainty, the higher the likelihood of loan default, that is $\frac{\partial \nu^j}{\partial \phi} \geq 0$. In addition, for a substantially

[14] This assumption is also necessary to avoid multiplicity of solutions.

Figure 1.2: Timing of the Model with Government Intervention.



low degree of uncertainty, the default probability for $x = \overline{x}$ students becomes 0 and the model is similar to the perfect information case when θ takes on only one value.

The Government Maximization Problem. The government maximizes the aggregate social welfare subject to the budget constraint:

$$\begin{gathered}\underset{\{P,r,a,\alpha,G\}}{\text{Max}}\ SW\big(P,r,a,\alpha,G\big) = \\ W^H + \alpha\mathbb{E}_x\,\mathbb{1}^A(P,r,a|x)\big[W^j(P,r,a|x) - W^H + (1-\mathbb{1}^{\overline{x}}(P|x))a + \mathbb{1}^{\overline{x}}(P|x)v^j(a-\overline{x})\big] + G \\ s.t. \\ \alpha\mathbb{E}_x\,\mathbb{1}^A(P,r,a|x)(1-\mathbb{1}^{\overline{x}}(P|x)(1-v^j))a + G \le B; \\ 0 \le a \le c; \quad 0 \le \alpha \le 1; \quad G \ge 0\end{gathered} \tag{1.17}$$

where $SW(.)$ stands for the expected aggregate social welfare; W^H is the expected welfare of students from staying in the home country and is determined by equation (1.8); $\mathbb{1}^{\overline{x}}(P|x)$ is an indicator function that is equal to 1 if $P = P_l$ and $x = \overline{x}$ and to 0 otherwise; v^j is the probability of the loan default and is determined by equation (1.16); $\mathbb{1}^A(P,r,a|x)$ is an indicator function which equals to 1 if students apply for the aid and to 0 otherwise. Alternatively,

$$\mathbb{1}^A(P,r,a|x) = \begin{cases} 1 & \text{if} \quad r=1 \quad \& \quad \mathbb{U}^R(P,a|x) \ge U^H \\ & \text{or} \quad r=0 \quad \& \quad max(\mathbb{U}^R(P,a|x), \mathbb{U}^F(P,a|x)) \ge U^H \\ 0 & \text{otherwise} \end{cases} \tag{1.18}$$

where $\mathbb{U}^j(P,a|x) = U^j + (1-\mathbb{1}^{\overline{x}}(P|x)(1-v^j))a - \mathbb{1}^{\overline{x}}(P|x)v^j\overline{x}$ for $j \in \{\{R\}\{F\}\}$ and the functional form of U^j is determined by equations (1.3) and (1.4). That is, students apply for aid if the new population group generates the expected utility gain net of the loss from the possible loan default, if applicable; $W^j(P,r,a|x)$ is the expected welfare of students who received the financial aid and end up in the population group $j \in \{\{R\}\{F\}\}$, that is

$$W^j(P,r,a|x) = \begin{cases} W^R & \text{if} \quad r=1 \quad \text{or} \quad r=0 \quad \& \quad \mathbb{U}^R(P,a|x) \ge \mathbb{U}^F(P,a|x) \\ W^F & \text{otherwise} \end{cases} \tag{1.19}$$

where W^R and W^F are determined by equations (1.9) and (1.10).

The maximization problem implies that scholarships are a type of aid with no obligation to repay and therefore all students will keep the amount in the second period. In the case of loans, students with $x = 0$ will keep the loan amount in the second period without any loss. Students with $x = \overline{x}$ will not repay the loan with probability v^j. The

default creates the disutility equal to $a - \overline{x} < 0$. Therefore, the default risk creates expected social welfare losses for students with $x = \overline{x}$ and can potentially distort their decision to accept loans.

With regard to the budget, the government expenditure is equal to the total amount of aid that is not repaid. If the aid is repaid, there is no cost for the government. Since scholarships do not oblige repayment, their expenditure will be exactly equal to the amount of distributed scholarships; that is, to αa. In the case of loans, the total expenditure on loans is the expected amount of default; that is, $\alpha(\gamma_x + (1-\gamma_x)\nu^j)a$, i.e. lower compared to scholarships. This implies that if the government budget is tight, loans induce lower expenses and allow the government to finance a larger fraction of students compared to scholarships.[15]

The discussion above is summarized in two observations below.

Observation 1 (default effect). For a sufficiently high degree of uncertainty (ϕ), loans create an expected loss in welfare that is absent for the scholarship.

Observation 2 (budgetary effect). For a fixed requirement on return, a fixed amount of the aid, and a fixed share of aid applicants, loans can finance a larger or equal fraction of students compared to scholarships.

These two observations imply that the optimal government policy depends on which default and budgetary effect is stronger and on the tightness of the budget.[16]

1.4.3.1 The Optimal Government Policy

The optimal government policy depends on the parameter levels ($\mathbb{E}(\theta)$, m). Below, we analyze the optimal government policy for four distinct cases (see Figure 1.3.). Each case stands for a specific range of $(\mathbb{E}(\theta), m)$.

Case I. $\mathbb{E}(\theta) < min(\hat{e}_1^S, \hat{e}_2)$**.**

Case I describes the conditions in which it is neither socially nor privately optimal to study abroad because students' expected ability is low. Clearly, in this case, the government will remain inactive and the students will remain at home.

Proposition 1.4.1. *Given case I, the government does not provide any financial aid ($P_i^* = P_0$).*

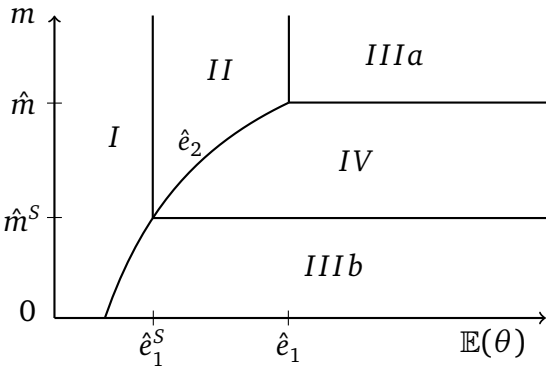
Next, we consider the cases for which the government strictly benefits from the intervention. The proofs of the propositions are presente in Section 1.10 of the Appendix. Below we develop an economic intuition behind each result.

Case II. $\mathbb{E}(\theta) \in [\hat{e}_1^S, min(\hat{e}_1, \hat{e}_2))$.

[15] One can imagine that the government can always borrow the money even though the budget level B is fixed.

[16] Clearly, if the budget is sufficiently large and the government is able to finance all students, there will be no budgetary effect of loans over scholarships.

Figure 1.3: The Socially and Privately (under no financial constraints) Optimal Outcomes and the Optimal Government Policy (P^*, r^*) for Different Values of $(\mathbb{E}(\theta), m)$ when $\chi \in (1, \frac{1}{\beta})$



Case I. Privately optimal: H, Socially optimal: H, Optimal Govt. Policy: (P_0, r)
Case II. Privately optimal: H, Socially optimal: R, Optimal Govt. Policy: $(P_s, 1)$
Case $IIIa$. Privately optimal: R, Socially optimal: R, Optimal Govt. Policy: $(P_l, 0)/(P_s, 0)$
Case $IIIb$. Privately optimal: F, Socially optimal: F, Optimal Govt. Policy: $(P_l, 0)/(P_s, 0)$
Case IV. Privately optimal: F, Socially optimal: R, Optimal Govt. Policy: $(P_l, 0)/(P_l, 1)/(P_s, 1)$

Proposition 1.4.2. *Given case II, the (weakly) optimal government policy is a scholarship with the return requirement ($P^*_{ii} = P_s$, $r^*_{ii} = 1$).*

For case II, it is socially optimal for students to study abroad and return ($W^R > W^H > W^F$). From the private point of view, these students would never study abroad even in the absence of financial constraints ($U^H > max(U^R, U^F)$).

Since group F is always inferior from both the social and private points of view, it immediately follows that requiring students to return is a (weakly) dominant policy for the government $r^*_{ii} = 1$. Since under no financial constraints students would remain at home, they need to receive a sufficient amount of aid to study abroad. A scholarship is non-repayable aid and all students will apply if a sufficient amount is provided. A loan is repayable aid and does not create any gain for students with $x = \overline{x}$. Consequently, these students will never apply for loans of any amount. Therefore, it follows that scholarships will induce a larger fraction of applications and generate higher social welfare compared to loans.

Case $IIIa - b$. $[\mathbb{E}(\theta) \geq \hat{e}_2,\ m < \hat{m}^S] \cup [\mathbb{E}(\theta) > \hat{e}_1,\ m \geq \hat{m}]$.

Proposition 1.4.3. *Given cases $IIIa - b$, there is a threshold level for the government budget ($\tilde{B}^{a-b}_{iii}(\phi)$), such that if $B \leq \tilde{B}^{a-b}_{iii}(\phi)$, the (weakly) optimal government policy is a loan without the return requirement ($P^*_{iii} = P_l$, $r^*_{iii} = 0$). If $B > \tilde{B}^{a-b}_{iii}(\phi)$, the (weakly) optimal government policy is a scholarship without the return requirement ($P^*_{iii} = P_s$, $r^*_{iii} = 0$). In addition, the threshold level $\tilde{B}^{a-b}_{iii}(\phi)$ is non-increasing in the degree of uncertainty ($\frac{\partial \tilde{B}^{a-b}_{iii}(\phi)}{\partial \phi} \leq 0$)*

For case $IIIa-b$ the socially and privately (under no financial constraints) optimal population groups coincide and are R for case $IIIa$ and F for case $IIIb$. Therefore, the government does not need to distort the return decision of students and the optimal policy is not to require them to return: $r^*_{iii}=0$.

Given $r^*_{iii}=0$, we analyze different degrees of uncertainty ϕ. First, suppose that the degree of uncertainty is sufficiently low that no one defaults on loans ($\nu^j=0$). Since $max(U^R,U^F)-U^H>0$, it follows that *all* students will apply for a loan if it enables them to cover the education cost. Hence, there will be no default and loans will have only the budgetary effect. Therefore, the government will (weakly) prefer loans to scholarships.[17]

Second, suppose the uncertainty is sufficiently high, such that the default probability is so large that $x=\overline{x}$ students never apply for loans ($max(U^R,U^F)-U^H+\nu^j(c-\overline{x})<0$). Then, there will be no budgetary effect since only student with $x=0$ will apply for a sufficiently high amount of loan. Similar to the logic of case II, a scholarship without the return requirement will be a dominant policy.

Finally, for the intermediate value of the uncertainty, the budgetary effect of loans dominates the default effect when the government budget is tight. As the government has more resources available, the budgetary effect becomes weaker and the government switches to scholarships. Importantly, increasing the degree of uncertainty leads to magnifying of the default effect and to the weakening of the budgetary effect. Therefore, as students become more uncertain about their own ability, the government becomes more inclined to offer scholarships.

Case IV. $\mathbb{E}(\theta)\geq\hat{e}_1$, $m\in[\hat{m}^S,\hat{m})$.

Proposition 1.4.4. *Given case IV, there are up to three segments of B divided by thresholds $\tilde{B}^I_{iv}(\phi)$ and $\tilde{B}^{II}_{iv}(\phi)$ where $\tilde{B}^I_{iv}(\phi)\geq\tilde{B}^{II}_{iv}(\phi)\geq 0$, such that*

-If $B<\tilde{B}^{II}_{iv}(\phi)$, the optimal government policy is a loan without the return requirement ($P^*_{iv}=P_l$, $r^*_{iv}=0$).

-If $\tilde{B}^{II}_{iv}(\phi)\leq B<\tilde{B}^I_{iv}(\phi)$, the optimal government policy is a loan with the return requirement ($P^*_{iv}=P_l$, $r^*_{iv}=1$).

-If $B\geq\tilde{B}^I_{iv}(\phi)$, the optimal government policy is a scholarship with the return requirement ($P^*_{iv}=P_s$, $r^*_{iv}=1$).

In addition, the highest threshold value of the government budget is non-increasing in the degree of uncertainty ($\frac{\partial\tilde{B}^I_{iv}(\phi)}{\partial\phi}\leq 0$).

For case IV, studying abroad and returning to the home country is a socially desirable outcome ($W^R>W^F>W^H$), whereas under no financial constraints students would study and remain abroad ($U^F>U^R>U^H$).

First, similar to the logic of case III, the government will choose either loans with

[17] For a large value of B the government will be indifferent as to loans and scholarships.

the return requirement or scholarships with the return requirement depending on the degree of uncertainty and on whether the budgetary effect is higher or lower than the default effect of loans.

However, the government might prefer to provide loans without the return requirement, although this policy leads to a socially sub-optimal population group F ($W^R > W^F$ for case IV), because loans without the return requirement generate a lower default probability ($m < 1-\beta \implies \nu^R \geq \nu^F$). Lower probability of default also implies lower budgetary expenses and a stronger budgetary effect, since more students can be financed. Therefore, if the budgetary effect is larger than the default effect together with the loss in social welfare ($W^R - W^F$), the government will choose loans without the return requirement over loans with the return requirement.

A summary of the results is in Figure 1.3. The next section extends the model and finds the range of parameters for which the stylized facts can be generated.

1.4.4 Extension and the Stylized Facts

This section builds on the previous section to demonstrate that the extended version of the model with two ex-ante ability types of students and two types of schools can qualitatively replicate all stylized facts.

The extended model is as follows. There are two groups of students: γ^h fraction of ex-ante high-ability students and γ^l fraction of ex-ante low-ability students ($\gamma^h + \gamma^l = 1$). Neither of these students nor the government knows individual productivity. The productivity is drawn from a uniform distribution in the second period. The distribution of students' ability is public information and fully described by $(\mathbb{E}(\theta^h), \phi)$ for ex-ante high-ability students and by $(\mathbb{E}(\theta^l), \phi)$ for low-ability students such that $\mathbb{E}(\theta^h) > \mathbb{E}(\theta^l)$. Both types of students face the same degree of uncertainty ϕ. Alternatively, even if the students' productivity cannot be perfectly evaluated, some students are perceived as more able compared to their peers (for instance, some students have better grades at school than others).

In addition, there are two schools available in the foreign country. One school provides a graduate degree and another offers an undergraduate degree. The return to graduate and undergraduate education (in the case of no failure) are $\overline{\mu}^g$ and $\overline{\mu}^u$, respectively, such that $\beta\overline{\mu}^g > \beta\overline{\mu}^u > 1$.

If a students studies abroad, she is allowed to choose to study only in one type of school. If a student studies at the graduate school, she faces a positive probability of failure π^i where $i \in \{\{h\}\{l\}\}$. It is assumed that ex-ante high-ability students face a lower probability of failure; that is, $\pi^h < \pi^l$. Further, we assume that the values of π^h and π^l are such that high-ability students always choose to study at graduate school to undergraduate school and low-ability students choose the opposite:

$$\pi^l > max\Big(\frac{\beta(\overline{\mu}^g - \overline{\mu}^u)}{\beta\overline{\mu}^g - 1}, \frac{(1-m)(\overline{\mu}^g - \overline{\mu}^u)}{(1-m)\overline{\mu}^g - 1}\Big) \tag{1.20}$$

and

$$\pi^h < min\Big(\frac{\beta(\overline{\mu}^g-\overline{\mu}^u)}{\beta\overline{\mu}^g-1},\frac{(1-m)(\overline{\mu}^g-\overline{\mu}^u)}{(1-m)\overline{\mu}^g-1}\Big). \tag{1.21}$$

Finally, since graduate studies are generally more difficult compared to undergraduate studies, we assume that no failure is involved during studies at the undergraduate school. Throughout the rest of the section we denote π^h by π.

Within the modified environment, the government determines a financial aid policy that is conditional on each ability group of students $((P^i, r^i, \alpha^i, a^i, G)$ where $i \in \{\{h\}\{l\}\})$. The maximization problem is:

$$\begin{gathered}
Max_{\{P^i,r^i,a^i,\alpha^i,G\}} SW(P^i,r^i,a^i,\alpha^i,G) = \\
\sum_{i\in\{\{h\}\{l\}\}} \gamma^i\Big[W^{i,H}+\alpha^i\mathbb{E}_x\mathbb{1}^{i,A}(P^i,r^i,a^i|x)\big[W^{i,j}(P^i,r^i,a^i|x)-W^{i,H}+ \\
(1-\mathbb{1}^{i,\overline{x}}(P^i|x))a^i+\mathbb{1}^{i,\overline{x}}(P^i|x)\nu^{i,j}(a^i-\overline{x})\big]+G \\
\text{s.t.} \\
\sum_{i\in\{\{h\}\{l\}\}} \gamma^i\alpha^i\mathbb{E}_x\mathbb{1}^{i,A}(P^i,r^i,a^i|x)(1-\mathbb{1}^{\overline{x}}(P^i|x)(1-\nu^{i,j})a^i+G\le B \\
0\le a^i\le c; 0\le\alpha^i\le 1; G\ge 0.
\end{gathered} \tag{1.22}$$

All variables are defined similarly to the benchmark model.

Below we identify the range of parameters that can generate the stylized facts.

Proposition 1.4.5. *Suppose that the following conditions hold :*

$$\mathbb{E}(\theta^h) > \frac{c}{(1-\pi)((1-m)\overline{\mu}^g-1)}, \tag{1.23}$$

$$\mathbb{E}(\theta^l) > \frac{c}{((1-m)\overline{\mu}^u-1)}, \tag{1.24}$$

$$\gamma^h > \frac{(\chi\beta\overline{\mu}^u-1)\mathbb{E}(\theta^l)-c}{(1-\pi)(\chi\beta\overline{\mu}^g-1)\mathbb{E}(\theta^h)+(\chi\beta\overline{\mu}^u-1)\mathbb{E}(\theta^l)-2c}, \tag{1.25}$$

and

$$k > \frac{(\chi\beta\overline{\mu}^u-1)\mathbb{E}(\theta^l)-c}{(1-\pi)(\chi\beta\overline{\mu}^g-1)\mathbb{E}(\theta^h)+(\chi\beta\overline{\mu}^u-1)\mathbb{E}(\theta^l)-2c} \tag{1.26}$$

where k solves the following equation:

$$\begin{gathered}
(1-\pi)max\Big(\frac{(\frac{c-E}{(1-m)\overline{\mu}^g}(k+2)-2\mathbb{E}(\theta^h)}{2\mathbb{E}(\theta^h)k},0\Big)+\pi\frac{(c-E)(k+2)-2\mathbb{E}(\theta^h)}{2\mathbb{E}(\theta^h)k}= \\
\frac{(1-\pi)(\chi\beta\overline{\mu}^g-1)\mathbb{E}(\theta^h)-c}{(1-\pi)(\chi\beta\overline{\mu}^g-1)\mathbb{E}(\theta^h)-c+\overline{x}}.
\end{gathered} \tag{1.27}$$

There are ranges of the degree of uncertainty ($\phi \in [\tilde{\phi}^I, \tilde{\phi}^{II}]$), the living cost abroad ($m \in [\hat{m}^S, \tilde{m}^I]$), and the government budget $B \in [\tilde{B}^I, \tilde{B}^{II}]$, such that the government prioritizes the high-ability students over low-ability students. Furthermore, given these ranges, the government finances all high-ability students with scholarships with the return requirement, and distributes the remainder of the budget in the form of loans without the return requirement to the low-ability students ($P^{h,*} = P_s$, $r^{h,*} = 1$, $P^{l,*} = P_l$, $r^{l,*} = 0$).

Equations (1.23) and (1.24) guarantee that it is ex-ante socially optimal for both type of students to study abroad. Equation (1.25) stands for the condition that the government always prefers to finance high-ability students rather than low-ability students and clearly this happens for sufficiently high γ^h. Equations (1.26) and (1.27) guarantee the existence of the segments for the living cost abroad, degree of uncertainty, and the budget level mentioned in the proposition.

The story of proposition 4.5 is the following. Students (both types) are ex-ante high able such that they prefer to study and permanently remain abroad. Due to externality, the government wishes to send students abroad and to induce them to return upon graduation. In addition, the share of ex-ante high-ability students is sufficiently high and the government with a tight budget prioritizes financing them over financing the low-ability students. Since graduate studies involve the risk of failure, when the default effect of a loan dominates its budgetary effect, it is optimal to support high-ability students with scholarships with the return requirement. Since undergraduate studies have no risk of failure, the budgetary effect of a loan can be higher than the default effect and the government might opt for loans. For certain ranges of parameters, the government by offering loans without the return requirement to low-ability students will mitigate the default effect and increase the budgetary effect.

1.5 Discussion and Further Research

We identify and theoretically analyze existing government-funded financing programs targeted towards higher education abroad. The unique data-set collected via Internet search allows us to compare programmatic characteristics of scholarship and loan programs in middle- and low-income countries. The stylized facts arising from the data demonstrate that scholarship programs are more likely to support students with higher academic merit, be aimed at graduate/postgraduate studies, and require recipients to return than loan programs.

We interpret stylized facts from a developing country perspective. We provide a two-country student migration model with financial constraints and a positive externality from "returnee" students. Neither students nor the government knows individual ability, which becomes observable only during employment. Additionally, there is a fraction of people who experience high disutility from loan default. Within this environment, the model shows that since some part of loans is always repaid, loan programs are cheaper and allow the government with a tight budget to send a higher fraction of students abroad compared to scholarships. However, if there is a sufficiently high like-

Table 1.2: Stylized Facts for Middle- and Low-Income Countries and Performance of the Theoretical Model.

Fact 1	Scholarship programs more frequently select students based on merit criteria than loan programs do.	Proposition 1.4.5
Fact 2	Scholarship programs are more likely to promote graduate and postgraduate studies than loan programs.	Proposition 1.4.5
Fact 3	Scholarship programs are more likely to require recipients to return after completion of studies than loan programs.	Proposition 1.4.5

lihood of students entering the employment market with low-productivity, loans might create higher expected losses due to possible default. Hence, if the budgetary effect of the loan is offset by possible losses from default, the optimal government policy will be to provide scholarships to insure students against non-repayment. We show that when students are heterogeneous in their expected ability and certain conditions hold, the government prioritizes the high-ability students and finances their graduate education with scholarships with the return requirement, and finances the undergraduate education of low-ability students with loans without the return requirement.

A summary of the stylized facts and the performance of the model is presented in Table 1.2. The current model succeeded in qualitatively explaining all three stylized facts on the comparison of financing policies promoting education abroad in middle- and low-income countries.

There are several fruitful directions in which to extend the analysis presented in this paper. One is to calibrate the model and confirm that it works well quantitatively, and to confirm that the identified range of parameters is consistent with the data. Another direction would be to analyze the optimal government policy in more general settings. In our model developed countries were inactive. However, a realistic environment would be a scenario in which developed countries lay out tuition fees and immigration policies for international students from developing countries and the developing countries provide financial support to their students for education abroad.

1.6 Appendix A

Key Terms and Definitions

This sections defines the terms used throughout the paper.

Developing country. Developing country is defined as a middle- or low-income country. **Country income group classification.** The country group classification (high-, middle- and low-income countries) is based on the World Bank classification of countries by Gross National Income per capita.

We classify financial aid programs promoting higher education abroad into two categories: scholarship programs and loan programs.

Scholarship program. We use the term scholarship to designate *non-repayable* education aid provided by a government to students to (fully or partially) cover either tuition fees or living/travel expenses during studies abroad, or both.

Loan program. We use the term loan to designate *repayable* education aid provided by a government to students to cover (fully or partially) either tuition fees or living/travel expenses, or both. The loan programs require students to (fully or partially) repay the amount of the aid (potentially with accrued interest) after completion of their studies abroad.

Return obligation. We define a program to have the return obligation if it is directly stated that a student is required or expected to return to the home country after their studies.

If a scholarship or loan program states that students are not required to return or provides no information regarding the return obligation, we interpret this as the government not requiring recipients to return after studies.

Note that the definitions of the program types do not allow us to distinguish scholarships that have to be repaid if a recipient does not return to the home country (**grants with operating return**). In our setting, we interpret these policies as being scholarships. Nevertheless, such interpretation does not qualitatively alter our stylized facts.

Selection based on merit criteria. We identify whether a program selects recipients based on certain merit. We define a program to be selective based on merit if at least one of the conditions below hold:

a) The program directly states that aid is given based on merit criteria.

b) The program requires recipients to demonstrate a minimum level of academic competency (such as minimum GPA) and/or the knowledge of a host country language (language test scores).

c) The program requires recipients to send documents related to academic achievements and/or work experience (academic records, standardized test scores, CV, etc.)

d) The program requires recipients to be accepted to a top school abroad.

If a program does not provide any information regarding selection based on merit, it is interpreted as missing or not having selection based on merit criteria.

Study level. We focus on two main study levels: undergraduate and graduate/postgraduate. Undergraduate level is equivalent to Bachelor's degree and graduate/postgraduate level include Master's and Ph.D. degrees. According to the data, some policies are exclusively targeted towards a specific study level (New Colombo Plan promoting undergraduate studies in Australia; postgraduate scholarship program Beca 18 in Peru), while others promote both levels (Bafog student loan in Germany; King's Scholarship in Thailand).

If a program mentions only one level of study, e.g. postgraduate level, we interpret this as the program exclusively targeting the postgraduate level.

If a program either mentions both levels of study or does not provide any information regarding the study level, we interpret this as the program not differentiating between levels.

Two reasons can explain why information about a characteristic, e.g. academic merit, is not specified on the website. First, the program does not select based on academic criteria and does not mention it on the website (this is our interpretation). Second, the program has the requirement but the information is simply missing. If the missing values are systematically present for scholarship or loan programs, the qualitative strengths of the stylized facts might be undermined. In any case, it seems reasonable to assume that a program not requiring recipients to return after studies does not mention the return obligation at all.

1.7 Appendix B

Methodology for Searching Programs

Scholarship Programs

1) Identify the official language(s) of the country.
2) Search for the English version web-site of the ministry of education and search ”scholarship” or ”grant” in the search tool.
3) Search via Google, first in English and then in the official language(s), combinations of the following words:
“country name government scholarship study overseas .countrycode”
“country name government scholarship study abroad .countrycode”
“country name government scholarship foreign education .countrycode”
“country name government financial aid study overseas .countrycode”
“country name government financial aid study abroad .countrycode”
“country name government financial aid foreign education .countrycode”
“country name government grant study overseas .countrycode”
“country name government grant study abroad .countrycode”
“country name government grant foreign education .countrycode”
4) Check on several sources, case studies, and projects, such as The International Comparative Higher Education Finance and Accessibility Project (2009), Mapping European Union Member States Higher Education External Cooperation Programmes and Policies (2010), UNESCO (2010), UNESCO (2012), the World Bank (2010).
5) If not found in either of these sources -> identify as not found.

Loan Programs

1) Identify the official language(s) of a country.
2) Search for the English version web-site of the ministry of education and search “loan” in the search tool.
3) Search via Google, first in English and then in the official language(s), combinations of the following words:
“country name government loan study overseas .countrycode”
“country name government loan study abroad .countrycode”
“country name government loan foreign education .countrycode”
“country name student loan study abroad .countrycode”
“country name student loan study overseas .countrycode”
“country name student loan foreign education .countrycode”
“country name student credit study abroad .countrycode”
“country name bank student loan study abroad .countrycode”
4) Check on several sources, case studies, and projects, such as The International Comparative Higher Education Finance and Accessibility Project (2009), Mapping European Union Member States Higher Education External Cooperation Programmes and Policies (2010), UNESCO (2010), UNESCO (2012), the World Bank (2010).
5) If not found in either of these sources -> identify as not found.

1.8 Appendix C

Description of the Programs

This section contains the methodology and the description of various characteristics of government-funded scholarship and loan programs promoting education abroad. The data is collected by the author using a web search engine during the period January-May, 2015. The last update was performed in August, 2015. The full data-set is available upon request.

Variables for Scholarship Programs:

I. Country.
II. Income group of a country (World Bank source).
III. Scholarship name.
IV. Web-source of the scholarship.
V. Starting date.
VI. Last year of being active.
VII. Budget of the scholarship.
VIII. Existence of private/other funding share in the budget of the scholarship (yes/no).
IX. Number of students financed.
X. Merit-based.
XI. Means-tested.
XII. Existence of a ceiling on the scholarship amount (yes/no).
XIII. Coverage of the scholarship (Tuition fees and living cost – 1, only tuition fee – 2, only living cost – 3).
XIV. The degree intensity (degree attainment – 1, short term/exchange – 2, both – 3).
XV. Study level (undergraduate only – 1, graduate/postgraduate only – 2, both – 3).
XVI. Fields – (priority fields - 1, any field with exceptions - 2, any field – 3).
XVII. Destination (exclusively one(or several) school(s) - 1, restricted to top schools in the field - 2, restricted to specific region - 3, restricted other- 4, No restriction - 5).
XVIII. Information about the amount of the scholarship.
XIX. Information about fields financed.
XX. Information about location and occupation.
XXI. Return obligation after completion of studies (yes/no).
XXII. The (minimum) number of years that is required for a recipient to work in the home country after completion of studies.
XXIII. Working requirement in a specific sector after completion of studies (yes/no).
XIV. The amount of the penalty that a recipient should pay in case of non-return (% of the scholarship amount paid to the recipient).
XXV. Return Benefits (yes/no).
XXVI. Comments on return requirement.

Variables for Loan Programs:

I. Country.
II. Income group of a country (World Bank source).
III. Loan name.
IV. Web-source of the loan.
V. Starting date.
VI. Last year of being active.
VII Type of the loan (pure loan – 1, hybrid loan – 2).
VIII Information about the type of loan.
IX. The Budget.
X. Number of students financed.
XI. Merit-based.
XII. Means-tested.
XIII. The degree intensity (degree attainment – 1, short term/exchange – 2, both – 3).
XIV. Study level (undergraduate only – 1, graduate/postgraduate only – 2, both – 3).
XV. Fields – (priority fields - 1, any field with exceptions - 2, any field – 3).
XVI. Destination (exclusively one (or several) school(s) - 1, restricted to top schools in the field - 2, restricted to specific region - 3, restricted other- 4, No restriction - 5).
XVII. Information about the amount of the scholarship.
XVIII. Information about fields financed.
XIX. Information about location and occupation.
XX. Return obligation after completion of studies (yes/no).
XXI. The (minimum) number of years that is required for a recipient to work in the home country after completion of studies.
XXII. The requirement to work in a specific sector/occupation after completion of studies (yes/no).
XXIII. The amount of the penalty that a recipient should pay in case of non-return (% of the scholarship amount paid to the recipient).
XXIV. Return Benefits (yes/no).
XXV. Comments on return requirement.
XXVI. Security type (only collateral – 1, only third party guarantee (organization, person) - , both – 3, no security – 4).
XXVII. Interest rate during studies.
XXVIII. Interest rate after completion of studies.
XXIX. Government subsidization of the interest rate (full/partial).
XXX. The maximum number of years for repayment of the loan.
XXXI. Number of months of a grace period.
XXXII. Other comments.

1.9 Appendix D

Summary Tables and Figures

Table 1.3: Countries Operating Only Scholarship Programs

Country	Income group
Andorra	High
Austria*	High
Bahrain	High
Belgium	High
Chile	High
Cyprus*	High
Czech Republic	High
Estonia*	High
Greece*	High
Ireland*	High
Latvia	High
Oman	High
Poland*	High
Portugal*	High
Saudi Arabia	High
Singapore	High
Slovenia*	High
Spain	High
Switzerland*	High
United Arab Emirates	High
Albania	Upper-Middle
Angola	Upper-Middle
Argentina	Upper-Middle
Azerbaijan	Upper-Middle
Brazil*	Upper-Middle
China*	Upper-Middle
Dominican Republic	Upper-Middle
Gabon	Upper-Middle
Iraq	Upper-Middle
Jordan	Upper-Middle
Kazakhstan*	Upper-Middle
Libya	Upper-Middle
Thailand*	Upper-Middle
Turkey	Upper-Middle
Egypt	Lower-Middle
El Salvador	Lower-Middle
Federated States of Moldova	Lower-Middle
Ghana	Lower-Middle
Indonesia*	Lower-Middle
Lesotho	Lower-Middle
Mauritania	Lower-Middle
Pakistan	Lower-Middle
South Sudan	Lower-Middle
Vietnam*	Lower-Middle
Liberia*	Low
Rwanda	Low

*These countries have more than one scholarship program.

Table 1.4: Countries Operating Only Loan Programs

Country	Income group
Brunei	High
Iceland	High
Liechtenstein	High
New Zealand	High
Botswana	Upper-Middle
Colombia*	Upper-Middle
Malaysia	Upper-Middle
Maldives	Upper-Middle
Mauritius*	Upper-Middle
Tunisia	Upper-Middle
Cabo Verde	Lower-Middle
Guatemala	Lower-Middle
Tanzania	Low
Uganda	Low
Zimbabwe	Low

*These countries have more than one loan program.

Table 1.5: Countries Operating Both Scholarship and Loan Programs

Country	Income group
Antigua and Barbuda	High
Australia*	High
Barbados	High
Canada	High
Denmark*	High
Finland*	High
France*	High
Germany*	High
Italy*	High
Japan	High
Korea, South	High
Kuwait	High
Lithuania	High
Luxembourg*	High
Malta*	High
Netherlands*	High

Country	Income group
Norway*	High
Russia*	High
Slovakia	High
Sweden*	High
Trinidad and Tobago	High
United Kingdom*	High
United States*	High
Ecuador*	Upper-Middle
Marshall Islands	Upper-Middle
Mexico	Upper-Middle
Namibia	Upper-Middle
Panama	Upper-Middle
Peru	Upper-Middle
Seychelles	Upper-Middle
Georgia	Lower-Middle
India*	Lower-Middle
Mongolia	Lower-Middle
Mozambique	Low

*These countries have more than one loan and one scholarship program.

Table 1.6: The Expenditure of Scholarship Programs

Country	Income group	The Avg % of the Expenditure on Scholarship programs in the Total Budget of Tertiary Education*
Albania	Upper-Middle	0.29
Azerbaijan	Upper-Middle	1.55
Brazil	Upper-Middle	2.19
Kazakhstan	Upper-Middle	0.04
Egypt	Lowe-Middle	0.12
El Salvador	Lower-Middle	1.92
Georgia	Lower-Middle	0.00
India	Lower-Middle	0.00
Yemen	Lower-Middle	3.51

Table 1.7: The Expenditure of Loan Programs

Country	Income Group	The Avg % of the Expenditure on Loan Programs in the Total Budget of Tertiary Education*
Botswana	Upper-Middle	9.84
Colombia	Upper-Middle	0.04
Georgia	Lower-Middle	0.44

*The indicator for the budget shows the total amount of the scholarship/loan paid to the students.

Table 1.8: The Number of Students sent abroad by Scholarship Programs in Middle- and Low-Income Countries

Country	Income Group	The Avg Num of Students per Million Population Sent By Scholarship Programs per Year
Albania	Upper-Middle	33.71
Angola	Upper-Middle	8.42
Azerbaijan	Upper-Middle	86.85
Ecuador	Upper-Middle	85.45
Gabon	Upper-Middle	1637.09
Kazakhstan	Upper-Middle	71.65
Libya	Upper-Middle	1128.76
Mexico	Upper-Middle	30.06
Peru	Upper-Middle	16.46
Turkey	Upper-Middle	15.86
Egypt	Lower-Middle	2.96
El Salvador	Lower-Middle	11.63
Georgia	Lower-Middle	25.63
India	Lower-Middle	0.03
Indonesia	Lower-Middle	6.99
Mongolia	Lower-Middle	82.78
Pakistan	Lower-Middle	2.75
South Sudan	Lower-Middle	252.24
Vietnam	Lower-Middle	15.61
Liberia	Low	10.74
Rwanda	Low	11.22

Table 1.9: The Number of Students sent abroad by Loan Programs in Middle- and Low-Income Countries

Country	Income Group	The Avg Num of Students per Million Population Sent By Loan Programs per Year
Botswana	Upper-Middle	3776.52
Colombia	Upper-Middle	21.53
Maldives	Upper-Middle	34.78
Namibia	Upper-Middle	2001.58
Tunisia	Lower-Middle	10.45
Georgia	Lower-Middle	2.49
India	Lower-Middle	0.22
Zimbabwe	Low	0.61

Table 1.10: Summary Table on the Comparison of Financial Aid Policies in Middle- and Low-Income Countries

Middle/Low-Income	Total #	%	Return Obligation		Academic Merit		Study Level		
			Yes	No/Not Specified	Yes	No/Not Specified	Under-graduate	Graduate/ Postgraduate	Both/Not Specified
Total Policies	76	100%	39.47%	60.53%	59.21%	40.79%	1.32%	44.73%	53.95%
Scholarships	51	67.11%	54.90%	45.10%	64.71%	35.29%	1.96%	56.86%	41.18%
Loans	25	32.89%	8.00%	92.00%	48.00%	52.00%	0.00%	20.00%	80.00%

1.10 Appendix E

Proofs

The market and social Outcomes. Based on equations (1.2), (1.3), and (1.4), under no financial constraints a student would choose group $D \in \{H, R, F\}$, if $max(U^H, U^R, U^F) = U^D$. This gives conditions described in equations (1.5), (1.6), and (1.7). Similarly, based on equations (1.8), (1.9), and (1.10), and the maximization problem (1.11), the socially optimal outcome is population group D if this group generates the maximum social welfare, or $max(W^H, W^R, W^F) = W^D$. This gives the conditions described in equations (1.12), (1.13), and (1.14).

The support of the distribution of θ. Since the distribution of θ is uniform and $\mathbb{E}(\theta)$ and ϕ are given, the functional forms of the upper and lower bounds of the support are derived from the following two equations:

$$\begin{aligned} \mathbb{E}(\theta) &= \frac{\underline{\theta} + \overline{\theta}}{2} \\ \phi &= \frac{\overline{\theta}}{\underline{\theta}} - 1. \end{aligned} \tag{1.E.1}$$

The default probability. Students who failed during studies abroad default on loans if

$$I + \theta - c < 0 \implies \theta < c - I. \tag{1.E.2}$$

Students who successfully graduated from studies abroad and returned to the home country default on loans if

$$I + \beta\overline{\mu}\theta - c < 0 \implies \theta < \tilde{\theta}_s^R = \frac{c - I}{\beta\mu}. \tag{1.E.3}$$

Students who successfully graduated from studies abroad and remained in the foreign country default on loans if

$$I+(1-m)\overline{\mu}\theta-c<0 \implies \theta<\tilde{\theta}_s^F=\frac{c-I}{(1-m)\mu}. \tag{1.E.4}$$

Using the fact that θ is uniformly distributed between $\frac{2\mathbb{E}(\theta)}{\phi+2}$ and $\frac{2\mathbb{E}(\theta)(\phi+1)}{\phi+2}$ one will arrive to equation:

$$v^j=max\Big((1-\pi)max\Big(\frac{\tilde{\theta}^j(\phi+2)-2\mathbb{E}(\theta)}{2\mathbb{E}(\theta)\phi},0\Big)+\pi\frac{(c-I)(\phi+2)-2\mathbb{E}(\theta)}{2\mathbb{E}(\theta)\phi},0\Big). \tag{1.E.5}$$

From the equation above, it immediately follows that $\frac{\partial v^j}{\partial \phi}\geq 0$ and ($\frac{dv^j}{d\phi}\geq 0$). It is also straightforward to show that when $\phi\leq\frac{2\mathbb{E}(\theta)}{c-I}-2 \implies v^j=0$.

Case II.

Below we consider the model with a sufficiently low degree of uncertainty $\phi\leq\frac{2\mathbb{E}(\theta)}{c-I}-2$ such that $v^j=0$. It suffices to prove that scholarships with the return requirement are the optimal policy for $\phi\leq\frac{2\mathbb{E}(\tilde{\theta})}{c-I}-2$.

We first discuss the government tools conditional on each type of financial aid, and from there we derive the optimal government policy type.

First, since $U^H>max(U^F,U^R)$ and $W^R>W^H>W^F$, it immediately follows that the government will always (weakly) prefer to set the return requirement ($r_{ii}^s=r_{ii}^l=1=r_{ii}^*$).

The second step is to find the optimal amount of the government policy. Students will apply for loans if:

$$\mathbb{1}^A(P_l,1,a|x=\overline{x})=1 \iff U^R-U^H>0 \;\&\; a\geq c-I \tag{1.E.6}$$

and

$$\mathbb{1}^A(P_l,1,a|x=0)=1 \iff U^R-U^H+a>0 \;\&\; a\geq c-I. \tag{1.E.7}$$

Similarly, students will apply for scholarships if

$$\mathbb{1}^A(P_s,1,a|x)=1 \iff U^R-U^H+a>0 \;\&\; a\geq c-I \;\forall\; x. \tag{1.E.8}$$

Since $U^R-U^H<0$, students with $x=\overline{x}$ will never apply for loans. As for the optimal amount of aid, the government will set it at the minimum level so as to make students indifferent towards the option of applying and not applying for the aid. Specifically,

$$a_{ii}^s=a_{ii}^l=max\big(c-I,U^R-U^H\big)=a_{ii}^*. \tag{1.E.9}$$

Given r_{ii}^* and a_{ii}^* above, we analyze how much welfare the scholarships and the loans create. First, suppose the government provides the scholarship with the return requirement. The maximization problem is

$$\underset{\alpha_{s1},G}{\text{Max}}\, SW(\alpha_{s1},G|P=P_s,r=1,a=a_{ii}^*)=\alpha_{s1}[(1-\pi)(\beta\chi\mu-1)\mathbb{E}(\theta)-c+a_{ii}^*]+G \;\; s.t.$$
$$\alpha_{s1}a_{ii}^*+G=B; \quad 1\geq\alpha_{s1}\geq 0; \quad G\geq 0 \tag{1.E.10}$$

Since the government budget should bind at the optimum, it follows that $\alpha^*_{s1} = min(\frac{B}{a^*_{ii}}, 1)$ and $G^* = B - \alpha^*_{s1} a^*_{ii}$. Solving the maximization problem gives

$$SW^*_{s1,ii} = \begin{cases} \frac{B}{a^*_{ii}}[(1-\pi)(\beta\chi\mu - 1)\mathbb{E}(\theta) - c] + B & \text{if} \quad B \in (0, a^*_{ii}) \\ (1-\pi)(\beta\chi\mu - 1)\mathbb{E}(\theta) - c + B & \text{if} \quad B \in [a^*_{ii}, \infty). \end{cases} \tag{1.E.11}$$

If the government provides the loan with the return requirement, the maximization problem is

$$\underset{\alpha_{l1}, G}{Max} SW(\alpha_{l1}, G | P = P_l, r = 1, a = a^*_{ii}) = \gamma_x \alpha_{l1}[(1-\pi)(\beta\chi\mu - 1)\mathbb{E}(\theta) - c + a^*_{ii}] + G \;\; s.t.$$
$$\gamma_x \alpha_{l1} a^*_{ii} + G = B; \quad 1 \geq \alpha_{l1} \geq 0; \quad G \geq 0. \tag{1.E.12}$$

Similarly, $\alpha^*_{l1} = min(\frac{B}{\gamma_x a^*_{ii}}, 1)$. The solution to the maximization problem is

$$SW^*_{l1,ii} = \begin{cases} \frac{B}{a^*_{ii}}[(1-\pi)(\beta\chi\mu - 1)\mathbb{E}(\theta) - c] + B & \text{if} \quad B \in (0, \gamma_x a^*_{ii}, 0)) \\ \gamma_x[(1-\pi)(\beta\chi\mu - 1)\mathbb{E}(\theta) - c] + B & \text{if} \quad B \in [\gamma_x a^*_{ii}, \infty). \end{cases} \tag{1.E.13}$$

Therefore, it immediately follows that the scholarship with the return requirement will be a weakly dominant policy $SW^*_{s1,ii} \geq SW^*_{l1,ii} \;\forall\; B$.

Case III.

The first observation in case $IIIa-b$ is that the government (weakly) prefers not to oblige recipients to return to the home country for each type of financial aid ($r^s_{iii} = r^l_{iii} = 0 = r^*_{iii}$). This is because the privately optimal (in the absence of financial constraints) and the socially optimal outcomes coincide. The outcomes are either R or F depending on the parameter values of $\mathbb{E}(\theta)$ and m. Therefore, for the government it is optimal not to distort the return migration decision of students and set $r^*_{iii} = 0$.

Without losing the generality, below we analyze the optimal government policy only for case $IIIa$. First, suppose that $\phi \leq \frac{2\mathbb{E}(\theta)}{c-I} - 2$. It immediately implies that $\nu^R = 0$. Suppose the government provides scholarships without the return requirement. The individual decision to apply for the scholarship without the requirement is:

$$\mathbb{1}^A(P_s, 0, a | x) = 1 \iff U^R - U^H + a \geq 0 \;\&\; a \geq c - I \;\forall\; x. \tag{1.E.14}$$

For case $IIIa$ it holds that $U^R > 0$. Therefore, the government will set the amount equal to $\underline{a}_{iii} = c - I$.

Hence, the government's maximization problem is

$$\underset{\alpha_{s0}, G}{Max} SW(G | P_s, r^*_{iii} = 0) = \alpha_{s0}[(1-\pi)(\beta\chi\mu - 1)\mathbb{E}(\theta) - I] + G \;\; s.t.$$
$$\alpha_{s0}(c - I) + G = B; \quad 1 \geq \alpha_{s0} \geq 0; \quad G \geq 0. \tag{1.E.15}$$

Because the government budget constraint binds, it holds that $\alpha^*_{s0,iii} = min(\frac{B}{c-I}, 1)$. Solving the maximization problem gives

$$SW^*_{s0,iii} = \begin{cases} \frac{B}{c-I}[(1-\pi)(\beta\chi\mu-1)\mathbb{E}(\theta)-c]+B & \text{if} \quad B \in (0, c-I) \\ (1-\pi)(\beta\chi\mu-1)\mathbb{E}(\theta)-c+B & \text{if} \quad B \in [c-I, \infty). \end{cases} \tag{1.E.16}$$

Now suppose the government distributes loans without the return requirement. The acceptance of the loan is the following:

$$\begin{aligned} &\mathbb{1}^A(P_l, 0, a|x=0) = 1 \iff U^R - U^H + a \geq 0 \;\&\; a \geq c-I \\ &\mathbb{1}^A(P_l, 0, a|x=\overline{x}) = 1 \iff U^R - U^H \geq 0 \;\&\; a \geq c-I. \end{aligned} \tag{1.E.17}$$

Similar to the scholarship case, it follows that the optimal amount of the loan is equal to $c-I$ and everyone will apply for the loan. The government maximizes

$$\begin{aligned} &\underset{\alpha_{l0}, G}{\text{Max}} SW(G|P_l, r^*_{iii}=0) = \alpha_{l0}[(1-\pi)(\beta\chi\mu-1)\mathbb{E}(\theta)-I]+G \;\; s.t. \\ &\qquad \gamma_x\alpha_{l0}(c-I)+G = B; \quad 1 \geq \alpha_{l0} \geq 0; \quad G \geq 0 \end{aligned} \tag{1.E.18}$$

Again, $\alpha^*_{l0,iii} = min(\frac{B}{\gamma_x(c-I)}, 1)$ and the solution is

$$SW^*_{l0,iii} = \begin{cases} \frac{B}{\gamma_x(c-I)}[(1-\pi)(\beta\chi\mu-1)\mathbb{E}(\theta)-c]+B & \text{if} \quad B \in (0, \gamma_x(c-I)) \\ (1-\pi)(\beta\chi\mu-1)\mathbb{E}(\theta)-c+B & \text{if} \quad B \in [(\gamma_x(c-I), \infty). \end{cases} \tag{1.E.19}$$

Therefore, it immediately follows that the loan without the return requirement dominates the scholarship without the return requirement.

Since ν^R is a continuous function in ϕ, it follows that for moderate uncertainty levels there is $\tilde{B}^a_{iii}(\phi)$ such that for $B > \tilde{B}^a_{iii}(\phi)$, the government chooses scholarships without the return requirement and for $B < \tilde{B}^a_{iii}(\phi)$ the government chooses loans without the return requirement. After some algebra one will arrive at the following:

$$\tilde{B}^a_{iii}(\phi) = (c-I)(1 - \frac{(1-\gamma_x)\nu^R\overline{x}}{(1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta)-c}) \tag{1.E.20}$$

if $\tilde{B}^a_{iii}(\phi) > (\gamma_x + (1-\gamma_x)\nu^R)(c-I)$ and $\tilde{B}^a_{iii}(\phi) = 0$ otherwise, where ν^R is defined by equations (1.15) and (1.16). It is straightforward to see that that indeed $\frac{\partial \tilde{B}^a_{iii}(\phi)}{\partial \phi} \leq 0$.

Similar logic applies to case $IIIb$, where all of the results similarly hold.

Case IV.

There are four possible rankings of the threshold levels of the budget:

1. $\tilde{B}^I_{iv}(\phi) = \tilde{B}^{II}_{iv}(\phi) = 0$. The optimal government policy is a scholarship with the return requirement for all values of B.

2. $\tilde{B}^I_{iv}(\phi) > \tilde{B}^{II}_{iv}(\phi) = 0$. The optimal government policy is a loan with the return requirement if $B < \tilde{B}^I_{iv}(\phi)$ and a scholarship with the return requirement if $B \geq \tilde{B}^I_{iv}(\phi)$).

3. $\tilde{B}^I_{iv}(\phi) = \tilde{B}^{II}_{iv}(\phi) > 0$. The optimal government policy is a loan without the return requirement if $B < \tilde{B}^{II}_{iv}(\phi)$ and a scholarship with the return requirement if $B \geq \tilde{B}^{II}_{iv}(\phi)$.

4. $\tilde{B}^I_{iv}(\phi) > \tilde{B}^{II}_{iv}(\phi) > 0$. The optimal government policy is a loan without the return requirement if $B < \tilde{B}^{II}_{iv}(\phi)$, a loan with the return requirement if $\tilde{B}^I_{iv}(\phi) > B \geq \tilde{B}^{II}_{iv}(\phi)$, and a scholarship with the return requirement if $B \geq \tilde{B}^I_{iv}(\phi)$.

For this case, it is not clear whether the government requires recipients to return or not. This is because if the government provides loans, it holds that $\nu^F \leq \nu^R$. This follows from the fact that $m < \hat{m}$ and equations (1.15) and (1.16).

Nevertheless, one can easily argue that scholarships without the return requirement will always be an inferior policy compared to scholarships with the return requirement. Therefore, below we compare the generated social welfare of three different policies.

Assume that the uncertainty is sufficiently low. If the government provides loans without the return requirement, the maximized social welfare is:

$$SW^*_{l0,iv} = \begin{cases} \frac{B[(1-\pi)((1-m)\overline{\mu}-1)\mathbb{E}(\theta)-c-(1-\gamma_x)\nu^F\overline{x}]}{(\gamma_x+(1-\gamma_x)\nu^F)(c-I)} + B & \text{if} \quad B < (\gamma_x + (1-\gamma_x)\nu^F)(c-I) \\ (1-\pi)((1-m)\overline{\mu}-1)\mathbb{E}(\theta) - c & \\ -(1-\gamma_x)\nu^F\overline{x} + B & \text{if} \quad B \geq (\gamma_x + (1-\gamma_x)\nu^F)(c-I) \end{cases} \tag{1.E.21}$$

If the government provides loans with the return requirement, the maximized social welfare is:

$$SW^*_{l1,\nu} = \begin{cases} \frac{(1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta)-c-(1-\gamma_x)\nu^R\overline{x}}{(\gamma_x+(1-\gamma_x)\nu^R)(c-I)}B + B & \text{if} \quad B < (\gamma_x + (1-\gamma_x)\nu^R)(c-I) \\ (1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta) - c & \\ -(1-\gamma_x)\nu^R\overline{x} + B & \text{if} \quad B \geq (\gamma_x + (1-\gamma_x)\nu^R)(c-I) \end{cases} \tag{1.E.22}$$

If the government provides scholarships with the return requirement, the maximized social welfare is:

$$SW^*_{s1,iv} = \begin{cases} \frac{[(1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta)-c}{c-I}B + B & \text{if} \quad B < c-I \\ [(1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta) - c + B & \text{if} \quad B \geq c-I. \end{cases} \tag{1.E.23}$$

Therefore, the functional forms of $\tilde{B}_v^{II}(\phi)$ and $\tilde{B}_v^{I}(\phi)$ are:

$$\tilde{B}_{iv}^{I}(\phi) = (c-I)\Big[1 - \frac{(1-\gamma_x)\nu^R\overline{x}}{(1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta)-c}\Big] \tag{1.E.24}$$

if $\tilde{B}_{iv}^{I}(\phi) > (\gamma_x + (1-\gamma_x)\nu^R)(c-I)$ and $\tilde{B}_v^{I}(\phi) = 0$ otherwise.

$$\tilde{B}_{iv}^{II}(\phi) = \frac{(\gamma_x + (1-\gamma_x)\nu^R)}{(1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta)-c-(1-\gamma_x)\nu^R} \times \Big[(c-I)[(1-\pi)((1-m)\overline{\mu}-1)\mathbb{E}(\theta)-c) - \frac{(1-\gamma_x)\nu^F\overline{x}}{(1-\pi)(\chi\beta\overline{\mu}-1)\mathbb{E}(\theta)-c-(1-\gamma_x)\nu^F\overline{x}}\Big] \tag{1.E.25}$$

if $\tilde{B}_{iv}^{II}(\phi) > (\gamma_x + (1-\gamma_x)\nu^F)(c-I)$ and $\tilde{B}_{iv}^{II}(\phi) = \tilde{B}_v^{I}(\phi)$ otherwise.

Some algebra shows that indeed $\tilde{B}_{iv}^{I}(\phi) \geq \tilde{B}_v^{II}(\phi)$. Finally, it can be shown that indeed $\frac{\partial \tilde{B}_{iv}(\phi)}{\partial \phi} \geq 0$.

Two Ability Groups

The equations that induce ex-ante higher-ability students to choose the graduate school and ex-ante lower-ability ones choose the undergraduate school are the following:

$$\begin{aligned}
&I + ((1-\pi^l)\beta\overline{\mu}^g + \pi^l)\mathbb{E}(\theta^l) - c < I + \beta\overline{\mu}^u\mathbb{E}(\theta^l) - c \\
&I + ((1-\pi^l)(1-m)\overline{\mu}^g + \pi^l)\mathbb{E}(\theta^l) - c < I + (1-m)\overline{\mu}^u\mathbb{E}(\theta^l) - c \\
&I + ((1-\pi^h)\beta\overline{\mu}^g + \pi^h)\mathbb{E}(\theta^h) - c > I + \beta\overline{\mu}^u\mathbb{E}(\theta^h) - c \\
&I + ((1-\pi^h)(1-m)\overline{\mu}^g + \pi^h)\mathbb{E}(\theta^h) - c > I + (1-m)\overline{\mu}^u\mathbb{E}(\theta^h) - c.
\end{aligned} \tag{1.E.26}$$

Given that the conditions in (1.20) and (1.21) hold, it immediately follows that the conditions given in (1.E.26) are satisfied.

Proposition 1.4.5.

First, it is clear that if the budget is limited such that it can accommodate with financial aid at most one ability group, the government will choose the ability group that brings the highest social welfare. For the government with such a limited budget six options are available: 1) a scholarship with the return requirement to high-ability students 2) a scholarship with the return requirement to low-ability students 3) a loan with the return requirement to high-ability students 4) a loan with the return requirement to low-ability students 5) a loan without the return requirement to high-ability students 6) a loan without the return requirement to low-ability students. Providing scholarships without the return requirement (to any ability group) is always inferior to the scholarships with the return requirement.

The generated welfare for each corresponding type of policy for a government with a tight budget are the following:

$$1.\ SW_{s1}^{h,*} = \frac{(1-\pi)(\chi\beta\overline{\mu}^{g}-1)\mathbb{E}(\theta^{h})-c}{c-I}B+B \quad \text{if} \quad B^{I} < \gamma^{h}(c-I) \tag{1.E.27}$$

$$2.\ SW_{s1}^{l,*} = \frac{(\chi\beta\overline{\mu}^{u}-1)\mathbb{E}(\theta^{l})-c}{c-I}B+B \quad \text{if} \quad B^{I} < \gamma^{l}(c-I) \tag{1.E.28}$$

$$3.\ SW_{l1}^{h,*} = \frac{(1-\pi)(\chi\beta\overline{\mu}^{g}-1)\mathbb{E}(\theta^{h})-c-(1-\gamma_{x})\nu^{h,R}\overline{x}}{(\gamma_{x}+(1-\gamma_{x})\nu^{h,R})max\Big(c-I,\overline{x}-\frac{(1-\pi)(\beta\overline{\mu}^{g}-1)\mathbb{E}(\theta^{h})-c}{\nu^{h,R}}\Big)}B+B$$

$$\text{if} \quad B^{I} < \gamma^{h}(\gamma_{x}+(1-\gamma_{x})\nu^{h,R})max\Big(c-I,\overline{x}-\frac{(1-\pi)(\beta\overline{\mu}^{g}-1)\mathbb{E}(\theta^{h})-c}{\nu^{h,R}}\Big) \tag{1.E.29}$$

$$4.\ SW_{l1}^{l,*} = \frac{(\chi\beta\overline{\mu}^{u}-1)\mathbb{E}(\theta^{l})-c-(1-\gamma_{x})\nu^{l,R}\overline{x}}{(\gamma_{x}+(1-\gamma_{x})\nu^{l,R})max\Big(c-I,\overline{x}-\frac{(\beta\overline{\mu}^{u}-1)\mathbb{E}(\theta^{l})-c}{\nu^{l,R}}\Big)}B+B$$

$$\text{if} \quad B^{I} < \gamma^{l}(\gamma_{x}+(1-\gamma_{x})\nu^{l,R})max\Big(c-I,\overline{x}-\frac{(\beta\overline{\mu}^{u}-1)\mathbb{E}(\theta^{l})-c}{\nu^{l,R}}\Big) \tag{1.E.30}$$

$$5.\ SW_{l0}^{h,*} = \frac{(1-\pi)((1-m)\overline{\mu}^{g}-1)\mathbb{E}(\theta^{h})-c-(1-\gamma_{x})\nu^{h,F}\overline{x}}{(\gamma_{x}+(1-\gamma_{x})\nu^{h,F})(c-I)}B+B$$

$$\text{if} \quad B^{I} < \gamma^{h}(\gamma_{x}+(1-\gamma_{x})\nu^{h,F})(c-I) \tag{1.E.31}$$

$$6.\ SW_{l0}^{l,*} = \frac{((1-m)\overline{\mu}^{u}-1)\mathbb{E}(\theta^{l})-c-(1-\gamma_{x})\nu^{l,F}\overline{x}}{(\gamma_{x}+(1-\gamma_{x})\nu^{l,F})(c-I)}B+B$$

$$\text{if} \quad B^{I} < \gamma^{l}(\gamma_{x}+(1-\gamma_{x})\nu^{l,F})(c-I) \tag{1.E.32}$$

The budget level B^{I} stands for the initial spending of the government and $\nu^{i,j}$ denotes the probability of default for ability type $i \in \{\{h\}\{l\}\}$ and for population group $j \in \{\{R\}\{F\}\}$. The functional forms of default probabilities are as follows:

$$\nu^{h,R} = (1-\pi)max\Big(\frac{(\frac{c-I}{\beta\overline{\mu}^{g}}(\phi+2)-2\mathbb{E}(\theta^{h})}{2\mathbb{E}(\theta^{h})\phi},0\Big)+\pi\frac{(c-I)(\phi+2)-2\mathbb{E}(\theta^{h})}{2\mathbb{E}(\theta^{h})\phi} \tag{1.E.33}$$

$$\nu^{h,F} = (1-\pi)max\Big(\frac{(\frac{c-I}{(1-m)\overline{\mu}^{g}}(\phi+2)-2\mathbb{E}(\theta^{h})}{2\mathbb{E}(\theta^{h})\phi},0\Big)+\pi\frac{(c-I)(\phi+2)-2\mathbb{E}(\theta^{h})}{2\mathbb{E}(\theta^{h})\phi} \tag{1.E.34}$$

$$v^{l,R} = max\Big(\frac{(\frac{c-I}{\beta\overline{\mu}^u}(\phi+2)-2\mathbb{E}(\theta^l)}{2\mathbb{E}(\theta^l)\phi}, 0\Big) \tag{1.E.35}$$

$$v^{l,F} = max\Big(\frac{(\frac{c-I}{(1-m)\overline{\mu}^u}(\phi+2)-2\mathbb{E}(\theta^l)}{2\mathbb{E}(\theta^l)\phi}, 0\Big) \tag{1.E.36}$$

Further, the following five conditions should be satisfied:

1. $SW_{s1}^{h,*} \geq SW_{l0}^{h,*}$
2. $SW_{s1}^{h,*} \geq SW_{l1}^{h,*}$
3. $SW_{l0}^{l,*} \geq SW_{s1}^{l,*}$
4. $SW_{l0}^{l,*} \geq SW_{l1}^{l,*}$
5. $SW_{s1}^{h,*} \geq SW_{l0}^{l,*}$

First, suppose for simplicity that $m = \hat{m}^S$. Since $v^{i,R} \geq v^{i,F}$, it is clear that equation 4 automatically holds. In addition, if equation 1 is satisfied, equation 2 will be also satisfied. Next, because $SW_{s1}^{h,*} > SW_{s1}^{l,*}$, there is a well defined range for the degree of uncertainty $\phi \in [\underline{\phi}, \overline{\phi}]$ for which conditions 3 and 5 hold. All five equations are satisfied if the degree of uncertainty is sufficiently high:

$$v^{h,R} \geq \frac{(1-\pi)(\chi\beta\overline{\mu}^g-1)\mathbb{E}(\theta^h)-c}{(1-\pi)(\chi\beta\overline{\mu}^g-1)\mathbb{E}(\theta^h)-c+\overline{x}}. \tag{1.E.37}$$

We denote the value of ϕ that breaks even equation 1 by k. The value of k is unique as the probability of the loan default is monotonic in ϕ. In addition, the ranges of parameters are well defined if $k > \underline{\phi}$.

Given that for the range existence it is necessary for low-ability students to be exposed to non-zero probability of the default, the functional form of $\underline{\phi}$ is given from the equation below:

$$\underline{\phi} = \frac{2\mathbb{E}(\theta^l)-\frac{c-I}{\chi\beta\overline{\mu}^u}}{\frac{c-I}{\chi\beta\overline{\mu}^u}-2\mathbb{E}(\theta^l)\frac{(\chi\beta\overline{\mu}^u-1)\mathbb{E}(\theta^l)-c}{(\chi\beta\overline{\mu}^u-1)\mathbb{E}(\theta^l)-c+\overline{x}}}. \tag{1.E.38}$$

Thus, one will arrive at the condition described by equations (1.26) and (1.27).

Lastly, equation (1.25) is defined from the following equation:

$$\gamma^h[((1-\pi)(\chi\beta\overline{\mu}^g-1)\mathbb{E}(\theta^h)-c] > \gamma^l[(\chi\beta\overline{\mu}^u-1)\mathbb{E}(\theta^l)-c]. \tag{1.E.39}$$

Chapter 2

Hosting International Students: A Developed Country Perspective

2.1 Introduction

Developed countries set various policies to attract and retain international students from developing countries. International students can generate two types of economic benefits for a host country. First, the host country directly receives revenues through tuition fees, which are typically equal to or higher than the fees charged to nationals (OECD 2011). Second, an international graduate might remain and contribute to the host country by paying taxes. In addition, international graduates may contribute to labor productivity of the host country and help with skills shortages in specific fields (Balch et al. 2012). International students also generate indirect benefits, such as enhancing the multicultural skills of national students (Mechtenberg and Strausz 2008) and the reputation of the host country's education system (De Ville et al. 1996). Because the higher education market is internationalized and the supply of international students is limited, developed countries engage in competition for students (Haupt et al. 2016).

This paper makes two contributions to the literature. First, for EU countries,[1] we collect data related to two stages of the international student path to a host country: university entry and transition to the labor market upon graduation. For the university entry stage, we collect information on university rankings, tuition fees, and admission requirements for public universities. For the labor market transition stage, we study immigration policies. We exclusively focus on policies tailored to international students from developing countries (non-EU/OECD) and who graduate from the host country university. The data allow us to establish stylized facts. We find that higher university ranking is associated with a higher GDP per capita and higher tuition fees. However, six countries (Austria, Belgium, France, Germany, Italy, and Luxembourg)

[1] At the time of writing, the United Kingdom was part of the EU. Therefore, we include the UK in this analysis.

are exceptions to this rule: although these countries have highly ranked universities, they charge among the lowest tuition fees in Europe. At the labor market transition stage, we find no association between the flexibility of immigration policies and the average rankings of universities. This suggests that, in practice, countries might set international student tuition fees and immigration policies independently.

Second, we build a theoretical model to account for these stylized facts qualitatively. In our model, two developed host countries compete for international students who come from one developing country. Higher education quality results in higher lifetime income for international students. The students differ in their ability, wealth, and preferences towards studying in a host country. These characteristics are students' private information and are not observable by any host government. Each country receives revenues from tuition fees and tax contributions conditional on a student remaining in the host country upon his/her graduation. Each host country's government sets a tuition fee and a screening policy, which screens out low-ability students. Within this environment, we account not only for the fact that highly ranked countries charge higher tuition fees, but also explain the existence of exceptional "high-rank-low-tuition" countries. Specifically, we suggest two socio-political explanations. First, the historical context in these exceptional countries may preclude them from raising fees for international students. Second, "high-rank-low-tuition" countries may be more selective than "high-rank-high-tuition" countries due to unfavorable views towards international students. In our model with symmetric host country education qualities, we analyze two scenarios. In the first scenario, one host country exogenously sets tuition fees at zero, whereas in the second scenario, one host country exogenously screens out low-ability students. We show that, for a certain range of parameter values, the constrained host country charges a lower tuition fee than the unconstrained one does and sets the screening policy in both scenarios. We also offer some facts to support our explanations.

The rest of the paper is organized as follows. Section 2.2 reviews the related literature. Section 2.3 discusses the methodology of the data collection and establishes stylized facts. Section 2.4 builds the model to account for the stylized facts qualitatively. Section 2.5 concludes and points towards further directions of our research.

2.2 Related Literature

The existing studies do not sufficiently investigate developed host country policies tailored exclusively to international students who arrive from developing countries. Most studies either focus on national student policies (refer to Garritzman 2016 for an extensive literature review on national student tuition fees) or provide only limited insights about the international student dimension (e.g., OECD and European Commission reports, and country case studies). Similarly, for the labor market transition stage, most studies do not exclusively focus on policies designed for international graduates of the host country university (e.g., OECD 2014).

Nevertheless, OECD (2020), European Commission/EACEA/Eurydice (2020), and EMN (2012, 2019) are relevant. OECD (2020) provides data on international student fees at public universities by education level for selected OECD countries. However, the report does not distinguish the fees by the nationality of international students and does not control for the field of study. European Commission/EACEA/Eurydice (2020) reports international student fees charged for non-EU students in all EU countries. However, the study does not provide information on the field or level of study for all EU countries.

For immigration policies, EMN (2012, 2019) contains useful and extensive information on various dimensions of international student mobility and relevant policies in EU countries. However, these reports do not directly compare the flexibility of immigration policies between countries.

Our study fills these gaps in the literature in three ways. First, we provide a robust comparative analysis of international student fees, as we fix education level, study field, and the nationality of an international student. Second, we rank countries by the flexibility of immigration policies targeted towards international graduates who enter the labor market of a host country. Third, we explore the relationship between university rankings, tuition fees, and the flexibility of immigration policies.

With regard to the theoretical literature, the only study that explicitly examines host-country competition for international students is by Haupt et al. (2016). They analyze a model with two developed countries that compete for international students coming from one developing country. Each host country maximizes its net benefits, consisting of tuition fee revenues and expected tax contributions collected from international students. Provision of education is costly, and the cost is increasing with the quality of education. Each government sets the quality of education and the tuition fees. The students are heterogeneous in their abilities and, given government policies, decide in which country to pursue their education. Haupt et al. (2016) find that the tuition fee differential between countries is increasing in the education quality differential in equilibrium. This is because a rise in tuition fees induces two effects on the benefits of each host country: on the one hand, the rise increases revenues per student and, on the other hand, reduces the number of students studying in that country. For the high-quality country, the former effect dominates the latter, as students are willing to pay high tuition fees due to the expected higher returns to the high-quality education. Hence, it follows that there exists an asymmetric equilibrium, in which one host country provides a higher quality of education and charges higher tuition fees than the other country.

Other studies investigate different aspects of international student mobility to developed countries, such as education quality competition (Mechtenberg and Strausz 2008, Delpierre and Verheyden 2014, Demange et al. 2020), education financing schemes and student mobility between developed countries (Gérard 2007), and the optimal tuition fee for a single host country (Lange 2013). Similar to these models, in our framework, international students acquire foreign education to enhance their

human capital and earn higher wages. In addition, we similarly assume that international students are heterogeneous in their abilities and preferences for living in the host country, which are students' private information and not observable by the governments.

Our model differs from those in other studies in the following dimensions. First, none of these models impose any market imperfection. We analyze a model in which students are heterogeneous in their wealth and cannot borrow due to imperfect credit markets. Setting high tuition fees can exclude poor international students who cannot afford education abroad in this environment. Second, we abstract from endogenous university quality choices and study the optimal tuition fee for a given education quality. In our model, governments can set a screening policy and control the quality of accepted students. An endogenous screening policy is a realistic feature of the model, as universities set out various exams and requirements for international applicants. We further investigate two scenarios in which either the tuition fee or the screening policy is exogenously set to explain the stylized facts.

2.3 The Data

This section describes the methodology of the data collection and establishes stylized facts.

2.3.1 Methodology

2.3.1.1 University Entrance Stage

Our data collection methodology is as follows. First, we collected data on an initial population of the EU public universities.[2] Second, we selected the education program of our interest for each university. Third, we collected the information on program characteristics, tuition fees, and selection procedures via e-mail communication with study offices and from the official university web pages.

To select the initial population of the universities, we used The Times Higher Education (THE) ranking portal for the academic year 2016-2017. THE ranking system sorts 978 universities worldwide based on measures encompassing multiple variables, including teaching, research, citations, and number of teachers.[3] We use THE as our source, because it provides detailed information on the total number of international students

[2]We chose the EU area as the focus of our analysis to ensure robustness of our comparative analysis. Although each EU member state has its own higher education system, the EU countries are a part of the European Higher Education Area and Bologna Process, which aim to ensure that the education systems are compatible between the countries and facilitate student mobility. Therefore, the choice of the EU countries allows us to minimize heterogeneity due to the peculiarities of each country's higher education system.

[3]Refer to THE (2017) for the complete list of universities.

by university, which we use in our sample.[4]

University population. To limit the university population, we first verified that the initial sample includes only public universities in EU countries. Second, we sorted universities by the absolute number of international students for each EU country.[5] For each EU country, we selected either five universities with the most international students or all available universities in the country, whichever number is smaller. As a result, the population of universities was limited to 102 universities. We list the sample of universities in Table 2.1 in Section 2.8 of the Appendix.

Program characteristics. We focus exclusively on Bachelor's level programs which are sometimes referred to as undergraduate level, license, or the first university cycle. The rationale is that immigration policies are likely to have the highest impact on the labor market transition process from this level of studies than from Master's or PhD studies. We also only analyzed full-time studies that result in degree attainment at the host university, and excluded exchange and short-term mobility. To obtain a robust comparison of tuition fees and university admission systems between countries, we collected the information only on studies related to Economics, Business Administration, and similar fields, for the following reasons. First, programs in Economics are not subject to field-specific policies that exist in some countries (e.g., Austria applies educational quotas only to Medical studies EMN 2012). Second, Economics/Business Administration is commonly offered even at universities (e.g., technical universities), whereas only a few universities offer programs in other fields (e.g., Exact Sciences). Finally, if available, we explore programs with the instruction languages that are both English and the host country's official language. If a university had more than one program in the field for a given language of instruction, we gleaned information for all programs and calculated a simple average of the tuition fees.

Inquiry e-mail. For each selected university, we obtained contact details of admission/international relations offices through the official web pages. We sent a standardized e-mail inquiring about tuition fees and selection procedures for the Bachelor's studies for the academic year of 2017-2018. The "applicant" has Georgian nationality, studies at a high school in Georgia, and is interested in applying to the Bachelor's level Economics program (or related) at the selected university. After the university responded, we analyzed the information received and followed up via e-mail, if necessary. An example of the inquiry letter can be found in the Appendix in Section 2.7.

The nationality of the "applicant". We chose Georgian as the nationality of our applicant for three reasons. First, Georgia is a middle-income non-EU country and,

[4]The two best-known international university rankings were considered: QS World University Rankings and the Times Higher Education. There were two reasons why we chose Times Higher Education over the QS World University Rankings. First, detailed information on the total number of international students by university (which we use in our sample) was available only for Times Higher Education rankings. Second, even though university rankings between two systems differ, the differences are not significant enough to qualitatively alter our stylized facts.

[5]International student refers to any student who is not a citizen of a host country. Unfortunately, the THE ranking data does not allow us to distinguish between EU and non-EU international students.

therefore, relevant to our research. Second, Georgia does not have colonial or historical ties with any EU countries. Historical ties can impact international student migration policies. For instance, students from Brazil are exempted from taking a Portuguese language test for entering a university in Portugal. Third, Georgia is not among the least developed countries, for which several universities in the EU allow tuition fee reductions (for example, universities in Austria and France).

Final data. We complemented the data gleaned from the e-mail communication with the information available from each university's web page. Our data consists of information on tuition fees, eligibility criteria, and admission requirements for each program (for both national and English programs, if available).[6]

2.3.1.2 The Legal Framework Related to the Period Following University Studies

We also documented legal conditions related to the transition from the Bachelor's studies in Economics (or related) program to employment. The immigration rules can vary by sector of employment for each EU country. Fixing the program to Economics allows us to analyze a legal path that does not offer additional flexible access, as various countries set flexible policies for some sectors. Furthermore, we study a "standard" legal path, which is not specific to an applicant's work experience or other characteristics.

The data were synthesized and analyzed through the EU Immigration Portal (2017), EMN (2012, 2019), reports by OECD (OECD 2014), and web pages describing immigration procedures for each country.

2.3.2 Data Analysis and the Stylized Facts

In total, we synthesized and analyzed information on the university entrance and transition to employment stages for 102 public universities in EU countries (Malta excluded). We present the whole population of the universities in Table 2.1 in Section 2.8 of the Appendix.

The findings are presented in Tables 2.2-2.4 in Section 2.8 of the Appendix. In Table 2.2, we sort country groups *A* and *B* in descending order in terms of the global average ranking of universities, with group *A* (*A*1 and *A*2) having, on average, highly ranked universities. According to the table, the universities in groups *A*1 and *A*2 rank, on average, in the top 375 in global rankings, whereas university rankings of group *B* vary from 413 to 900 (for programs in the national language and English). Note that we present the results for programs with both instruction languages. This is because not all universities offer studies in English at Bachelor's level (e.g., Austria, Cyprus, and Greece), and focusing only on English programs would have omitted relevant information. Importantly, the stylized facts do not qualitatively change with the language of instruction.

[6]The tuition fees include only official expenses related to standard tuition (e.g., student fees or extra fees if a student does not earn a degree in an agreed time are not considered).

We also group countries by the flexibility of their immigration policies. In Table 2.3 in Section 2.8 of the Appendix, country groups A'-C' are sorted in descending order in terms of flexibility of immigration policies tailored to a Georgian Bachelor's graduate from Economics entering the host country labor market, with group A' having the most flexible policies. We define a country as having the most flexible immigration policy if it grants a grace period to a Georgian international student for job-searching upon graduation *and* an employer in this country is not obliged to pass a "labour market test" when hiring this graduate.[7]

We also group countries by both global average ranking of universities (groups $A1$, $A2$, B) and the flexibility of their immigration policies (groups A', B', C') to explore whether there is any relationship (refer to Table 2.4).

The stylized facts are as follows:

Fact 1. Countries with higher average university rankings have higher GDP per capita than those with lower average university rankings.

According to Table 2.2, $A1$ and $A2$ countries with highly ranked universities have higher GDP per capita (USD 41,756 for $A1$ and USD 39,540 for $A2$ countries) compared with B countries (USD 26,580).

Fact 2. Higher university rankings are associated with higher tuition fees charged to international students.

According to Table 2.2, $A1$ countries charge EUR 11,356 per year for programs in the national language and EUR 11,843 per year for programs in English, on average; B countries charge EUR 2,711 per year for programs in the national language and EUR 3,136 per year for programs in English, on average.[8]

Fact 3. The exception to Fact 2 are $A2$ countries (Germany, Belgium, Luxembourg, Italy, Austria, and France) which charge low tuition fees despite their high rankings.

According to Table 2.2, universities in group $A2$ rank similarly to those in group $A1$ (in both national and English language programs) and charge, on average, the lowest tuition fees in the EU: the average tuition fee in group $A2$ is EUR 1,562 and EUR 758 for programs in the national language and English, respectively.

Fact 4. There is no strong association between the flexibility of immigration policies tailored to international graduates entering the host country labor market and the average ranking of universities.

[7] "The labour market test" requires an employer to keep the job position open for a certain period, such that it formally proves that no national or EU worker is qualified for this position. (EMN, 2012)

[8] Several countries offer programs in the national language for free (Finland, Germany, Estonia, the Czech Republic, Slovakia, and Poland). The rationale of these countries might be to consider international students as fully integrated into the country if the student is fluent in the host country's language and to treat them similar to national students. We interpret these fee-free observations as exceptions and exclude them from our calculations of group average tuition fees.

According to Table 2.4, among countries with the most flexible tuition fee policies are some $A1/A2$ countries (Germany, Finland, and the Netherlands) and some B countries with lower university rankings (Estonia and Lithuania). In addition, some high education quality countries, such as the UK, Austria, and Belgium, mandate the strictest immigration policies aimed towards international graduates.

The stylized facts provide valuable insights to host country international student policies. Fact 1 states that richer countries are more likely to provide high-quality education. Fact 2 is in line with the prediction of Haupt et al. (2016): students graduating from higher-quality universities are expected to earn more, and hence, are willing to pay more than those graduating from lower-quality universities. As a result, higher-quality countries can push prices up compared with the lower-quality countries.

However, the model by Haupt et al. 2016 cannot explain Fact 3, that is, why universities in $A2$ countries (e.g., France and Germany) charge lower tuition fees than those in $A1$ countries (e.g., the UK and Ireland), even though the university rankings are similar between these two groups.[9]

Fact 4 sheds light on the connection between a host country's tuition fee and immigration policies. International students are considered to be an additional source of high-skilled labor for host countries. If the immigration policies were connected to tuition fee policies at public universities, countries with higher university rankings would ease their immigration process to retain more international graduates. However, Fact 4 does not support this hypothesis. We interpret Fact 4 as immigration policy not being connected with tuition fee policies.

In sum, Fact 2 is in line with the explanation by Haupt et al. (2016). However, the existence of high-quality-low-tuition fees (Fact 3) does not conform with a standard economic explanation. Fact 4 suggests that the tightness of immigration policy is related neither to university rankings nor to tuition fees and, therefore, also cannot explain Fact 3. We suggest that the explanation for Fact 3 may lie in socio-economic factors. In Section 2.3.3, we explore two potential socio-political factors which motivate the model developed in Section 2.4.

2.3.3 Socio-Economic Factors

This section discusses two potential socio-economic reasons for the observed tuition fee differential between $A1$ and $A2$ countries: Section 2.3.3.1 analyzes institutional and historical factors that may have precluded $A2$ countries from raising their fees, and Section 2.3.3.2 focuses on differences in admission selectivity between $A1$ and $A2$ universities.

[9] One potential reason the UK and Ireland charge higher fees could be English as an official language, which can drive demand from international students (Abbot and Silles 2016). Even so, the Netherlands, Denmark, Sweden, and Finland are non-English-speaking countries in group $A1$, and charge higher fees than $A2$ countries.

2.3.3.1 Tuition Fee Policies

This section analyzes non-economic factors that explain low tuition fees in the universities in group *A*2 (Austria, Belgium, France, Germany, Italy, and Luxembourg). The literature suggests that *A*2 countries historically may have followed a "non-market-based" approach, whereas *A*1 countries may have had a market-oriented objective.

In fact, *A*2 countries have historically been reluctant to increase tuition fees despite rising education costs, whereas the United Kingdom was among the first to increase fees (Marcucci and Johnstone 2007, Garritzman 2016). The literature provides the following explanations. First, the motivation for keeping tuition fees low is to ensure access to university education for low-income families (OECD 2014). Second, hiking tuition fees in countries with historically low fees becomes costly due to a "positive feedback effect" from the electorate. The "positive feedback effect" implies that implementing a policy that burdens the electorate, e.g., raising tuition fees, is not beneficial for a political party, and low fees become "path-dependent" (Garrizman, 2016). The third explanation might lie in how *A*1 and *A*2 states govern the universities: *A*2 countries traditionally have considered provision of tertiary education to be an obligation of the state and have directly governed their public universities, whereas institutions in the United Kingdom were historically independent of the state, and decisions regarding fees were left to universities' discretion (Teichler 2003)

With regard to international students, countries in group *A*2 may also follow a "non-market-based" approach, as these countries also never substantially increased tuition fees to international students. The explanation might lie in the social, political, and cultural dimensions of the countries. The traditions of these universities provide equal access to education for all students irrespective of nationality (France, according to The World and All its Voices, 2018), colonial ties and cultural factors (Guruz 2008), the desire to generate political goodwill from international graduates who return home after studies (e.g., Germany, according to Times Higher Education 2017), considering higher education as a public good in the context of international students (Luijten-Lub et al. 2005) are among these socio-political reasons. In addition, in these countries, changing international tuition fees can be "interpreted as a prelude to charging all students", and, therefore, policy-makers might be cautious about raising fees (Times Higher Education 2017).

Group *A*1 includes two subgroups. The first subgroup consists of the UK and Ireland, i.e., countries that are "market-oriented" towards both national and international students. These countries have among the highest national student fees in Europe: annual payments for national students of Bachelor's studies are EUR 10,450 and EUR 6,000 for the UK and Ireland, respectively (European Commission/EACEA/Eurydice 2018). Because countries generally set international fees at least as high as national fees (OECD 2011), it is not surprising that the UK and Ireland also charge high fees to international students.

The second subgroup of *A*1 consists of Denmark, Finland, the Netherlands, and Sweden. These countries may be considered to have a hybrid approach: they require low

payments from national students, however, over the last 15 years, these countries have substantially raised the international non-EU fees (Cai and Kivisto 2011). Their approach fulfills two goals at the same time: maintaining the "education for all" principle when treating the national students and implementing a "market-based view" when treating international students from non-EU countries (Sanchez-Serra and Marconi 2018).

In summary, the literature suggests that *A*1 countries might have followed a "market-based" approach when treating international students. In contrast, various socio-political factors might have been precluding *A*2 countries from raising their international student fees.

2.3.3.2 Admission Selectivity

We explore how *A*1 and *A*2 universities compare in terms of admission selectivity of non-EU students. We first review relevant studies and then offer some analysis to shed light on the topic. Our analysis suggests that the available information is limited and it is difficult to assess which universities are more selective towards international students.

The literature on the topic is scarce. With regard to national student admissions, many studies document some university admissions practices (Galland and Oberti 2000, Usher and Cervenan 2005, Kuptsch and Pang 2006, European Parliament 2014, Huisman and van der Wende 2016, Altbach et al. 2017, EMN, 2019). However, the data limitations and peculiarity of the admission processes in each country make it difficult to directly compare admission strictness across countries (Edwards et al. 2012).

With regard to international student admissions, to our knowledge, only McGrath et al. (2014, 2016) explicitly compare admission systems across EU countries. McGrath et al. (2014, 2016) classify higher education systems in France, Germany, and Italy as "open" and those of the UK and Sweden systems as "selective".[10] Nevertheless, these studies stress that an "open" higher education system does not automatically imply easier access for international students to universities. Moreover, due to the existence of additional bespoke admission barriers, it is difficult to robustly compare admission systems between the countries.

We attempt to shed light on the topic by analyzing several indicators. To be consistent with the stylized facts established in Section 2.3.2, we consider indicators relevant to the admission process of an international student from Georgia applying to a full-time BA program in Economics (or related) at a public university. We glean information on education quotas, views towards immigration, and the number of the first study permits granted from EMN (2012, 2019), ESS (2017), and Eurostat (2020). The rationale is that countries may use quotas to directly regulate the inflow of interna-

[10] According to McGrath et al. (2016), a country is defined as having an "open system" if a school-leaving certificate makes a (domestic) student eligible for university studies, and to be "selective "if additional requirements, e.g., admission tests, are in place.

tional students (EMN 2012), and unfavorable views towards immigration can impact policies tailored to international students, e.g., the number of education visas issued (Gaddie 2015). We also construct and analyze indicators on strict eligibility criterion and minimum language requirements from our unique data-set.[11]

Table 2.5 in Section 2.8 of the Appendix compares these indicators between $A1$ and $A2$ countries. From Table 2.5 it follows that it is not clear which universities have stricter admission selectivity. For instance, the quotas (3 out of 6 countries) and unfavorable views towards immigrants (3 out of 4 countries) seem more prevalent in $A2$ countries than in $A1$ countries. In contrast, more English language programs in $A1$ countries have stricter minimum English language criteria (90%) than those in $A2$ countries have (44%), and both $A1$ and $A2$ countries are similar in terms of stricter eligibility criteria (50%). In addition, both $A1$ and $A2$ groups annually grant a similar number of first study permits per million population (356 and 302, respectively).

Data limitations render the interpretation of this comparative analysis difficult. Countries may use other tools besides quotas when they face a surplus of international students (EMN 2012). In addition, it is difficult to compare the selectivity of quotas between countries, as the information on the size of a quota and the numbers of applicants are not available. Lastly, we cannot observe whether eligibility/minimum language criteria limit the number of incoming students in practice.

Given that both the literature and the data on the topic are limited, we entertain the possibility that $A2$ countries might be more selective than $A1$ countries due to unfavorable views towards international students. That could explain why universities in $A2$ countries offer fewer English-taught programs in Economics than universities in non-English speaking $A1$ countries do: according to Table 2.1 in Section 2.8 of the Appendix, only 31% (8 out of 26) of universities in $A2$ countries offer an English program, whereas 60% (12 out of 20) of universities in non-English speaking $A1$ countries do the same. In addition, this would not contradict the empirical observations provided in Table 2.5, as more countries in the $A2$ group impose education quotas and possess unfavorable views towards immigrants.

We emphasize the exploratory nature of our approach. We also note that $A2$ countries may be stricter towards international students than $A1$ countries for other reasons, such as more students preferring to study in these countries, or the geographical location of $A2$ countries. Given the lack of information, we entertain only one potential explanation: due to unfavorable views towards international students, $A2$ countries are more selective than $A1$ countries. In Section 2.4, we build a two-country model with international student mobility and confirm the possibility of that explanation. In the model, $A2$ countries practice stricter university admission requirements for non-economic reasons. We show that there is a certain range of model parameters values for which $A2$ countries charge lower tuition fees than $A1$ countries.

[11] We also considered information related to standardized test requirements for non-EU students. However, these data were not informative for a comparative analysis.

2.4 The Model

We develop a model which qualitatively accounts for the stylized facts. In Section 2.4.1, we develop a benchmark model. Section 2.4.2 extends the benchmark model and considers two scenarios with two host countries which have symmetric university education qualities. In scenario 1, one country exogenously charges zero tuition fees, and in scenario 2, one country exogenously screens out low-ability students. We identify the range of values of parameters for which the constrained country charges lower tuition fees and screens out low-ability students in both scenarios. We also provide a numerical example for illustration.

2.4.1 Benchmark Model

Two developed countries, country 1 and country 2, compete for international students from a developing country (home country) by setting tuition fees and an ability screening policy at the university entrance stage. There are two stages in the model:

Stage 1: The government of each host country $i \in \{1,2\}$ simultaneously sets tuition fees $t_i \geq 0$ and the screening policy $S_i \in \{0,1\}$.

Stage 2: Given the tuition fees and the ability screening policies set by the two countries, international students decide whether to study in country 1, country 2, or to remain in their home country.

International Students. The international students differ in three characteristics. First, they are heterogeneous in their ability a, such that there is π_a fraction of students with ability a^H and $1-\pi_a$ fraction of students with ability a^L where $a^H > a^L > 0$ and $\pi_a \in (0,1)$. Second, the students differ in their initial wealth W, such that there is π_w fraction of students with wealth W^H and $1-\pi_w$ fraction of students with wealth W^L where $W^H > W^L > 0$ and $\pi_w \in (0,1)$. Therefore, the pool of international students consists of four types of students: rich and high-ability (rH), rich and low-ability (rL), poor and high-ability (pH), and poor and low-ability (pL).

Third, international students are heterogeneous in their preferences towards studying in country i: each student experiences $I(i)mx$ disutility if he/she studies in country i where $m > 0$ is the preference cost parameter and x and $I(i)$ are random variables distributed independently. The value of x is drawn from a uniform distribution in a range $[0,1]$ and $I(1)+I(2)=1$ where $I(1)$ is either 1 or 0 with the probability of $\frac{1}{2}$. That is, half of the students have no disutility from studying in country i and another half experiences mx disutility.

All individual student characteristics (ability, wealth, and the disutility from studying in country i) are students' private information and are not observable by any of the host governments.

In the second stage, students decide between studying in country 1, studying in country 2, and remaining at home. If a student remains at home, he/she will earn a net

wage equal to $(1-\tau^D)a\underline{q}-\underline{t}$ where $\tau^D > 0$, $\underline{q} \geq 0$, and $\underline{t} \geq 0$ stand for the tax rate, the university quality, and the university tuition fee in the developing country, respectively. If a student studies in country i, he/she anticipates that with probability $p \in (0,1)$ he/she will remain and work in country i upon his/her graduation, and with probability $(1-p)$ he/she will return to his/her developing home country. Parameter p can be interpreted as the combination of the flexibility of the host country's immigration policy and other factors affecting return migration decisions (e.g., homesickness), that are assumed to be exogenous from the student's point of view.[12] A student earns the net wage of $(1-\tau)aq_i$ if he/she remains in country i upon his/her graduation. If he/she returns to his/her developing home country, he/she earns $\beta a(1-\tau^D)q_i$ where q_i stands for the university quality in country i, such that $q_i > \underline{q}$ for $i \in \{1,2\}$; $\tau \in [0,1]$ is a tax rate, and is assumed to be the same in both developed countries; parameter $\beta \in (0,1]$ stands for the depreciation of the university education premium, implying that the skills acquired during studies abroad are not as valuable in the developing country as in the developed one.

We assume a student's net wage earned after hie/her return to the developing home country never exceeds the net wage earned in the developed country. However, it is higher than the wage earned after acquiring education at home.

Assumption 2.1. $(1-\tau) \geq \beta(1-\tau^D)$ *and* $\beta q_i > \underline{q}$.

Given the tuition fees (t_1, t_2) and the screening policies (S_1, S_2) set by governments in the first stage, a student with ability a, wealth W, and disutility parameters x and I, receives the following expected utility from studying in country i:

$$U_i = W + \rho a q_i - t_i - I(i)mx \tag{2.1}$$

where $\rho := p(1-\tau) + (1-p)(1-\tau^D)\beta$.

If that student remains at home, he/she receives the following utility:

$$U_H = W + \Delta \tag{2.2}$$

where $\Delta := (1-\tau^D)a\underline{q} - \underline{t}$ stands for the net utility received from staying at home.

A student's decision to study in country i depends on the confluence of several factors. First, his/her initial wealth needs to exceed the tuition fee charged by country i:

$$W \geq t_i. \tag{2.3}$$

Second, the utility received from studying in country i should be higher than the utility received either from studying in country j or that received from remaining in the home country:

$$U_i \geq max(U_j, U_H) \tag{2.4}$$

[12] Because we found no association between the quality of university education and the flexibility of immigration policy (Fact 4), we assume that p is the same for both host countries.

Combining equations (2.2)-(2.4) results in the following equation:

$$t_i \leq min\big(W, \rho q_i a - \Delta - I(i)mx, t_j + \rho a(q_i - q_j) + (1 - 2I(i))mx\big). \tag{2.5}$$

Third, a student is eligible to study in country i if he/she is not screened by country i. The screening policy works as follows: if the government in country i sets the screening policy ($S_i = 1$), only high-ability students are accepted, and low-ability students are screened out. If the government opts for no screening policy ($S_i = 0$), both high-ability and low-ability students can choose whether to study in country i or not. The scenario may be similar to a real-life situation: universities may not be able to fully evaluate the ability of international students who come from developing countries and who receive their pre-university education from a relatively inferior education system. Nevertheless, universities can screen out low-ability students by assigning entrance examinations and/or requesting standardized test scores (e.g., IELTS). We assume that there is no cost related to implementing a screening policy. We also assume that if a country is indifferent between setting a screening policy or not, it does not set the screening policy.

Hence, the ability of students that are eligible to study in country i are:

$$\begin{cases} a = a^H & \text{if } S_i = 1 \\ a \in \{a^H, a^L\} & \text{if } S_i = 0. \end{cases} \tag{2.6}$$

The governments. Wealth (W), ability (a), and disutility from studying in country i (x and $I(i)$) are student's private information and not observable by any government. As a result, each government sets the screening policy and the tuition fee, which are unconditional on any student characteristics.

The provision of education is costly and, the cost per student is increasing with the education quality: $c(q_i) = cq_i$ is the education cost per student for country i where $c > 0$.

Given the students' decisions described by equations (2.5)-(2.6), the screening policy and the tuition fee set by country j (S_j, t_j), the government of country i sets the screening policy and the tuition fee (S_i, t_i) to maximize its net aggregate benefit generated by international students, which equals:

$$R_i(S_i, t_i | S_j, t_j) = \sum_{g \in G_i(S_i, t_i)} \alpha_i(g | S_i, t_i, S_j, t_j)\big(p\tau q_i a(g) + t_i - cq_i\big) \tag{2.7}$$

where $R_i(.)$ stands for the net aggregate benefit for country i; $G_i(.)$ stands for the set of all types of students who *can afford* to study in country i, *are not screened out* from country i and *prefer to study in country* i over remaining at home; $\alpha_i(g|.)$ stands for the fraction of students of type g who study in country i; g stands for the type of students, such that $g \in \{rH, rL, pH, pL\}$; $a(g_i)$ takes value a^H if $g \in \{rH, pH\}$ and a^L if $g \in \{rL, pL\}$.

Below we impose several additional assumptions.

Assumption 2.2. $(p\tau - c + \rho)a^L q_i - \Delta^L > 0$

for $i = 1, 2$ where $\Delta^L = (1 - \tau^D)a^L \underline{q} - \underline{t}$.

Assumption 2.2 implies that the expected joint net benefit from low-ability students, which is the sum of the expected net government benefit and the student's net expected wage, has to be positive.

Assumption 2.3. $c < p\tau a^H$.

Assumption 2.3 can be interpreted as the university education cost always being lower than the expected tax revenue generated by high-ability students.

Assumption 2.4. $W^H \geq \rho max(q_1, q_2)a^L - \Delta^L$.

Assumption 2.4 implies that the wealth of rich students (rH, rL) has to exceed the maximum net private benefit that a low-ability student can receive from studying abroad.

Below we describe several properties of the model.

The types of students. Each student decides to study in country i according to equations (2.5)-(2.6). Equation (2.8) describes the set of all types of students who *can afford* to study in country i, *are not screened out* from country i and *prefer to study in country* i over remaining at home, denoted by $G_i(S_i, t_i)$, for different values of S_i and t_i.

$$G_i(S_i, t_i) = \begin{cases} \emptyset & \text{if} \quad t_i > \overline{t}_i^H \\ \{rH\} & \text{if} \quad S_i = 0 \;\&\; t_i \in \left(max(\overline{t}_i^L, W^L), \overline{t}_i^H\right] \\ & \text{or if} \;\; S_i = 1 \;\&\; t_i \in (W^L, \overline{t}_i^H]\big) \\ \{rH, pH\} & \text{if} \quad S_i = 0 \;\&\; t_i \in (\overline{t}_i^L, W^L] \\ & \text{or if} \;\; S_i = 1 \;\&\; t_i \leq W^L \\ \{rH, rL\} & \text{if} \quad S_i = 0 \;\&\; t_i \in (W^L, \overline{t}_i^L] \\ \{rH, rL, pH, pL\} & \text{if} \quad S_i = 0 \;\&\; t_i \leq min(\overline{t}_i^L, W^L) \end{cases} \tag{2.8}$$

where $\overline{t}_i^{H,L} := min(\rho q_i a^{H,L} - \Delta^{H,L}, W^H)$ stand for the maximum tuition fee that a student with ability H, L and no preference cost ($x = 0$ or $I(i) = 0$) is willing to pay to study in country i.

Set $G_i(S_i, t_i)$ is also illustrated in Figure 2.2 in Section 2.10 of the Appendix. The intuition of equation (2.8) is as follows. If the tuition fee is high, such that the benefit from staying at home exceeds that from studying abroad ($t_i > \overline{t}_i^H$), no student will study in country i. Next, consider the situation when at least one type of student is willing to study in country i ($t_i < \overline{t}_i^H$) and that country i does not set the screening policy ($S_i = 0$). There exist two tuition fee threshold levels: at $t_i = \overline{t}_i^L$ low-ability students are indifferent between studying in country i and remaining at home; $t_i = W^L$ is the maximum tuition fee poor students can afford to pay. When country i's tuition fee exceeds both thresholds ($t_i \in \left(max(\overline{t}_i^L, W^L), \overline{t}_i^H\right]$), only rich and high ability

students will study in country i. When country i's tuition fee is between the low-ability students' threshold fee and the poor students' threshold fee ($t_i \in (\overline{t}_i^L, W^L]$), only high-ability students will study in country i. Likewise, when country i's tuition fee is between the poor students' threshold fee and the low-ability students' threshold fee ($t_i \in (W^L, \overline{t}_i^L]$), only the rich students will study in country i. Lastly, when the tuition fee is lower than both thresholds ($t_i \leq min(\overline{t}_i^L, W^L)$), all students will study in country i.

When country i sets the screening policy ($S_i = 1$), it excludes low-ability students. Therefore, the only threshold fee will exist for poor students ($t_i = W^L$), and the intuition is similar to the paragraph above.

Enrollment. Given the assumption that the disutility from studying in country i (x) is uniformly distributed between 0 and 1, country i enrollment given group $g \in G_i(S_i, t_i)$ can be expressed as follows:

$$\alpha_i(g|S_i, t_i, S_j, t_j) = \\ f(g)\Big(\frac{\rho a(g) q_i - t_i - \Delta + \mathbb{1}_{g \in G_j(S_j, t_j)}\big(t_j - \rho a(g) q_j + \Delta\big)\big)}{2m} + \frac{1}{2}\Big) \tag{2.9}$$

where $f(g)$ has the following functional form:

$$f(g) = \begin{cases} \pi_w \pi_a & \text{if } \ g = \{rH\} \\ \pi_w(1-\pi_a) & \text{if } \ g = \{rL\} \\ (1-\pi_w)\pi_a & \text{if } \ g = \{pH\} \\ 1-\pi_w)(1-\pi_a) & \text{if } \ g = \{pL\}; \end{cases} \tag{2.10}$$

$a(g)$ takes value a^H if $g \in \{rH, pH\}$ and a^L if $g \in \{rL, pL\}$; indicator function $\mathbb{1}_{g \in G_j(S_j, t_j)}$ takes value 1 if country j competes for g group of students with country i (i.e., $g \in G_j(S_j, t_j)$ and $g \in G_i(S_j, t_j)$) and 0 otherwise.

Two implications follow from equation (2.9). First, country i's enrollment is decreasing with country i's fee and non-decreasing in country j's fee. Second, the enrollment is increasing with country i's education quality and non-increasing in country j' education quality. That is, higher education quality and a lower tuition fee are advantageous in attracting international students.

The screening policy. Next, we analyze each government's decision to screen out low-ability students. It is beneficial for each government to accept low-ability students if the generated benefit per student is non-negative, and to screen them out otherwise. That is, the best response screening policy of country i has the following functional form:

$$S_i^{BR}(S_j, t_j) = \begin{cases} 1 & \text{if } \ t_i < (c - p\tau a^L) q_i \\ 0 & \text{if } \ t_i \geq (c - p\tau a^L) q_i. \end{cases} \tag{2.11}$$

Note that the screening policy decision of country i is independent of country j's actions and is only determined by country i's tuition fee.

The tuition fee. From equation (2.8) it follows that no country will charge fees higher than $\overline{t}_i^H$. In addition, the benefit function of country i is discontinuous in tuition fee levels at which set $G_i(S_i, t_i)$ changes, i.e., when $t_i \in \{W^L, \overline{t}_i^L, \overline{t}_i^H\}$, and continuous otherwise.

For the model to be tractable, we assume that the preference cost parameter is sufficiently high such that, for the range in which the tuition fee is continuous, an increase in tuition fees always increases the benefit of the host country.

Assumption 2.5. $m > (2\rho a^H + p\tau a^H - \rho a^L - c)max(q_1, q_2) - 2\Delta^H + \Delta^L$.

Hence, using assumption 2.5 and uniform distribution of x, it can be shown that

$$\frac{\partial R_i(S_i, t_i|S_j, t_j)}{\partial t_i} > 0 \text{ for } \{t_i : t_i \in [0, \overline{t}_i^H], \sim (t_i \in \{W^L, \overline{t}_i^L, \overline{t}_i^H\})\}. \tag{2.12}$$

Equation (2.12) implies that, given a specific group of students $g \in G_i(S_i, t_i)$, country i charges the highest possible tuition fee to that group irrespective of the screening policy and the tuition fee set by another country. That is, each country's best response function for the tuition fee is chosen from the following three options:

$$t_i^{BR}(S_j, t_j) \in \{W^L, \overline{t}_i^L, \overline{t}_i^H\}. \tag{2.13}$$

Sections 2.4.1.1 and 2.4.1.2 analyze the equilibrium of the benchmark model when the education qualities of the host countries are symmetric and asymmetric, respectively. Sections 2.4.2.1 and 2.4.2.2 extend the benchmark model and study two scenarios for symmetric education qualities.

2.4.1.1 Symmetric Education Qualities ($q_1 = q_2 = q$)

This section describes the model solution when the university education qualities are equal. In the proposition below, we only consider a range of parameter values for which there exists a unique symmetric Nash equilibrium. Complete characterization of the Symmetric Nash Equilibrium can be found in Table 2.7 and Figure 2.5 in Section 2.10 of the Appendix.

Proposition 2.4.1. *When the countries are symmetric in their university qualities ($q_1 = q_2$), there exists a range of values for W^L, c, π_a, π_w, for which there exists a unique symmetric Nash equilibrium. In this equilibrium, the countries set equal tuition fees ($t_1^* = t_2^*$), adopt the same screening policy ($S_1^* = S_2^*$), and attract the same types of students ($G_1^* = G_2^*$).*

Furthermore, there exist threshold values for the fraction of high-ability students ($\hat{\pi}_a^1, \hat{\pi}_a^2, \hat{\pi}_a^3$) and the fraction of rich students ($\hat{\pi}_w^1, \hat{\pi}_w^2, \hat{\pi}_w^3$), such that this Nash Equilibrium can be classified as follows:

Type* 1 *(screening policy). *Both countries set a screening policy and attract only high-ability students ($\{rH, pH\}$) if the education provision cost is sufficiently high ($c > p\tau a^L$), the wealth of poor students is sufficiently low ($W^L < cq - p\tau qa^L$), the fraction of rich students is sufficiently low ($\pi_w < \hat{\pi}_w^2$), and the fraction of high-ability students is sufficiently high ($\pi_a > \hat{\pi}_a^2$).*

Type* 2 *(no screening policy). *No country sets screening policy if one of the two conditions hold: i) the wealth of poor students is sufficiently high ($W^L > cq - p\tau qa^L$) or ii) the education provision cost is sufficiently high ($c > p\tau a^L$), the wealth of poor students is sufficiently low ($W^L < cq - p\tau qa^L$), the fraction of rich students is sufficiently high ($\pi_w > min(\hat{\pi}_w^1, \hat{\pi}_w^3)$).*

Moreover, Type **2** *(no screening policy) equilibrium can be classified as follows:*

Sub-type* 2-1: Both countries attract only rich and high-ability students ($G_1^* = G_2^* = \{rH\}$) if both the fraction of rich students and the fraction of high-ability students are sufficiently high ($\pi_w > \hat{\pi}_w^1$, $\pi_a > \hat{\pi}_a^1$).*

Sub-type* 2-2: Both countries attract only high-ability students ($G_1^* = G_2^* = \{rH, pH\}$) if the wealth of poor students is sufficiently high ($W^L \geq \bar{t}^L$), the fraction of rich students is sufficiently low ($\pi_w < \hat{\pi}_w^2$), and the fraction of high-ability students is sufficiently high ($\pi_a > \hat{\pi}_a^1$).*

Sub-type* 2-3: Both countries attract only rich students ($G_1^* = G_2^* = \{rH, rL\}$) if the wealth of poor students is sufficiently low ($W^L < \bar{t}^L$), the fraction of rich students is sufficiently high ($\pi_w > \hat{\pi}_w^3$), and the fraction of high-ability students is sufficiently low ($\pi_a < \hat{\pi}_a^3$).*

Sub-type* 2-4: Both countries attract all students ($G_1^* = G_2^* = \{rH, rL, pH, pL\}$), if the wealth of poor students is sufficiently high ($W^L > cq - p\tau qa^L$), and both the fraction of rich students and the fraction of high-ability students are sufficiently low ($\pi_w < \hat{\pi}_w^2$, $\pi_a < \hat{\pi}_a^2$).*

We note that reducing tuition fees induces two types of effects on the objective function of country i:

Revenue-per-student effect. On the one hand, according to equation (2.7), a tuition fee reduction directly lowers the net government benefit per student of type g.

Enrollment effect. On the other hand, lowering the fees changes the student enrollment in two ways. First, according to equation (2.9), country i attracts more students at a lower tuition fee within all available groups ($g \in G_i(S_i, t_i)$). Second, given that country i chooses only from three tuition fees according to equation (2.13), a decrease in t_i can expand the set of all groups of students for country i ($G_i(S_i, t_i)$).

The resulting Nash equilibrium depends on the aggregate of *revenue-per-student* and *enrollment* effects, which in turn depend on parameter levels W^L, c, π_a, π_w.

The intuition of proposition 2.4.1 is as follows. No country will institute a screening

policy as long as low-ability students generate positive benefits for the host country. The only case when this benefit can be negative is when the education cost exceeds the tax revenues collected from low-ability students ($c > p\tau a^L$) and the wealth of poor students is sufficiently low ($W^L < cq - p\tau qa^L$). Moreover, if the fraction of rich students is sufficiently low and the fraction of high-ability students is sufficiently high, the enrollment effect will dominate the revenue-per-student effect and both countries will set low tuition fees to attract poor students. However, at this price, the governments will also screen out low-ability students and only high-ability students will study abroad. Note that we do not allow countries to set differential tuition fees for different ability students, as this might be unrealistic. In practice, universities do not typically accept all applicants for many reasons, such as their potential adverse impact on the quality of university education, university reputation concerns, and considerations of perceived equity.

Next, the set of students in Type 2 (no screening policy) equilibrium depends on the values of W^L, c, π_a, π_w. Specifically, when both percentages of high-ability students and rich students are sufficiently high, the revenue-per-student effect will dominate the enrollment effect, and the countries will charge the highest fees to attract only rich, high-ability students (Sub-type 2-1). As the fraction of rich (high-ability) students becomes low, the poor (low-ability) student enrollment effect will dominate, and countries will reduce the tuition fees. Consequently, if both fractions of high-ability students and poor students are low, countries will charge the lowest fees and attract all students (Sub-type 2-4). Note that this holds only for the case when the wealth of poor students is sufficiently high ($W^L > cq - p\tau qa^L$).

For sub-types 2-2 and 2-3, countries charge moderate fees, as either the poor student enrollment effect or the low-ability student enrollment effect is dominant. Consider the case when the wealth of poor students exceeds the low-ability students' threshold tuition fee ($W^L \geq \overline{t}^L$). If countries charge a moderate fee ($t_i = W_L$), they will attract only high-ability students. Therefore, if the fraction of high-ability students is sufficiently high and the fraction of rich students is sufficiently low, the poor student enrollment effect will dominate, and countries opt for the moderate fee (Sub-type 2-2). Likewise, consider the case when the wealth of poor students is lower than the low-ability students' threshold tuition fee ($W^L < \overline{t}^L$). That is, if countries charge the moderate fee ($t_i = \overline{t}^L$), they will attract only rich students. Therefore, if the fraction of high-ability students is sufficiently low, and the fraction of rich students is sufficiently high, the low-ability student enrollment effect will be dominant, and countries will opt for the moderate fee (Sub-type 2-3).

Proposition 2.4.1 qualitatively accounts for the similarity of tuition fees among the same group of countries. That is, countries within each group $A1$, $A2$, and B have similar education qualities and set similar tuition fees. Interestingly, there exists a range of parameters for which both countries set a screening policy and exclude low-ability students (Type 1).

Section 2.4.1.2 explains the tuition fee differential between $A1$ and B countries, and

Section 2.4.2 extends the benchmark model with symmetric education qualities to account for the tuition fee differential between the $A1$ and $A2$ groups.

2.4.1.2 Asymmetric Education Qualities: $q_1 > q_2$

This section qualitatively accounts for the tuition fee differences between A countries and B countries. We assume that country 1 is a high-quality country: $q_1 > q_2$.

Compared with the symmetric case, higher education quality gives an advantage to a high-quality country, as it increases both enrollment and revenue per student for the country. Importantly, it can be shown that higher education quality differential will cause the revenue-per-student effect to increase more than the loss in the enrollment effect. That is, given the values of W^L, c, π_a, π_w and the screening policy and the tuition fee of the low-quality country, an increase in the education quality differential induces the high-quality country to weakly increase fees. Moreover, if the fraction of rich students is sufficiently high, the revenue-per-student effect will dominate the student enrollment effect, and the high-quality country will charge strictly higher tuition fees than the low-quality country.

Proposition 2.4.2. *Consider asymmetric educational qualities ($q_1 > q_2$). In the Nash equilibrium, the high-quality country always sets weakly higher tuition fees than the low-quality country does: $t_1^* \geq t_2^*$.*

Furthermore, there exists a threshold value for the fraction of rich students ($\overline{\pi}_w$), such that when the fraction of rich students exceeds the threshold ($\pi_w > \overline{\pi}_w$), the high-quality country sets strictly higher tuition fees than the low-quality country does: $t_1^* > t_2^*$.

Proposition 2.4.2 can qualitatively explain the observed stylized fact that universities in $A1$ countries charge higher tuition fees than B countries do. The next section demonstrates why $A1$ countries charge higher fees than $A2$ countries.

2.4.2 Symmetric Education Qualities: Extensions

The benchmark model cannot explain why $A1$ and $A2$ countries with similarly high-quality universities charge differential tuition fees. The subsections below build upon socio-economic factors discussed in Sections 2.3.3.1 and 2.3.3.2 and embed them into the model. We consider a setup in which both countries are symmetric ($q_1 = q_2 = q$) and analyze two scenarios in which country 2's decision is subject to an exogenous constraint. In scenario 1, the constrained country exogenously offers education for free and decides on a screening policy; in scenario 2, country 2 exogenously has stricter admission criteria and decides on a tuition fee.

2.4.2.1 Scenario 1: Country 2 Charges Zero Tuition Fees ($t_2 = 0$)

This section explores the environment in which one country keeps the tuition fees at zero due to socio-political, historical, and other non-economic factors. We assume

that tuition fees are exogenously set at zero for country 2, whereas country 1 faces an unconstrained maximization problem.

In the absence of tuition fee payments, the net aggregate benefit of country 2 will consist of only expected tax revenues. At zero tuition fees, all types of students *can afford* and *prefer* to study in country 2 over remaining at home. However, country 2 has a choice to screen out low-ability students. From equation (2.11) it follows that country 2 will screen out the low-ability students if the expected tax revenue from these low-ability students exceeds the education cost ($c > p\tau a^L$), and will not screen out them otherwise.

Hence, the set of all types of students who *can afford* to study in country 2, *are not screened out* from country 2 and *prefer to study in country* 2 over remaining at home, is as follows:

$$G_2(S_2, 0) = \begin{cases} \{rH, pH\} & \text{if } c > p\tau a^L \\ \{rH, rL, pH, pL\} & \text{otherwise.} \end{cases} \tag{2.14}$$

Country 1 does not face the constraint and, therefore, its best response function will be determined according to equations (2.11) and (2.13). It is straightforward to see that in scenario 1, the unconstrained country (country 1) will charge higher tuition fees compared with the constrained country by construction. However, depending on the values of W^L, c, π_a, π_w, the Nash Equilibrium can differ in terms of the screening policy and student types studying in each country.

Proposition 2.4.3. *Consider symmetric educational qualities and zero-tuition-fee scenario ($t_2 = 0$). There exists a Nash equilibrium and this equilibrium is unique. In this equilibrium, the unconstrained country always charges higher tuition fees than the constrained country does: $t_1^* > t_2 = 0$.*

Moreover, there exists the threshold value for the fraction of rich students ($\tilde{\pi}_w$), such that when the cost of education exceeds the tax benefit from low-ability students ($c > p\tau a^L$) and the fraction of rich students is sufficiently high ($\pi_w \geq \tilde{\pi}_w$), in the equilibrium, only the constrained country sets the screening policy ($S_1^* = 0$, $S_2^* = 1$).

The complete characterization of the Nash equilibrium can be found in Table 2.8 and Figure 2.6 in Section 2.10 of the Appendix.

The intuition of the proposition 2.4.3 is as follows. When the cost of education exceeds the expected tax revenues generated from low-ability students ($c > p\tau a^L$), at zero tuition fees, the constrained country will screen out low-ability students to avoid generating negative benefits. From proposition 2.4.1 it follows that, for the unconstrained country, there are two conditions under which it does not apply the screening policy. First, when the wealth of poor students is sufficiently high ($W^L > cq - p\tau q a^L$), attracting poor students will generate positive benefits and no screening will be beneficial. Second, consider the situation when the wealth of poor students is low ($W^L \leq cq - p\tau q a^L$). When the fraction of rich students is sufficiently high, the revenue-per-student effect will dominate the poor student enrollment effect, and the unconstrained

country will not find it beneficial to accept poor students. Consequently, it will charge moderate or high fees and will not set a screening mechanism. With regard to the types of students, the result is ambiguous and depends on the values of parameters of π_w and π_a.

Proposition 2.4.3 formally shows the existence of the asymmetric tuition fee equilibrium for symmetric education qualities: the constrained country charges lower tuition fees by construction.

Scenario 2 below investigates the equilibrium when country 2 exogenously sets the screening policy.

2.4.2.2 Scenario 2: Country 2 Sets a Screening Policy ($S_2 = 1$)

Motivated by section 2.3.3.2, we examine whether exogenous stricter admission criteria can lead to low tuition fees in *A*2 countries. For that, we assume that the screening policy for country 2 is set exogenously ($S_2 = 1$).

As country 2 can only attract high-ability students, its best response function becomes:

$$(S_2^{BR}(S_1, t_1), t_2^{BR}(S_1, t_1)) \in \{(1, \overline{t}^H), (1, W^L)\}. \tag{2.15}$$

The respective set of all types of students who *can afford* to study in country 2, *are not screened out* from country 2 and *prefer to study in country* 2 over remaining at home is:

$$G_2(1, t_2) = \begin{cases} \{rH\} & \text{if } t_2 = \overline{t}^H \\ \{rH, pH\} & \text{if } t_2 = W^L. \end{cases} \tag{2.16}$$

Below, we consider the range of parameter values for which there is a unique Nash Equilibrium, and when, in equilibrium, the constrained country charges lower tuition fees than the unconstrained one does.

Proposition 2.4.4. *Consider symmetric educational qualities and an exogenous-screening-policy scenario ($S_2 = 1$). When the wealth of poor students is sufficiently low ($W^L < \overline{t}^L$), threshold values $\tilde{\tilde{\pi}}_a^1, \tilde{\tilde{\pi}}_w^1, \tilde{\tilde{\pi}}_w^2$ exist, such that when the fraction of high-ability students is sufficiently low ($\pi_a < \tilde{\tilde{\pi}}_a^1$,), and the fraction of rich students is moderate ($\pi_w \in (\tilde{\tilde{\pi}}_w^1, \tilde{\tilde{\pi}}_w^2)$), there exists a unique Nash equilibrium in which the unconstrained country charges higher tuition fees and does not set a screening policy: $t_1^* > t_2^*$, $S_1^* = 0$, and $S_2^* = 1$.*

In this equilibrium, the constrained country serves high-ability students ($\{rH, pH\}$), while the unconstrained country caters to the rich students ($\{rH, rL\}$).

The complete characterization of the Nash equilibrium can be found in Table 2.9 and Figure 2.7 in Section 2.10 of the Appendix.

The intuition of proposition 2.4.4 is as follows. For the moderate value of the fraction of rich students, the poor student enrollment effect dominates the revenue-per-student

effect for the constrained country. Consequently, the constrained country charges low tuition fees and attracts high-ability students ($\{rH, pH\}$). For the unconstrained country, as the fraction of high-ability students is sufficiently low and the fraction of rich students is moderate, the low-ability student enrollment effect is dominant. Consequently, in equilibrium, the unconstrained country finds it beneficial to charge moderate fees and accept only rich students ($\{rH, rL\}$). At this price, no poor student will study in the unconstrained country. As a result, in equilibrium, the constrained country sets lower fees than the unconstrained one.

Using propositions 2.4.3 and 2.4.4 and Figures 2.6 and 2.7 in Section 2.10 of the Appendix, it can be shown that, when the cost of education exceeds the tax benefit of low-ability students ($c > p\tau q a^L$) and the wealth of poor students is moderate ($W^L \in (cq - p\tau q a^L, \bar{t}^L)$), the range of π_a and π_w for which only the unconstrained country sets the screening policy is larger for scenario 1 than for scenario 2. However, when the wealth of poor students is sufficiently low ($W^L < cq - p\tau q a^L$), this range is smaller for scenario 1 than for scenario 2.

Propositions 2.4.3 and 2.4.4 qualitatively account for the existence of "high-quality-low-tuition-fee" countries. Section 2.4.2.3 analyzes a numerical example and shows the existence of the range of parameters when, for both scenarios, the constrained country charges lower tuition fees than the unconstrained one.

2.4.2.3 A Numerical Example

In this section, we impose realistic parameter assumptions and find that there exists a range of values of π_a and π_w, for which the equilibrium for two scenarios are qualitatively the same.

The aim is to calibrate the values of the following parameters: $\underline{t}$, $\underline{q}$, q, π_a, a^H, a^L, c, π_w, W^H, W^L, τ^D, τ, β, p, m.

Normalization. We normalize the tuition fee in the developing country ($\underline{t} = 1$).

Earnings of university graduates abroad. We assume that the (lifetime) income for university graduates is 40 times higher than the cost of education in the host countries,[13] that is

$$\frac{(\pi_a a^H + (1 - \pi_a) a^L)}{c} = 40. \tag{2.17}$$

Note that we assume that the proportion of high-ability students in the developed countries is the same as that in the developing countries. This assumption may be realistic, as students who study abroad are likely to fall into a higher tier of the ability distribution of a developing country.

[13] According to the OECD (2018), the ratio of average lifetime earnings (without accounting for foregone earnings) of tertiary graduates over public spending per student is 39 for EU students.

Earnings Gini of college graduates in receiving countries. We assume that the earnings Gini is 0.25[14] for the host developed countries, that is

$$Gini^{Earnings} = \frac{\pi_a(1-\pi_a)(a^H - a^L)}{\pi_a a^H + (1-\pi_a)a^L} = 0.25. \tag{2.18}$$

The wealth Gini of international students from developing countries. Additionally, we impose that the wealth Gini is 0.45 for international students:

$$Gini^{Wealth} = \frac{\pi_w(1-\pi_w)(W^H - W^L)}{\pi_w W^H + (1-\pi_w)W^L} = 0.45. \tag{2.20}$$

A coefficient 0.45 is a reasonable assumption, as the wealth Gini coefficient is generally half of the size of the income Gini coefficient.[15]

Additional assumptions. We impose further assumptions on the model parameters. We set the host country income tax rate at 25% ($\tau = 0.25$).[16] For the developing country, we set the tax rate at 20% ($\tau^D = 0.2$) and the foreign education premium depreciation at 0.7 ($\beta = 0.7$). Further, we set the value of the staying probability (p) at 0.25;[17] We also assume that the quality of education in the developing country is proportional to the cost of education: $\underline{q} = 1.4c$. In addition, we restrict the fraction of high-ability students and rich students to be within realistic bounds, such that $max(\pi_a, \pi_w) < 0.5$. We set the values of the preference cost parameter (m): $m = 90$. To ensure that assumptions 2.1 and 2.5 hold, we assume that $q = 5$ and $W^H = 30$.

Choice of education cost parameter (c). Note that the parameter assumptions above do not exactly pin down the exact values for c, π_a, π_w. We are exploring whether there exists a range of values of the parameters for which the two scenarios result in the same equilibrium. It turns out that, for that range to exist, the value of c has to be sufficiently high, such that the education cost exceeds the tax benefit received from low-ability students ($c > p\tau a^L$). For the sake of illustration, we set $c = 2$.

Result. The result is depicted in Figure 2.1. According to the figure, there exists a range of values of π_w and π_a, such that, given that range in both scenarios, the unconstrained country sets higher tuition fees than the constrained one ($t_1^* > t_2^*$). Interestingly, in that range, both countries set the same screening policy and attract the same types of students in both scenarios. Specifically, the constrained country

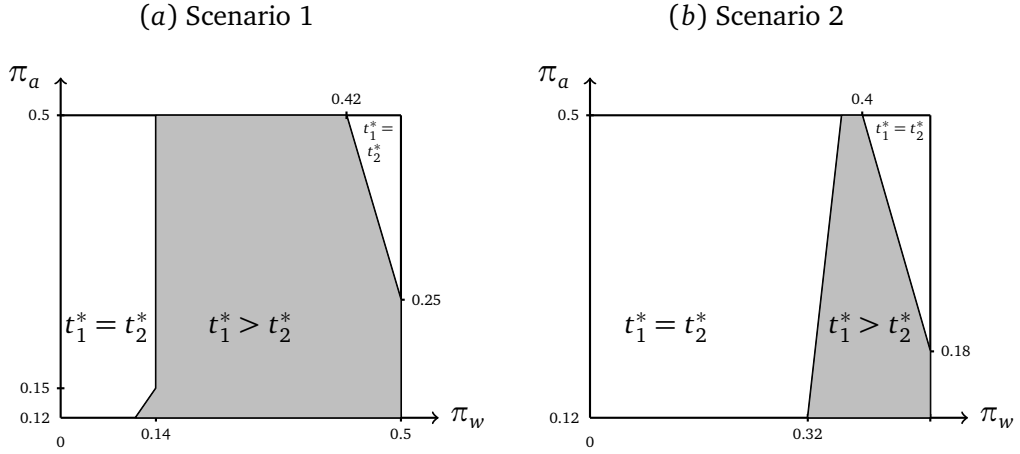
[14]There is no Gini estimate for international student earnings available in the literature. Nevertheless, a Gini of 0.25 is in line with Budria and Perreira (2005), who estimate Gini of earnings of domestic university graduates in selected EU countries to be between 0.18-0.29.

[15]According to Davies et al. (2008), the wealth Gini varies between 0.55 and 0.73 for selected EU countries, which is twice as high as the income Gini in the same countries. (Dabla-Norris et al., 2015, World Bank, 2020). Note that, as we focus on international students, it might realistic to expect their wealth Gini be lower than in the general population.

[16]The average EU income tax rate calculated based on OECD (2018): Indicator A5.1. Payments for social contributions are excluded from the calculations.

[17]This is in line with the international student stay rate in the EU. Refer to OECD (2011), which reports a 25% stay rate.

Figure 2.1: Range of values of π_a, π_w for which Two Scenarios Lead to a similar Nash Equilibrium



sets a screening policy ($S_2^* = 1$) and attracts only high-ability students ($\{rH, pH\}$). The unconstrained country does not set a screening policy ($S_1^* = 0$), however, it sets tuition fees sufficiently high, so that only rich students will find it beneficial to study there ($\{rH, rL\}$).

The intuition of the result is as follows. Given that the fraction of rich students is moderate and the fraction of high-ability students is sufficiently low, the low-ability student enrollment effect is dominant for the unconstrained country. Hence, it does not set a screening policy, charges moderate fees, and attracts only rich students. The constrained country sets a screening policy under the zero-tuition-fee scenario, because it can be shown that, given the parameter value assumptions, the education cost exceeds the tax benefit from low-ability students ($c > p\tau a^L$). In addition, under the exogenous-screening-policy scenario, the poor student enrollment effect is dominant, and the constrained country charges low fees. Therefore, this country screens out low-ability students, sets low fees, and serves only high-ability students.

The numerical example suggests that the observed tuition fee differential between the high-quality *A*1 and *A*2 universities might be equally plausible due to socio-political factors that either restrict the fees from rising or cause stricter selectivity in *A*2 universities. Moreover, irrespective of the scenario, in the equilibrium, the constrained country screens out low-ability students and only attracts high-ability students, whereas the unconstrained country does not a the screening policy and serves only the rich students.

2.5 Conclusion

The paper documents stylized facts on EU host country policies tailored to international students. We find that a higher university ranking is associated with higher GDP per capita and higher tuition fees. However, as an exception to this rule, there

are $A2$ countries (Austria, Belgium, Germany, France, Italy, and Luxembourg) that have high university rankings and charge the lowest tuition fees. Finally, we found no strong association between the flexibility of immigration policies and the average ranking of universities.

Further, we develop a model to account for the stylized facts qualitatively. Our model can generate high-ranking-high-tuition fee patterns, similar to Haupt et al. (2016). In addition, our model accounts for the existence of the exceptional $A2$ countries that charge low tuition fees despite their high university rankings. We suggest that the reason may be socio-political factors that either exogenously fix tuition fees at a low level or impel $A2$ universities to be more selective than $A1$ universities. Importantly, after imposing realistic assumptions on the model parameters, the two of the scenarios result in an equilibrium in which $A2$ countries set lower tuition fees and accept only high ability students, and $A1$ countries set higher tuition fees and accept only rich students.

The model presents a fruitful environment for further research. This paper has only qualitatively accounted for the stylized facts, and did not analyze optimal policy for the governments. For instance, one could extend the model with an endogenous immigration policy, and find an EU-wide optimal policy that would maximize the aggregate social benefits for countries.

2.6 Appendix A

Key Terms and Definitions

EU Countries. The European Union countries includes 28 members: Austria, Belgium, Croatia, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. At the time of writing this paper, the United Kingdom was part of the EU.

IELTS. The International English Language Testing System (IELTS) measures language proficiency using a nine-band scale to identify levels of proficiency, from non-user (band score 1) through to expert (band score 9).

Immigration quota. A quota established for and by the country, normally for labour migration, for the entry of immigrants. (EMN 2012)

International student. According to the EMN (2012) glossary, an international student is a non-EU/EEA national "accepted by an establishment of higher education and admitted to the territory of a Member State to pursue as his/her main activity a full-time course of study leading to a higher education qualification recognized by the Member State, including diplomas, certificates or doctoral degrees in an establishment of higher education, which may cover a preparatory course pbeforesuch education according to its national legislation." (EMN 2012) For our purposes, we use the term "international student" to designate non-EU/non-EEA/non-OECD nationals.

Flexible immigration policy. We define a country as having the most flexible immigration policy if it grants a grace period to a Georgian international student for job-searching in the host country upon his/her graduation *and* an employer in this country is not obliged to pass a "the labour market test" when hiring this graduate.

Labour Market Test. "Labour market test is a mechanism that aims to ensure that migrant workers are only admitted after employers have unsuccessfully searched for national workers, EU citizens – in EU member States this also means European Economic Area (EEA) workers – or legally residing third-country nationals with access to the labor market according to national legislation." (EMN 2012)

OECD Countries. Member countries of the Organisation for Economic Co-operation and Development: Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

Times Higher Education. Times higher education is one of the most common university ranking systems. It "provides the definitive list of the world's best universities, evaluated across teaching, research, international outlook, reputation and more. THE's data are trusted by governments and universities and are a vital resource for

students, helping them choose where to study." (Source: Times Higher Education)

2.7 Appendix B

The Inquiry E-mail

Subject: Requirements for Admission

Dear Sir/Madam,

I am a Georgian student studying at a high school in Georgia, and I am interested in applying to [*the university name*] for [*the program name*] at a Bachelor's level. While I am still making up my mind about which specialization to choose, I have a few questions regarding the requirements for admission into your university. In particular, I would like to ask you the following:

- What are the academic requirements?

- What are the language requirements?

- What is the tuition fee?

- How do the requirements and tuition fees vary for the same program in [*native language of the country*]?

Your answers are highly appreciated.

Best regards,

Davit Khuskivadze

2.8 Appendix C

Table 2.1: The Sample of Public Universities

Country	University	Number of International Students	University Ranking	Tuition Fee: Program in National Language (EUR per year)	Tuition Fee: Program in English (EUR per year)
Austria	University of Vienna	9,025	161	1,453	NA
Austria	University of Innsbruck	5,457	301-350	1,453	NA
Austria	Vienna University of Technology	4,757	251-300	1,453	NA
Austria	University of Graz	2,492	401-500	1,453	NA
Austria	Graz University of Technology	1,010	351-400	1,453	NA
Belgium	Université Libre de Bruxelles	7,588	201-250	4,175	NA
Belgium	KU Leuven	7,421	40	1,250	1,250
Belgium	University of Liège	4,971	301-350	4,175	NA
Belgium	University Catholique de Louvain	4,544	128	2,760	NA
Belgium	Ghent University	3,184	118	5,424	NA
Bulgaria	Sofia University	926	801+	3,300	3,850
Croatia	University of Zagreb	673	801+	3,700	3,700
Cyprus	University of Cyprus	562	351-400	6,834	NA
Cyprus	Cyprus University of Technology	181	401-500	7,000	NA
Czech Republic	Charles University in Prague	7,649	401-500	free	6,000
Czech Republic	Masaryk University	7,267	601-800	free	NA
Czech Republic	Brno University of Technology	3,907	601-800	free	1,300
Czech Republic	Czech Technical University	3,302	601-800	free	4,070
Czech Republic	Czech University of Life Sciences	2,904	801+	free	1,300
Denmark	University of Southern Denmark	4,050	251-300	6,500	6,500
Denmark	Copenhagen Business School	4,022	251-300	9,500	9,500
Denmark	Aarhus University	3,449	98	8,500	8,500
Denmark	Aalborg University	2,893	201-250	6,500	NA
Denmark	Technical University of Denmark	1,451	176	NA	7,500
Estonia	Tallinn University of Technology	783	601-800	free	3,300
Estonia	University of Tartu	379	301-350	free	3,400
Finland	Aalto University	2,531	201-250	free	12,000
Finland	University of Helsinki	1,402	91	free	NA
Finland	Tampere University of Technology	740	501-600	free	NA
Finland	Lappeenranta University of Technology	715	501-600	free	NA
Finland	University of Oulu	706	201-250	free	NA
France	Aix-Marseille University	9,665	301-350	170	170
France	University of Strasbourg	8,305	301-350	184	NA
France	University of Lille	8,063	401-500	189	189
France	Panthéon-Sorbonne University	8,024	401-500	500	NA
France	University of Bordeaux	6,260	301-350	700	700
Germany	Technical University of Munich	8,124	46	free	free
Germany	RWTH Aachen University	7,191	78	free	NA
Germany	Free University of Berlin	6,911	75	free	NA
Germany	Goethe University Frankfurt	6,818	201-250	free	NA
Germany	Ruhr University Bochum	5,553	251-300	free	NA
Greece	National and Kapodistrian University of Athens	5,579	501-600	673	NA
Greece	Aristotle University	3,999	401-500	673	NA
Greece	University of Patras	1,469	601-800	673	NA
Greece	University of Ioannina	851	501-600	673	NA
Greece	University of Crete	581	301-350	673	NA
Hungary	University of Debrecen	3,746	801+	NA	4,900
Hungary	University of Szeged	2,356	601-800	600	4,400
Hungary	University of Pécs	2,354	601-800	1,600	4,900
Hungary	Eötvös Loránd University	1,741	601-800	900	2,500
Ireland	University College Dublin	5,360	201-250	19,426	19,426
Ireland	Trinity College of Dublin	3,951	131	18,300	18,300
Ireland	University College Cork	2,540	351-400	9,500	9,500
Ireland	University of Limerick	2,253	501-600	11,423	11,423
Ireland	NUI Galway	2,226	201-250	10,750	10,750

Table 2.1: Continued.

Country	University	Number of International Students	University Ranking	Tuition Fee: Program in National Language (EUR per year)	Tuition Fee: Program in English (EUR per year)
Italy	Sapienza University of Rome	8,073	251-300	1,000	NA
Italy	University of Bologna	5,914	201-250	1,465	1,465
Italy	University of Turin	4,353	351-400	1,200	NA
Italy	Polytechnic University of Milan	4,061	201-250	1,000	1,000
Italy	University of Florence	3,736	401-500	800	NA
Latvia	University of Latvia	825	801+	1,650	2,400
Latvia	Riga Technical University	749	801+	2,000	2,500
Lithuania	Vilnius University	738	601-800	2,040	2,400
Lithuania	Kaunas University of Technology	395	801+	1,560	2,800
Luxembourg	University of Luxembourg	2,870	178	533	533
Netherlands	Maastricht University	7,534	94	7,500	7,500
Netherlands	Erasmus University Rotterdam	4,152	69	8,900	8,900
Netherlands	University of Groningen	3,287	80	8,200	8,200
Netherlands	Leiden University	2,596	77	11,500	11,500
Netherlands	University of Amsterdam	2,534	63	9,285	9,285
Poland	University of Warsaw	3,356	501-600	free	2,100
Poland	Jagiellonian University	2,507	601-800	free	NA
Poland	Warsaw University of Technology	1,041	501-600	free	NA
Poland	Adam Mickiewicz University	786	801+	free	NA
Poland	University of Łódź	728	801+	free	2,500
Portugal	University of Lisbon	4,776	401-500	4,500	4,500
Portugal	University of Coimbra	3,266	401-500	7,000	NA
Portugal	University of Porto	2,858	401-500	3,000	NA
Portugal	Nova University of Lisbon	2,331	501-600	6,000	6,000
Portugal	University of Minho	1,848	501-600	6,500	NA
Romania	Babeş-Bolyai University	743	601-800	2,760	2,760
Romania	Alexandru Ioan Cuza University	711	801+	3,000	3,000
Romania	University of Bucharest	626	801+	1,880	1,880
Romania	West University of Timişoara	542	601-800	2,200	NA
Slovakia	Comenius University in Bratislava	2,268	601-800	free	3,000
Slovenia	University of Ljubljana	1,824	601-800	3,000	3,000
Slovenia	University of Maribor	419	501-600	1,990	1,990
Spain	Complutense University of Madrid	7,671	501-600	2,300	2,300
Spain	University of Granada	5,358	501-600	757	NA
Spain	University of Barcelona	4,757	201-250	4,123	4,123
Spain	Autonomous University of Madrid	4,711	351-400	2,300	2,300
Spain	University of Valencia	4,315	501-600	900	900
Sweden	Lund University	4,328	96	10,000	10,000
Sweden	Uppsala University	3,033	93	9,200	NA
Sweden	Stockholm University	2,502	144	9,200	9,200
Sweden	University of Gothenburg	2,131	170	6,800	NA
Sweden	Umea University	1,670	251-300	9,000	NA
UK	University College London	13,443	15	18,580	18,580
UK	University of Manchester	12,245	55	17,000	17,000
UK	Coventry University	8,727	601-800	11,927	11,927
UK	King's College London	8,355	36	17,050	17,050
UK	University of Nottingham	8,327	147	18,000	18,000

Notes: Source: THE (2017) and the author's data. The university ranking is measured by a number between 1 to 1,000, with 1 indicating the highest ranking. The university rankings up to 200 are provided in exact numbers, while those over 200 appear in bands: 201-250, 251-300, 301-350, 351-400, 401-500, 501-600, 601-800, 801-1000. Throughout the paper, we assume an average value of a band's range for the universities that rank higher than 200. Tuition fees show annual fees charged for a Georgian student studying at an Economics program (or similar) on a Bachelor's level.
NA — Not Applicable. Value "NA" indicates that the university does not offer a Bachelor's degree program in Economics or related fields.

Table 2.2: University Rankings, GDP per capita and Tuition Fees in EU Member States

Country Group	Country	GDP per capita(USD)[a]		Average Ranking of Universities				Average Annual Tuition Fees (EUR)			
				National Language Programs		English Programs		National Language Programs		English Programs	
		Country Average	Group Average	Country Average	Group Average	Country Average	Group Average	Country Average	Group Average[b]	Country Average	Group Average[c]
A1	Netherlands	45,484	41,756	77	212	77	188	9,077	11,356	9,077	11,843
	Sweden	45,488		156		120		8,840		9,600	
	UK	38,509		191		191		16,511		16,511	
	Denmark	45,484		218		206		7,750		8,000	
	Ireland	61,378		301		301		13,880		13,880	
	Finland	38,994		328		225		free		12,000	
A2	Germany	43,788	39,540	140	259	46	246	free	1,562	free	758
	Belgium	41,826		167		40		3,557		1,250	
	Luxembourg	93,900		178		178		533		533	
	Italy	34,220		310		300		1,093		1,233	
	Austria	44,048		317		NA		1,453		NA	
	France	37,775		375		367		349		353	
B	Cyprus	23,301	26,580	413	636	NA	686	6,917	2,711	NA	3,136
	Spain	32,219		450		425		2,076		2,406	
	Portugal	26,549		490		500		5,400		5,250	
	Estonia	27,345		513		513		free		3,350	
	Greece	24,095		515		NA		673		NA	
	Slovenia	29,097		625		625		2,495		2,495	
	Czech Republic	30,381		690		688		free		3,168	
	Hungary	24,831		700		750		1,033		4,175	
	Slovakia	28,254		700		700		free		3,000	
	Poland	25,323		720		725		free		2,300	
	Lithuania	26,971		800		800		1,800		2,600	
	Romania	20,484		800		833		2,460		2,547	
	Bulgaria	17,000		900		900		3,300		3,850	
	Croatia	20,664		900		900		3,700		3,700	
	Latvia	23,080		900		900		1,825		2,450	

Notes: 2017 data, author's calculations. The data on programs and tuition fees are collected by the author for the academic year of 2017/2018. Tuition fees show annual fees charged for non-EU/non-EEA students for studying in an Economics program (or similar) at the Bachelor's level.
[a] Source: World Bank. PPP adjusted, International $, in 2011 constant prices. The data for 2015.
[b,c] Simple average; The group averages for the tuition fees exclude fee-free countries from the calculation.
NA — Not Applicable. Value "NA" indicates that the university does not offer a Bachelor's degree program in Economics or related fields.

Table 2.3: University Rankings and Immigration Policies in EU Member States

Country Group	**Country**	**Existence of a Grace Period (Yes/No)**[a]	**"Labour Market Test" Requirement (Yes/No)**[b]
A'	Estonia	Yes	No
	Finland		
	Germany		
	Lithuania		
	Netherlands		
B'	Denmark	Yes	Yes
	Ireland		
	Italy		
	Sweden		
	Croatia	No	No
	Czech Republic		
	Greece		
	Poland		
	Slovakia		
C'	Austria[c]	No	Yes
	Belgium		
	Bulgaria		
	Cyprus		
	France[d]		
	Hungary		
	Latvia		
	Luxembourg		
	Portugal		
	Romania		
	Slovenia		
	Spain		
	UK		

[a] Sources: EMN (2012), OECD (2014), EMN (2019), and country-specific immigration web-pages. A grace period is defined as being given to international students if they are allowed to remain in the host country upon graduation. The grace period typically ranges from 6 to 12 months.
[b] Sources: EMN (2012), OECD (2014b), EMN (2019), and country-specific immigration web-pages. "Labour Market Test" is "a mechanism that aims to ensure that migrant workers are only admitted after employers have unsuccessfully searched for national workers, EU citizens or legally residing third-country nationals with access to the labor market according to national legislation." (EMN 2012).
[c,d] Austria and France allow only Master's and PhD international graduates to search for a job upon their completion.

Table 2.4: The Country Matrix

Country Group	*A*1					*A*2					*B*				
	I	**II**	**III**	**IV**	**V**	**I**	**II**	**III**	**IV**	**V**	**I**	**II**	**III**	**IV**	**V**
A'	**Finland, Netherlands**					**Germany**					**Estonia, Lithuania**				
	202	101	446	160	35%	140	46	124	107	38%	656	656	224	23	24%
B'	**Denmark, Ireland, Sweden**					**Italy**					**Croatia, Czech Republic, Greece, Poland, Slovakia**				
	226	226	298	95	22%	234	234	204	2	1%	660	660	54	31	13%
C'	**United Kingdom**					**Austria, Belgium, France, Luxembourg**					**Cyprus, Hungary, Latvia, Portugal, Romania, Spain**				
	191	191	1690	91	5%	280	280	476	181	5%	616	616	110	21	14%

I — The average ranking of universities with national language programs in Economics (or related) at the Bachelor's level.
II — The average ranking of universities with English programs in Economics (or related) on a Bachelor's level.
III — The average number of first permits issued annually for study for 12 months or over per million population of the host country. Sources: Eurostat, the World Bank; non-EU and non-OECD students, the average of 2014-2018.
IV — The average number of the annual immigration status change from education to paid work per million population of the host country. Sources: Eurostat, the World Bank; non-EU and non-OECD students, the average of 2014-2018.
V — Rate of non-EU/non-OECD graduates from education to paid work (yearly average, %): ([the number of the immigration status change from education to paid work]/[(the number of total mobile graduates (all levels)]). Sources: Eurostat, the World Bank; non-EU and non-OECD students, the average of 2014-2018.
m — Information missing.

Table 2.5: Educational Quota, Views on Migration, Eligibility Criteria, and Language Requirements.

Country Group	Country	Quota[a]		Views on Migrants[b]		Programs with Stricter Eligibility Criteria[c]		Programs with Stricter Minimum English Language Criteria[d]		Average Annual Number of First Study Permits per Million Population of the Host Country[e]	
		Yes/No	Total Number by Group	Total Number By Country	Countries with Unfavorable Views	Total Number by Country	% by country group	Total Number by Country	% by country group	Total Number by Country	Group Average[f]
A1	Netherlands	No	1 out of 6	>5	1 out of 6	1 out of 5	50%	3 out of 3	90%	432	356
	Sweden	No		>5		0 out of 5		2 out of 2		201	
	UK	No		<5		4 out of 5		4 out of 5		m	
	Denmark	Yes		>5		5 out of 5		3 out of 3		255	
	Ireland	No		>5		3 out of 5		5 out of 5		550	
	Finland	No		>5		2 out of 5		0 out of 1		476	
A2	Germany	Yes	3 out of 6	>5	3 out of 4	5 out of 5	50%	1 out of 1	44%	124	302
	Belgium	Yes		<5		2 out of 5		1 out of 1		330	
	Luxembourg	No		m		1 out of 1		1 out of 1		203	
	Italy	Yes		m		0 out of 5		0 out of 4		m	
	Austria	No		<5		5 out of 5		1 out of 1		114	
	France	No		<5		0 out of 5		0 out of 1		738	

[a] Sources: EMN (2012), EMN (2019), and web sources. We only consider quotas that are applicable to Economics (or related) studies at the Bachelor's level. If the quotas are only applied in other fields (e.g., Medical studies in Austria), we mark these observations as being Non-Quota.
[b] Source: ESS (2017). The figures are based on the European Social Survey data. The questionnaire contains various questions on immigration and politics. The indicator used in this paper provides a mean score of the answers to the following question: "Is [country] made a worse or a better place to live by people coming to live here from other countries?" Answer "0" indicates "The Worst," and answer "10" indicates "The Best." We define unfavorable view towards immigrants as "5" or lower.
[c] Source: Author's calculations; data for 2017. Eligibility criteria are defined as stricter if a program requires international applicants to have any of the following: a) to have completed 1 year of university studies in their home country b) to have completed a one-year preparatory program at the host university c) to have passed university entrance exams in their home country d) to meet a minimum grade requirement during their high school studies. The eligibility criteria do not differ by the language of instruction.
[d] Source: Author's calculations; data for 2017. The minimum English language requirements are defined as stricter if a program requires international applicants to English programs to have an IELTS score of at least 6.0. The International English Language Testing System (IELTS) measures the language proficiency using a nine-band scale to identify levels of proficiency, from non-user (band score 1) to expert (band score 9).
[e] Source: Eurostat and Author's calculations; The average of 2013-2015. First permits granted for study reasons for 12 months or more, where "Study category relates to persons granted a first residence permit and who are admitted to pursue a course of study at an establishment of higher or professional education (students)."(EUROSTAT)
[f] Weighted average by the population of the host country.
m — Information missing.

2.9 Appendix D

Proofs

Equations (2.8) **and** (2.12). From equations (2.2) and (2.4) it follows that, the threshold tuition fee below which no student from group with ability a and wealth W prefers studying in country i to remaining home is

$$t_i^{tr} = \begin{cases} \rho q_i a - \Delta & \text{if } W = W^H \\ min(W^L, \rho q_i a - \Delta) & \text{if } W = W^L. \end{cases} \tag{D.1}$$

Combining equation (D.1) with equation (2.6) immediately leads to equation (2.8) and Figure 2.2.

From equation (2.7) it follows that, on the continuous segment of the net benefit function, i.e., when $t_i \notin \{W^L, \rho q_i a^L - \Delta^L, min(\rho q_i a^H - \Delta^H, W^H)\}$, the following condition holds:

$$\frac{\partial R_i(S_i, t_i | S_j, t_j)}{\partial t_i} = \sum_{g \in G_i(S_i, t_i)} \frac{\partial \alpha_i(g | S_i, t_i, S_j, t_j)}{\partial t_i} \big(p\tau q_i a(g) + t_i - c q_i\big) + \alpha_i(g | S_i, t_i, S_j, t_j). \tag{D.2}$$

Combining equations (2.9) and (D.2) leads to the following equation:

$$\frac{\partial R_i(S_i, t_i | S_j, t_j)}{\partial t_i} = \sum_{g \in G_i(S_i, t_i)} f(g) \frac{m + ((\rho - p\tau)a(g) + c)q_i - \Delta - 2t_i + \mathbb{1}_{g \in G_j(S_j, t_j)} \big(t_j - \rho a(g) q_j + \Delta\big)}{2m}. \tag{D.3}$$

Given that the value of m is sufficiently high according to assumption 2.5, the expression in equation (D.3) is positive.

Proposition 2.4.1

Proof. To prove the proposition, we employ the following approach. First, we characterize three cases based on different ranges of (W^L, c). Second, we derive the best response function of country i and depict it on a graph with π_w and π_a. Third, to find the Nash equilibrium, we plot the best response functions for both countries for all three cases.

Equation (2.11) characterizes the choice of a screening policy by country i. The best response tuition fee for country i is chosen from the set described in equation (2.13), such that, given the screening policy-tuition fee pair set by country j, it maximizes the net aggregate benefit of country i. Combining equations (2.8), (2.11), and (2.13) lead to the three different cases that characterize the set $G_i(S_i, t_i)$ corresponding to each tuition fee described in equation (2.13). Specifically, these cases are as follows:

- **Case 1.** $W^L \in [\overline{t}^L, \overline{t}^H]$.
- **Case 2.** $W^L \in (cq - p\tau q a^L, \overline{t}^L)$.
- **Case 3.** $W^L \in (0, cq - p\tau q a^L)$ and $c > p\tau a^L$.

These cases are also illustrated in Table 2.6 in Section 2.10 of the Appendix.

Given case 1-3, we derive the best response function for country i. The following lemma describes the properties of the best response function.

Lemma 2.9.1. *When the countries are symmetric in their university qualities ($q_1 = q_2$), given cases $1-3$ and the screening policy-tuition fee pair of country j, country i's best response function can be described by three threshold curves on (π_w, π_a) plane. These threshold curves are denoted by $\lambda_1(t_j), \lambda_2(t_j), \lambda_3(t_j)$, such that:*

- *at λ_1, country i is indifferent between two tuition fee options: $t_i = \overline{t}^L$ and $t_i = W^L$;*
- *at λ_2, country i is indifferent between two tuition fee options: $t_i = \overline{t}^H$ and $t_i = W^L$;*
- *at λ_3, country i is indifferent between two tuition fee options: $t_i = \overline{t}^H$ and $t_i = \overline{t}^L$.*

Furthermore, the following property holds:

$$\begin{cases} \lambda_1(.|t_j'') < \lambda_1(.|t_j') \\ \lambda_2(.|t_j'') < \lambda_2(.|t_j') \\ \lambda_3(.|t_j'') < \lambda_3(.|t_j') \end{cases} \tag{D.4}$$

where t_j'' and t_j' stand for tuition fees charged by country j and $t_j'' > t_j'$. The best response function and the threshold curves for country i when $(S_j, t_j) = (0, \overline{t}^H)$ are depicted in Figure 2.3 in Section 2.10 of the Appendix.

To illustrate a proof of lemma D.4, we assume that $W^H > \rho q a^H - \Delta^H$ and consider only case 2. Note that given cases 1-3 and three available tuition fee choices for country 2, there are 9 distinct cases and, therefore, 27 objective functions to analyze. For illustration we only show derivations in which $(S_2, t_2) = (0, W^L)$. The logic of the remaining objective functions is similar to the example presented below.[18]

We enlist the objective functions of country 1 conditional for $(S_2, t_2) = (0, W^L)$ for case 2.

$$R_1^{sym}(S_1 = 0, t_1 = \rho q a^H - \Delta^H | S_2 = 0, t_2 = W^L) = \frac{\pi_w \pi_a (m + W^L - \rho q a^H + \Delta^H)((p\tau + \rho)a^H - c)q - \Delta^H)}{2m}. \tag{D.5}$$

[18] Complete functional forms of these 27 expressions and complete derivations are available upon request.

$$R_1^{sym}(S_1=0,t_1=\rho q a^L-\Delta^L|S_2=0,t_2=W^L)= \\ \frac{\pi_w(m+W^L-\rho q a^L+\Delta^L)(p\tau(\pi_a a^H+(1-\pi_a)a^L q+\rho q a^L-cq-\Delta^L)}{2m}. \tag{D.6}$$

$$R_1^{sym}(S_1=0,t_1=W^L|S_2=0,t_2=W^L)= \\ \frac{m(p\tau(\pi_a a^H+(1-\pi_a)a^L)q+W^L-cq)}{2m}. \tag{D.7}$$

To prove the existence of threshold curves $\lambda_1(.|S_2,t_2)$-$\lambda_3(.|S_2,t_2)$, we note that the objective functions from equations (D.5)-(D.7) are monotonic in π_a and π_w. Using the assumption that the value of m is sufficiently large (assumption 2.5), we evaluate differences of these objective functions at the boundaries of π_a and π_w below.

$R_1^{sym}(S_1=0,t_1=\rho q a^H-\Delta^H|S_2=0,t_2=W^L)-R_1^{(2)}(S_1=0,t_1=\rho q a^L-Delta^L|S_2=0,t_2=W^L)=$

$$\begin{cases} 0 & \text{if } \pi_w=0 \ \& \ \forall \ \pi_a \\ -\frac{(m+W^L-\rho q a^L+\Delta^L)((p\tau+\rho)a^L-c)q-\Delta^L)}{2m}<0 & \text{if } \pi_w=1 \ \& \ \pi_a=0 \\ \frac{(\rho q-\underline{q})(a^H-a^L)(m+W^L-((\rho+p\tau)a^H+\rho a^L-c)q+\Delta^H+\Delta^L}{2m}>0 & \text{if } \pi_w=1 \ \& \ \pi_a=1. \end{cases} \tag{D.8}$$

$R_1^{sym}(S_1=0,t_1=\rho q a^H|S_2=0,t_2=W^L)-R_1^{(2)}(S_1=0,t_1=W^L|S_2=0,t_2=W^L)=$

$$\begin{cases} -\frac{1}{2}(W^L+p\tau q a^L-cq)<0 & \text{if } \forall \ \pi_w \ \ and \ \ \pi_a=0 \\ -\frac{1}{2}(W^L+p\tau q a^H-cq)<0 & \text{if } \pi_w=0 \ \ and \ \ \pi_a=1 \\ \frac{(\rho q a^H-\Delta^H-W^L)(m-(p\tau+\rho)a^H-c)q+\Delta^H)}{2m}>0 & \text{if } \pi_w=1 \ \ and \ \ \pi_a=1. \end{cases} \tag{D.9}$$

$R_1^{sym}(S_1=0,t_1=\rho q a^L-\Delta^L|S_2=0,t_2=W^L)-R_1^{(2)}(S_1=0,t_1=W^L|S_2=0,t_2=W^L)=$

$$\begin{cases} -\frac{1}{2}(W^L+p\tau q a^L-cq<0 & \text{if } \pi_w=0 \ \ and \ \ \pi_a=0 \\ -\frac{1}{2}(W^L+p\tau q a^H-cq)<0 & \text{if } \pi_w=0 \ \ and \ \ \pi_a=1 \\ \frac{(\rho q a^L-\Delta^L-W^L)(m-((p\tau+\rho)a^L-c)q)+\Delta^L}{2m}>0 & \text{if } \pi_w=1 \ \ and \ \ \pi_a=0 \\ \frac{(\rho q a^L-\Delta^L-W^L)(m-(p\tau a^H+\rho a^L-c)q+\Delta^L)}{2m}>0 & \text{if } \pi_w=1 \ \ and \ \ \pi_a=1. \end{cases} \tag{D.10}$$

Equations (D.8)-(D.10) and the monotonicity of the objective functions proves the existence of $\lambda_1(.|S_2,t_2)$-$\lambda_2(.|S_2,t_2)$. Specifically, for case (2) and $S_2=0,t_2=W^L$, the functional forms of these thresholds, denoted by $\lambda_1^W,\lambda_2^W,\lambda_3^W$, can be written as follows:

$$\lambda_1^W(.|S_2=0,t_2=W^L)=\big(cq(m(1-\pi_w)-\pi_w(\Delta^L+W^L-\rho q a^L))+ \\ \pi_w(\Delta^L+W^L-\rho q a^L)(a^H q(\rho+p\tau)-\Delta^L)-m(W^L+\Delta^L\pi_w+q a^H(p\tau-\pi_w(\rho+p\tau))))\big)/ \\ \big((a^H-a^L)p\tau q(m-m\pi_w-\pi_w(\Delta^L+W^L-\rho q a^H))))\big). \tag{D.11}$$

$$\lambda_2^W(.|S_2=0,t_2=W^L)= \frac{m(p\tau q a^L+W^L-cq)}{\pi_w(m+W^L-\rho q a^H+\Delta^H)((p\tau+\rho)a^H q-cq-\Delta^H)-mp\tau q(a^H-a^L)}. \tag{D.12}$$

$$\lambda_3^W(.|S_2=0,t_2=W^L)=\big(m+W^L-\rho q a^L+\Delta^L\big)\big((p\tau+\rho)a^L q-cq-\Delta^L\big)/ \big(q(p\tau a^L(\Delta^L+m+W^L-\rho q a^L)+a^H(m\rho+\rho W^L-p\tau\Delta^L+p\tau\rho q a^L))-\rho q^2(a^H)^2(\rho+p\tau) -cq(m+W^L-\rho q a^H)-\Delta^2(a^H)-\Delta^H(m+cq+W^L-2\rho q a^H-p\tau q a H)\big). \tag{D.13}$$

Similarly, one can derive the threshold curves conditional on $(S_2=0,t_2=\rho q a^L-\Delta^L)$ and $(S_2=0,t_2=\rho q a^H-\Delta^H)$, denoted by $(\lambda_1^L,\lambda_2^L,\lambda_3^L)$ and $(\lambda_1^H,\lambda_2^H,\lambda_3^H)$, respectively. The property described in equation (D.4) follows from the assumption that m is sufficiently large (assumption 2.5) after some tedious algebra.

Then we can characterize the Nash Equilibria by plotting all nine threshold curves for each case 1-3. The analysis of the segments generated by these nine lines leads to the complete characterization of the Nash Equilibrium, which is described in Table 2.7 and Figure 2.5 in Section 2.10 of the Appendix.

□

Proposition 2.4.2

Proof. To prove proposition 2.4.2, we develop the following lemma.

Lemma 2.9.2. *When the countries are asymmetric in their university qualities ($q_1>q_2$), similar to the symmetric case, there exists threshold curves $\lambda_{i1}(t_j)^{As},\lambda_{i1}(t_j)^{As},\lambda_{i1}(t_j)^{As}$ for countries $i=1,2$. Moreover, the following conditions holds for the high-quality country:*

$$\begin{cases} \frac{d\lambda_{11}^{As}(.|t_2)}{dq_1}<0 & \text{for case 1}\\ \frac{d\lambda_{11}^{As}(.|t_2)}{dq_1}>0 & \text{for cases 2 and 3}\\ \frac{d\lambda_{12}^{As}(.|t_2)}{dq_1}<0 & \\ \frac{d\lambda_{13}^{As}(.|t_2)}{dq_1}<0. & \end{cases} \tag{D.14}$$

That is, given the tuition fee of the low-quality country, an increase in the education quality differential causes shifts in the threshold curves, which induces a weak increase in the tuition fees charged by the high-quality country.

To prove lemma 2.9.2, we consider the best response function for the high-quality country. Similar to the symmetric quality case, below we only demonstrate calculations for country 1 under case 2 and conditional on $(S_2,t_2)=(0,W^L)$. The logic for the remaining cases is similar to the example presented below.

The objective functions of country 1 are as follows:

$$R_1^{As}(S_1=0,t_1=\rho q_1 a^H-\Delta^H|S_2=0,t_2=W^L)= \\ \frac{\pi_w\pi_a(m+W^L-\rho q_2 a^H+\Delta^H)((\rho+p\tau)a^H-c)q_1-\Delta^H)}{2m}, \tag{D.15}$$

$$R_1^{As}(S_1=0,t_1=\rho q_1 a^L-\Delta^L|S_2=0,t_2=W^L)= \\ \frac{\pi_w(\pi_a(m+W^L+(q_1a^H-q_1a^L-q_2a^H)\rho+\Delta^L)(\rho a^L+p\tau a^H-c)q_1-\Delta^L}{2m} \\ +\frac{\pi_w(1-\pi_a)(\Delta^L+m+W^L-\rho q_2 a^L)(((\rho+p\tau)a^L-c)q_1-\Delta^L)}{2m}, \tag{D.16}$$

$$R_1^{As}(S_1=0,t_1=W^L|S_2=0,t_2=W^L)=\big(\pi_a(m+a^H(q_1-q_2)\rho)(W^L-cq+a^H pq_1\tau)+ \\ +(1-\pi_a)(m+a^L(q_1-q_2)\rho)(W^L-cq_1+a^L pq_1\tau)\big)/(2m) \tag{D.17}$$

Using equations (D.15)-(D.17), one can derive threshold curves $\lambda_{i1}^{As}(t_j),\lambda_{i2}^{As}(t_j),\lambda_{i3}^{As}(t_j)$ and prove lemma 2.9.2 after some tedious algebra. Figure 2.3 in Section 2.10 of the Appendix depicts threshold curves $\lambda_{i1}^{As}(W^L),\lambda_{i2}^{As}(W^L),\lambda_{i3}^{As}(W^L)$, which are denoted by $\lambda_{i1}^{As,W},\lambda_{i2}^{As,W},\lambda_{i3}^{As,W}$.

The existence of $\overline{\pi}_w$ can be illustrated by considering an extreme case when $\pi_w=0$. It immediately follows that $R_i^{As}(S_1=0,t_1=\rho q_1 a^L-\Delta^H)=0$ and $R_i^{As}(S_1=0,t_1=\rho q_1 a^L-\Delta^L)=0$ for countries $i=1,2$, which implies that both countries will set the lowest fees $t_1=t_2=W^L$. The existence of $\overline{\pi}_w$ follows from the fact that functions $R_i^{As}(S_1=0,t_1=\rho q_1 a^L-\Delta^H)-R_i^{As}(S_1=0,t_1=W^L)$ and $R_i^{As}(S_1=0,t_1=\rho q_1 a^L-\Delta^L)-R_i^{As}(S_1=0,t_1=W^L)$ are monotonic in π_w and positive when $\pi_w=1$.

The Nash equilibria are depicted in Figure 2.4 in Section 2.10 of the Appendix.

□

Proposition 2.4.3

Proof. Similar to the symmetric equilibrium derivation, we first derive the best response function of country i and depict it on a graph with π_w and π_a. Then, we plot the best response functions for both countries for all three cases to characterize the Nash Equilibrium.

For the derivation of the best response functions, we sketch the objective functions for the unconstrained country below. For illustration, we assume that $c>p\tau a^L$ and analyze case 2.

From equations (2.11) and (2.13) it follows that constrained country 2 sets the screening policy. Then, the objective functions of country 1 become:

$$R_1^{sc1}(S_1=0, t_1=\rho q a^H-\Delta^H | S_2=0, t_2=0)= \\ \frac{\pi_w \pi_a (m-a^H q^h \rho+\Delta^H)(((\rho+p\tau)a^H-c)q-\Delta^H)}{2m} \tag{D.18}$$

$$R_1^{sc1}(S_1=0, t_1=\rho q a^L-\Delta^L | S_2=0, t_2=0)= \\ \pi_w\Big(\frac{\pi_a(m-\rho q a^L+\Delta^L)((\rho a^L+p\tau a^H-c)q-\Delta^L)}{2m}+ \\ \frac{(1-\pi_a)((\rho a^L+p\tau a^L-c)q-\Delta^L)}{2}. \tag{D.19}$$

$$R_1^{sc1}(S_1=0, t_1=W^L | S_2=0, t_2=0)=\frac{\pi_a(m-W^L)(W^L-cq+p\tau q a^H)}{2m}+ \\ \frac{(1-\pi_a)(m-\Delta^L-W^L+\rho q a^L)(W^L+p\tau q a^L-cq)}{2m}. \tag{D.20}$$

Following similar calculations as presented in the symmetric case, one can derive the functional forms for threshold curves $\lambda_1^0, \lambda_2^0, \lambda_3^0$. Plotting these threshold curves will characterize the best response for the unconstrained country. Given that the constrained country's tuition fee is fixed at zero, the complete characterization of the Nash Equilibrium is straightforward. The complete characterization of the equilibria can be found in Table 2.8 and Figure 2.6 in Section 2.10 of the Appendix. Type II_2 corresponds to the Nash equilibrium described in proposition 2.4.3.

□

Proposition 2.4.4

Proof. Similar to the symmetric equilibrium derivation, we first derive the best response function of country i and depict it on a graph with π_w and π_a. Then, we plot the best response functions for both countries for all three cases to characterize the Nash Equilibrium.

According to equations (2.15), country 2 (the constrained country) chooses the optimal screening policy-tuition fee pair from the two following options: $(S_2^*, t_2^*)=(1, \overline{t}^H)$ and $(S_2^*, t_2^*)=(1, W^L)\}$. The respective functional forms for country 1 threshold values $(\lambda_{11}^H, \lambda_1 2^H, \lambda_{13}^H)$ and $(\lambda_{11}^W, \lambda_{12}^W, \lambda_{13}^W)$ are derived by using a similar approach to the one employed in the symmetric case.

Below we describe the objective functions for country 2. Case 2 is considered for illustration.

$$R_2^{sc2}(S_2=1, t_2=\rho q a^H-\Delta^H | S_1=0, t_1=\rho q a^H-\Delta^H)= \\ \frac{\pi_w \pi_a((p\tau a^H+\rho a^H-c)q-\Delta^H)}{2}. \tag{D.21}$$

$$R_2^{sc2}(S_2=1, t_2=W^L|S_1=0, t_1=\rho q a^H-\Delta^H)= \frac{\pi_a(m+\rho q a^H-W^L-\Delta^H)(p\tau a^H q+W^L-cq)}{2m}. \tag{D.22}$$

$$R_2^{sc2}(S_2=1, t_2=\rho q a^H-\Delta^H|S_1=0, t_1=\rho q a^L-\Delta^L)= \frac{\pi_w\pi_a(m-(\rho q-\underline{q})(a^H-a^L))((p\tau a^H+\rho a^H-c)q-\Delta^H)}{2}. \tag{D.23}$$

$$R_2^{sc2}(S_2=1, t_2=W^L|S_1=0, t_1=\rho q a^L-\Delta^L)= \frac{\pi_a(m+\rho q a^H((1-\pi_w)+\pi_w\rho q a^L-(1-\pi_w)\Delta^H-\pi_w\Delta^L)-W^L)(p\tau a^H q+W^L-cq)}{2m}. \tag{D.24}$$

$$R_2^{sc2}(S_2=1, t_2=\rho q a^H-\Delta^H|S_1=0, t_1=W^L)= \frac{\pi_w\pi_a(m-(\rho q a^H-W^L-\Delta^H))((p\tau a^H+\rho a^H-c)q-\Delta^H)}{2}. \tag{D.25}$$

$$R_2^{sc2}(S_2=1, t_2=W^L|S_1=0, t_1=W^L)= \frac{\pi_w\pi_a q(p\tau a^H+\frac{W^L}{q}-c)}{2}. \tag{D.26}$$

Combining equations (D.21)-(D.22), (D.23)-(D.24), (D.25)-(D.16) lead to derivation of country 2 threshold curves λ_{21}^H, λ_{21}^L, and λ_{21}^W. Similar to the symmetric case, one can derive country 1 threshold curves λ_{11}^H- λ_{13}^H, λ_{11}^L- λ_{13}^L, λ_{11}^W- λ_{13}^W. Plotting these threshold curves for both countries for three scenarios leads to a characterization of the Nash Equilibrium. The complete characterization of the equilibrium is presented in Figure 2.7 and Table 2.9 in Section 2.10 of the Appendix. The Nash Equilibrium described in proposition 2.4.4 corresponds to type III_4 and sub-type d_8 equilibrium.

□

Numerical Example

Below we describe the calibration process. Note that, given thirteen equations and fifteen parameters to calibrate, we will have two degrees of freedom. Therefore, we keep π_w π_a as variable parameters in our exercise.

The derivation is as follows. First, we express all parameter values as functions of π_w and/or π_a. Second, we check under which conditions assumptions 2.1-2.5 are satisfied. Third, we derive the objective functions for both scenarios and plot the results on a graph.

From equations (2.17), (2.18), and (2.20) it follows that, a^H, a^L and W^L should have the following functional forms:[19]

$a^H = \frac{40(Gini^{Earnings}+\pi_a)}{\pi_a}$

[19]For the Gini coefficient derivation, refer to Figure 2.8 in Section 2.10 of the Appendix.

$a^L = \frac{40(1-Gini^{Earnings}-\pi_a)}{1-\pi_a}$

$W^L = \frac{W^H \pi_w (1-Gini^{Wealth})-\pi_w}{Gini^{Wealth}+(1-Gini^{Wealth})\pi_w+\pi_w^2}$.

Second, we pin down the range of parameter values of π_w and π_a, for which assumptions 2.1-2.5 hold. These assumptions can be rewritten as follows:

Assumption 1. $(1-\tau)-\beta(1-\tau^D) = 0.19 > 0$; $\beta q - \underline{q} = 0.75 > 0$.

Assumption 2. $(p\tau+\rho)a^L q - \Delta^L - cq = \frac{9-15\pi_a}{1-\pi_a} > 0 \ \forall \ \pi_a < 0.5$.

Assumption 3. $c - p\tau a^H = \frac{-0.5-0.625}{\pi_a} < 0$.

Assumption 4. $W^H - (\rho q a^L - \Delta^L) = \frac{4.875+3.5\pi_a}{(1-\pi_a)} > 0$.

Assumption 5. $m - ((2\rho a^H + p\tau a^H - \rho a^L - c)q - 2\Delta^H + \Delta^L) = \frac{8.875-81\pi_a+75\pi_a^2}{\pi_a(1-\pi_a)} > 0$ if $\pi_a \in [0.12, 0.5)$.

Therefore, for assumptions 2.1-2.5 to hold, $\pi_a > 0.12$.

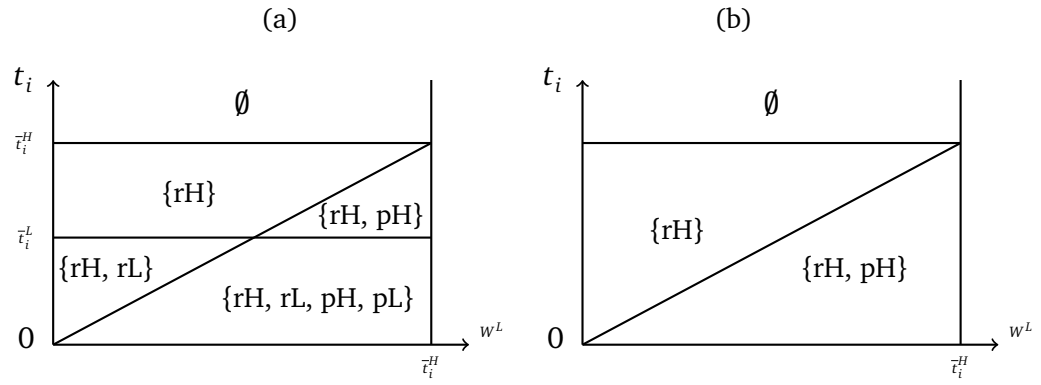
Third, we derive the objective functions for each for each scenario. To derive the objective functions, we first need to identify the sign of $c - p\tau a^L$ and which case 1-3 is relevant to our parameter assumptions, as the objective functions differ for each case. First, from parametric assumptions it immediately follows that $c - p\tau a^L = \frac{1-4\pi_a}{8(1-\pi_a)} > 0$ for all values of π_a. Second, it holds that $\rho q a^L - \Delta^L > W^L > (cq - p\tau q a^L)$ for $\pi_w \in [0.1, 0.46]$, which is equivalent of case 2. Given that the type of equilibrium we are seeking occurs when the fraction of rich students is moderate, we only need to analyze the situation in which $\pi_w \in [0.1, 0.46]$, or case 2.

We omit tedious derivations and note that all the calculations follow similar steps as described by equations (D.18)-(D.26) for case 2. After plugging in the parameter values from the assumptions, one can calculate the objective functions for both countries and arrive at the results depicted in Figure 2.1 in Section 2.10 of the Appendix.

2.10 Appendix E

Tables and Figures

Figure 2.2: The Set of the Types of Students who *Can Afford* to Study in Country i, *Are not Screened Out* from Country i and *Prefer to Study in Country i* over Remaining at Home when (a) There is no Screening Policy ($S_i = 0$); (b) There is a Screening Policy ($S_i = 1$)



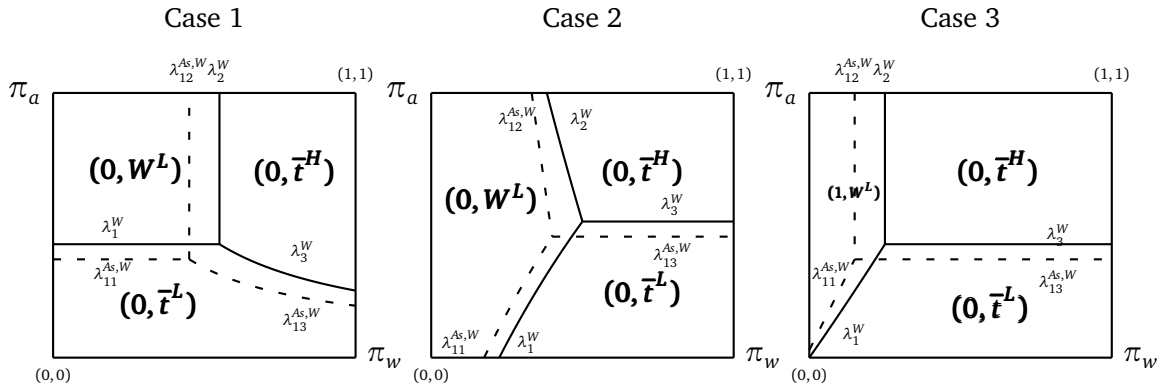
Notes: $\bar{t}_i^H = min(\rho q_i a^H - \Delta^H, W^H)$ and $\bar{t}_i^L = \rho q_i a^L - \Delta^L$.

Table 2.6: Symmetric Education Qualities. Characterization of the Group of Students ($G_i(S_i, t_i)$) given the Tuition Fee and the Screening Policy of Country i

Case	**Range**	$\mathbf{t_i}$	$\mathbf{S_i}$	$\mathbf{G_i(S_i, t_i)}$
Case 1	$W^L \in [\bar{t}^L, \bar{t}^H]$	$\bar{t}^H$	0	$\{rH\}$
		W^L	0	$\{rH, pH\}$
		$\bar{t}^L$	0	$\{rH, rL, pH, pL\}$
Case 2	$W^L \in (cq - p\tau q a^L, \bar{t}^L)$	$\bar{t}^H$	0	$\{rH\}$
		$\bar{t}^L$	0	$\{rH, rL\}$
		W^L	0	$\{rH, rL, pH, pL\}$
Case 3	$W^L < cq - p\tau q a^L$ and $c > p\tau a^L$	$\bar{t}^H$	0	$\{rH\}$
		$\bar{t}^L$	0	$\{rH, rL\}$
		W^L	1	$\{rH, pH\}$

Notes: $\bar{t}^H = min(\rho q a^H - \Delta^H, W^H)$ and $\bar{t}^L = \rho q a^L - \Delta^L$.

Figure 2.3: Symmetric and Asymmetric Education Qualities: Best Response Function $(S_i^{BR}(0, W^L), t_i^{BR}(0, W^L))$ for Different Values of W^L, c, π_a, π_w



— Symmetric Qualities: Both Countries

- - Asymmetric Qualities: High-Quality Country (Country 1)

Notes: $\bar{t}^H = min(\rho q a^H - \Delta^H, W^H)$ and $\bar{t}^L = \rho q a^L - \Delta^L$; cases 1-3 are defined in table 2.6.

Figure 2.4: Asymmetric Educational Qualities $(q_1 > q_2)$: Nash Equilibrium for Different Values of W^L, c, π_a, π_w

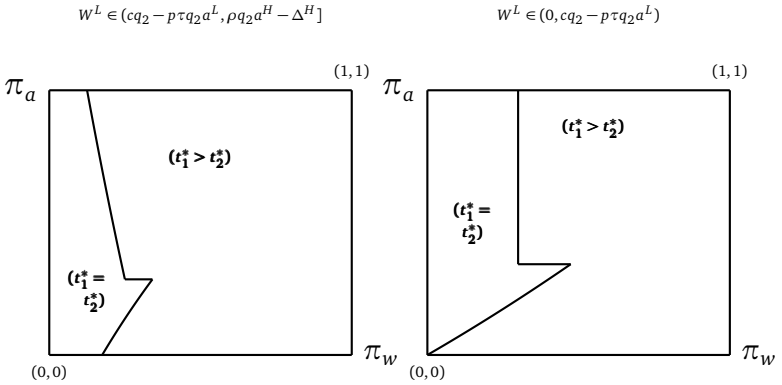


Table 2.7: Symmetric Educational Qualities (No Constraint): Nash Equilibrium for Different Values of W^L, c, π_a, π_w

Type	**Sub-type**	$\mathbf{t_1^*}$ vs. $\mathbf{t_2^*}$	$(\mathbf{S_1^*}, \mathbf{S_2^*})$	$\mathbf{N_1^*}$ vs. $\mathbf{N_2^*}$	$\mathbf{G_1^*}$	$\mathbf{G_2^*}$	**Case**	c	$\pi_\mathbf{a}$	$\pi_\mathbf{w}$
1	**1**	$t_1^* = t_2^*$	$(1,1)$	$N_1^* = N_2^*$	$\{rH, pH\}$	$\{rH, pH\}$	$\{3\}$	$c > p\tau a^L$	high	low
2	**2-1**	$t_1^* = t_2^*$	$(0,0)$	$N_1^* = N_2^*$	$\{rH\}$	$\{rH\}$	$\{1,2,3\}$	all values	high	high
2	**2-2**	$t_1^* = t_2^*$	$(0,0)$	$N_1^* = N_2^*$	$\{rH, pH\}$	$\{rH, pH\}$	$\{1\}$	all values	high	low
2	**2-3**	$t_1^* = t_2^*$	$(0,0)$	$N_1^* = N_2^*$	$\{rH, rL\}$	$\{rH, rL\}$	$\{2,3\}$	all values	low	high
2	**2-4**	$t_1^* = t_2^*$	$(0,0)$	$N_1^* = N_2^*$	$\{rH, rL, pH, pL\}$	$\{rH, rL, pH, pL\}$	$\{1,2\}$	all values	low	low

Notes: N_i^* stands for the total fraction of students studying in country i, such that $N_i^* = \sum_{g \in G_i(S_i^*, t_i^*)} \alpha_i^*$; cases 1-3 are defined in table 2.6.

Table 2.8: Symmetric Educational Qualities (Scenario 1): Nash Equilibrium for Different Values of W^L, c, π_a, π_w

Type	**Subtype**	$\mathbf{t_1^*}$ vs. $\mathbf{t_2^*}$	$(\mathbf{S_1^*}, \mathbf{S_2^*})$	$\mathbf{N_1^*}$ vs. $\mathbf{N_2^*}$	$\mathbf{G_1^*}$	$\mathbf{G_2^*}$	**Case**	c	$\pi_\mathbf{a}$	$\pi_\mathbf{w}$
$\mathbf{II_1}$	$\mathbf{b_1}$	$t_1^* > t_2^*$	$\mathbf{(0,0)}$	$N_1^* < N_2^*$	$\{rH\}$	$\{rH, rL, pH, pL\}$	$\{1,2\}$	$c \leq p\tau a^L$	high	high
$\mathbf{II_1}$	$\mathbf{b_2}$	$t_1^* > t_2^*$	$\mathbf{(0,0)}$	$N_1^* < N_2^*$	$\{rH, pH\}$	$\{rH, rL, pH, pL\}$	$\{2\}$	$c \leq p\tau a^L$	high	low
$\mathbf{II_1}$	$\mathbf{b_3}$	$t_1^* > t_2^*$	$\mathbf{(0,0)}$	$N_1^* < N_2^*$	$\{rH, rL\}$	$\{rH, rL, pH, pL\}$	$\{2\}$	$c \leq p\tau a^L$	low	high
$\mathbf{II_1}$	$\mathbf{b_4}$	$t_1^* > t_2^*$	$\mathbf{(0,0)}$	$N_1^* < N_2^*$	$\{rH, rL, pH, pL\}$	$\{rH, rL, pH, pL\}$	$\{1,2\}$	$c \leq p\tau a^L$	low	low
$\mathbf{II_2}$	$\mathbf{c_1}$	$t_1^* > t_2^*$	$\mathbf{(0,1)}$	$N_1^* < N_2^*$	$\{rH\}$	$\{rH, pH\}$	$\{1,2,3\}$	$c > p\tau a^L$	high	high
$\mathbf{II_2}$	$\mathbf{c_2}$	$t_1^* > t_2^*$	$\mathbf{(0,1)}$	$N_1^* < N_2^*$	$\{rH, pH\}$	$\{rH, pH\}$	$\{2\}$	$c > p\tau a^L$	high	low
$\mathbf{II_2}$	$\mathbf{c_3}$	$t_1^* > t_2^*$	$\mathbf{(0,1)}$	ambiguous	$\{rH, rL\}$	$\{rH, pH\}$	$\{2,3\}$	$c > p\tau a^L$	low	high
$\mathbf{II_2}$	$\mathbf{c_4}$	$t_1^* > t_2^*$	$\mathbf{(0,1)}$	ambiguous	$\{rH, rL, pH, pL\}$	$\{rH, pH\}$	$\{1,2\}$	$c > p\tau a^L$	low	low
$\mathbf{II_3}$	$\mathbf{c_5}$	$t_1^* > t_2^*$	$\mathbf{(1,1)}$	$N_1^* < N_2^*$	$\{rH, pH\}$	$\{rH, pH\}$	$\{3\}$	$c > p\tau a^L$	low	low

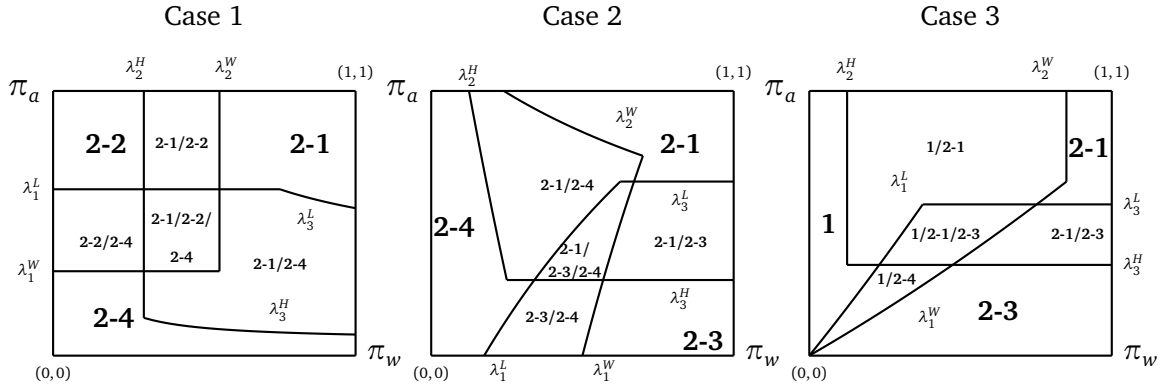
Notes: N_i^* stands for the total fraction of students studying in country i, such that $N_i^* = \sum_{g \in G_i(S_i^*, t_i^*)} \alpha_i^*$; cases 1-3 are defined in table 2.6.

Table 2.9: Symmetric Educational Qualities (Scenario 2): Nash Equilibrium for Different Values W^L, c, π_a, π_w

Type	**Subtype**	$\mathbf{t_1^*}$ vs. $\mathbf{t_2^*}$	$(\mathbf{S_1^*}, \mathbf{S_2^*})$	$\mathbf{N_1^*}$ vs. $\mathbf{N_2^*}$	$\mathbf{G_1^*}$	$\mathbf{G_2^*}$	**Case**	$\pi_\mathbf{a}$	$\pi_\mathbf{w}$
$\mathbf{III_1}$	$\mathbf{d_1}$	$t_1^* = t_2^*$	$(0,1)$	$N_1^* = N_2^*$	$\{rH\}$	$\{rH\}$	$\{1,2,3\}$	high	high
$\mathbf{III_1}$	$\mathbf{d_2}$	$t_1^* = t_2^*$	$(0,1)$	$N_1^* = N_2^*$	$\{rH, pH\}$	$\{rH, pH\}$	$\{1\}$	high	low
$\mathbf{III_1}$	$\mathbf{d_3}$	$t_1^* = t_2^*$	$(0,1)$	$N_1^* > N_2^*$	$\{rH, rL, pH, pL\}$	$\{rH, pH\}$	$\{2\}$	low	high
$\mathbf{III_2}$	$\mathbf{d_4}$	$t_1^* = t_2^*$	$(1,1)$	$N_1^* = N_2^*$	$\{rH, pH\}$	$\{rH, pH\}$	$\{3\}$	low	high
$\mathbf{III_3}$	$\mathbf{d_5}$	$t_1^* \leq t_2^*$	$(0,1)$	$N_1^* > N_2^*$	$\{rH, rL, pH, pL\}$	$\{rH, pH\}$	$\{1\}$	low	low
$\mathbf{III_3}$	$\mathbf{d_6}$	$t_1^* < t_2^*$	$(0,1)$	$N_1^* > N_2^*$	$\{rH, rL, pH, pL\}$	$\{rH\}$	$\{1\}$	low	high
$\mathbf{III_3}$	$\mathbf{d_7}$	$t_1^* < t_2^*$	$(0,1)$	$N_1^* > N_2^*$	$\{rH, rL\}$	$\{rH\}$	$\{2,3\}$	low	high
$\mathbf{III_4}$	$\mathbf{d_8}$	$t_1^* > t_2^*$	$(0,1)$	ambiguous	$\{rH, rL\}$	$\{rH, pH\}$	$\{2,3\}$	low	high & low

Notes: N_i^* stands for the total fraction of students studying in country i, such that $N_i^* = \sum_{g \in G_i(S_i^*, t_i^*)} \alpha_i^*$; cases 1-3 are defined in table 2.6.

Figure 2.5: Symmetric Educational Qualities (No Constraint): Nash Equilibrium for Different Values of W^L, c, π_a, π_w

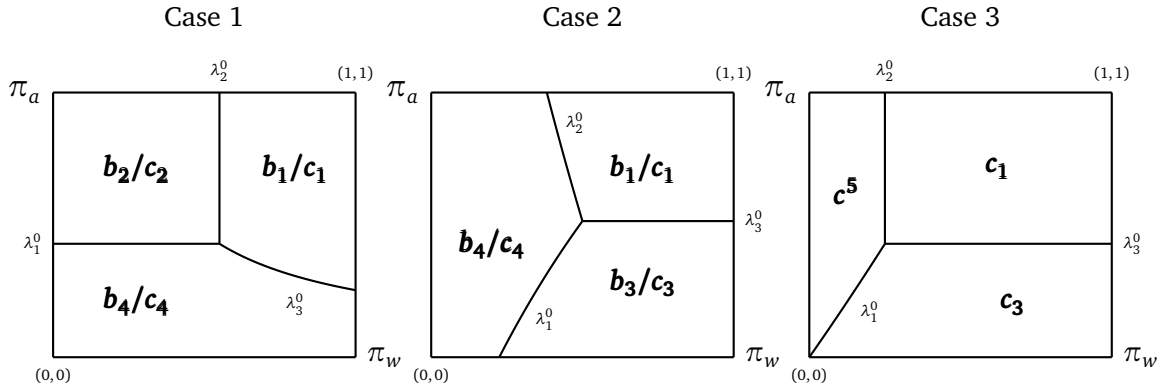


Threshold values $(\hat{\pi}_a^1, \hat{\pi}_a^2, \hat{\pi}_a^3, \hat{\pi}_w^1, \hat{\pi}_w^2, \hat{\pi}_w^3)$ are defined as follows.

- $\hat{\pi}_a^1 = \lambda_1^L$ for case 1, and $\hat{\pi}_a^1 = \lambda_3^L$ for cases 2 and 3.
- $\hat{\pi}_a^2 = \lambda_1^W$ for case 1, $\hat{\pi}_a^2 = 1$ for case 2 and $\hat{\pi}_a^2$ solves $\lambda_2^H(\hat{\pi}_a^2) = \lambda_1^L(\hat{\pi}_a^2)$ for case 3.
- $\hat{\pi}_a^3 = 0$ for case 1 and $\hat{\pi}_a^3 = \lambda_3^H$ for cases 2 and 3.
- $\hat{\pi}_w^1 = \lambda_2^W$ for cases 1 and 3, and $\hat{\pi}_w^1$ solves $\lambda_1^W(\hat{\pi}_w^1) = \lambda_2^W(\hat{\pi}_w^1)$ for case 2.
- $\hat{\pi}_w^2 = \lambda_2^H$ for cases 1 and 3, and $\hat{\pi}_w^2$ solves $\lambda_2^H(\hat{\pi}_w^2) = 1$ for case 2.
- $\hat{\pi}_w^3 = 1$ for case 1 and $\hat{\pi}_w^3$ solves $\lambda_1^W(\hat{\pi}_w^3) = \lambda_3^H(\hat{\pi}_w^3)$ for cases 2 and 3.

Note: cases 1-3 are defined in table 2.6.

Figure 2.6: Symmetric Educational Qualities (Scenario 1): Nash Equilibrium for Different Values of W^L, a^L, π_a, π_w

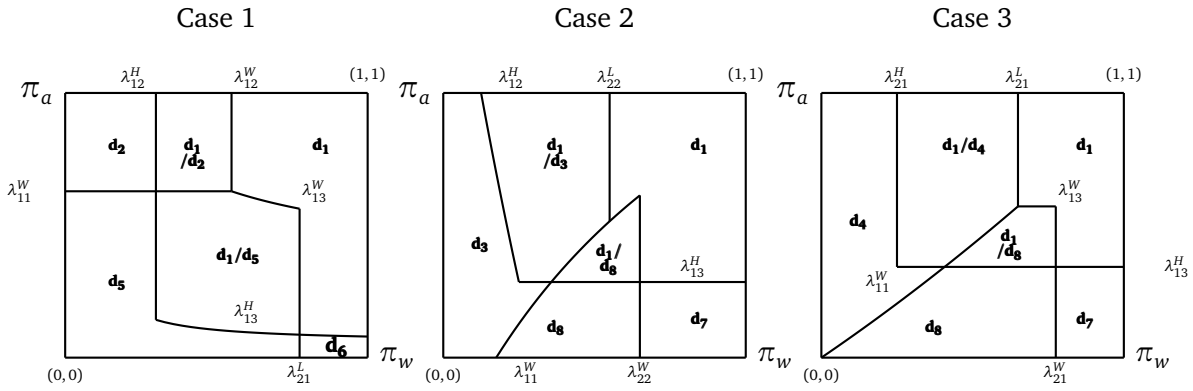


Threshold value $(\tilde{\pi}_w)$ is derived as follows:

$\tilde{\pi}_w = 0$ for cases 1 and 2, and $\tilde{\pi}_w = \lambda_2^0$ for case 3.

Note: cases 1-3 are defined in table 2.6.

Figure 2.7: Symmetric Educational Qualities (Scenario 2): Nash Equilibrium for Different Values of W^L, a^L, π_a, π_w

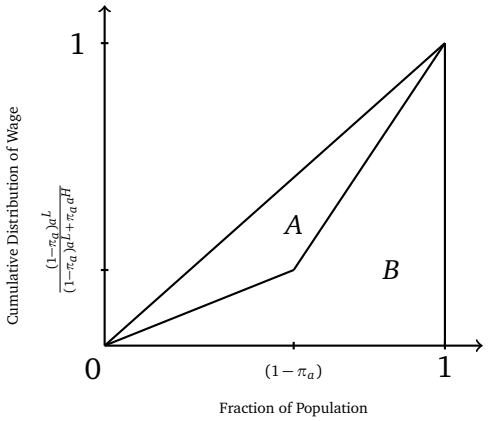


The threshold values ($\tilde{\tilde{\pi}}_a^1, \tilde{\tilde{\pi}}_w^1, \tilde{\tilde{\pi}}_w^2$) are defined as follows.

- $\tilde{\tilde{\pi}}_a^1 = 0$ for case 1, and $\tilde{\tilde{\pi}}_a^1 = \lambda_{13}^H$ for cases 2 and 3.
- $\tilde{\tilde{\pi}}_w^1 = 1$ for case 1, and $\tilde{\tilde{\pi}}_w^1$ solves $\lambda_{11}^W(\tilde{\tilde{\pi}}_{w1}^1) = \lambda_{13}^H(\tilde{\tilde{\pi}}_{w1}^1)$ for cases 2 and 3.
- $\tilde{\tilde{\pi}}_w^2 = 1$ for case 1, $\tilde{\tilde{\pi}}_w^2 = \lambda_{22}^W$ for case 2, and $\tilde{\tilde{\pi}}_w^2 = \lambda_{21}^W$ for case 3.

Note: cases 1-3 are defined in table 2.6.

Figure 2.8: Earnings Gini Calculation



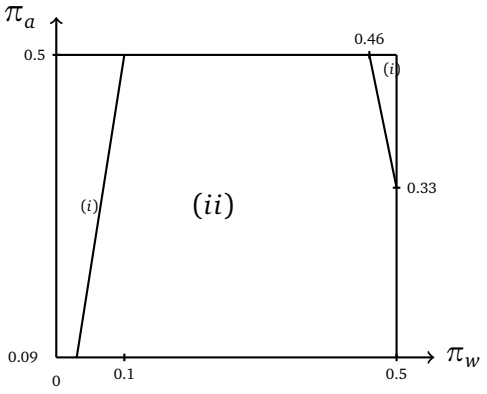
Following the standard text-book definition of the Gini coefficient, the earnings Gini is calculated as the ratio of the area between the Lorenz curve and the perfect equality line. The Lorenz curve represents the correspondence between the fraction of the total income earned and a cumulative fraction of the population of the country. The 45 degree line represents the perfect equality line. Hence, following Figure 2.8 and using geometry, the Gini coefficient for income is $\frac{A}{A+B}$, where

$A+B=\frac{1}{2}$

$B=\frac{(1-\pi_a)^2a^L}{2((1-\pi_a)a^L+\pi_a a^H)}+\frac{(1-\pi_a)\pi_a a^L}{2((1-\pi_a)a^L+\pi_a a^H)}+\frac{\pi_a^2 a^H}{2((1-\pi_a)a^L+\pi_a a^H)}=\frac{a^L(1-\pi_a^2)+a^H\pi_a^2}{2((1-\pi_a)a^L+\pi_a a^H)}.$

Using the expressions for A and B, one immediately derives equation (2.18). A similar calculation is employed for deriving the wealth Gini (equation (2.20)).

Figure 2.9: Numerical Example: Range of Values of π_a and π_w for which (i) $W^L < cq - p\tau q a^L$; (ii) $W^L \geq cq - p\tau q a^L$



Chapter 3

Information, Perceived Returns, and College Major Choices

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3.1 Introduction

College major choices represent an important specialization-specific human capital investment and can largely determine an individual's future earnings and career prospects (Hastings et al. 2013). However, little is known about how students choose college majors (Kirkeboen et al. 2016). A large number of studies have emphasized the roles of factors affecting students' choices, including tastes, parental education, credit constraints, and pecuniary and non-pecuniary benefits. Pecuniary benefits are an important consideration and are largely determined by future salary and employment opportunities. However, many students likely make their major choices based primarily on their subjective beliefs (Arcidiacono et al. 2012 and Montmarquette et al. 2002) as the information on the salaries and unemployment rates for each major may not be perfectly observed by the students. Indeed, a growing body of studies has shown that students do not hold accurate beliefs about earnings conditional on a college major (Betts 1996, Conlon 2020, Jensen 2010, Nguyen 2008, Wiswall and Zafar 2015b). Furthermore, Hastings et al. (2016), Oreopoulos and Dunn (2014), and Wiswall and Zafar (2015a) find that students in Chile, Canada, and the US overestimate returns to post-secondary or higher education. In contrast, Conlon (2020) and Jensen (2010) find that students underestimate returns in the US and the Dominican Republic, respectively. These studies illustrate that there is large heterogeneity in students' perceived earnings.

Due to a dearth of accurate information, students may make suboptimal educational decisions based on perceived potential earnings and employment opportunities. There-

fore, college major choices made under imperfect information may be inefficient for students and the society as a whole.[1] In such settings, policy interventions providing relevant information could help students to make better-informed choices (Bettinger et a. 2012, Conlon 2020, Dinkelman and Martínez 2014, Hastings and Weinstein 2008, Jensen 2010, Nguyen 2008). Nevertheless, little is known about the mechanisms through which information affects students' educational choices.

Using a novel experimental design, we focus on direct and indirect effects of information provision on student college major choices. We extend the literature on educational choices in two ways. Firstly, we investigate the effects of indirect information provision, i.e., allowing for information spillover effects on specialization choices.[2] Secondly, we focus on the immediate (intended) and actual changes in student college major choices in response to the provision of information. A handful of studies consider the immediate effects of information, however, these changes in behavior may not concretely inform real-life choices. For this reason, we study the persistency in terms of both direct and indirect information effects in terms of immediate and actual (final) outcomes. Additionally, we study whether responsiveness to information depends on age. Observing the intended and actual changes for the younger and older students, we discuss possible alternative timing of the information provision and the effectiveness of such interventions.

The experiment was conducted in three rounds in 2017-2019 on tenth and eleventh grade students in Tbilisi, Georgia. At the time of the experiment, tenth grade students had two years to make an actual college major decision, while eleventh grade students had only one year. In the first round, we elicited students' *baseline intended college major choices* and beliefs about the average earnings and unemployment rates of individuals for every field of study, and the same for those workers with no tertiary education. Further, we implemented a belief elicitation mechanism by providing incentives to students to truthfully report their major choices.[3] Then, schools were randomly divided into control and treated groups. A randomly selected half of the classes in the treated schools received information on the population earnings and unemployment figures (direct provision - treatment group). The remaining half in the treated schools were not given any information (indirect provision - spillover group). However, their peers from the same school could pass the information on to them (indirect provision). In the second round, a month after the first round, we surveyed students and collected *revised intended college major choices*. In the third round, we collected their *actual college major choices*.[4] Hence, the two main outcome variables

[1] Information provision could have a stronger impact on choices and efficiency in less developed countries with few or limited possibilities for students to access accurate and relevant information. Information on earnings and unemployment rates are not available in Georgia, rather Georgian Statistical Office publishes wages by industry.

[2] We use the terms specialization and college major choices interchangeably throughout the paper.

[3] We made an announcement that we were sending specific major information to students after the first round (see Section 3.2.3).

[4] We followed up with the eleventh-grade students after a year, while tenth grade students were followed up after two years, when their actual college major choices were finalized.

of the experiment are *the revised intended and actual college major choices*.

This study answers the following key questions: (i) Do students respond to the information provided? Do they hold accurate beliefs about earnings and unemployment? (ii) When is the ideal time to intervene, i.e., is the information more relevant to the older (younger) students? (iii) Does the information have to be provided directly or can it be effectively passed on by other students? This would be easier and less costly for policy makers to implement.[5] (iv) How do the treatment and spillover effects differ in terms of the intended and actual college major choices? (v) What are the channels through which information affects college major choices?

We find that the students in our sample overestimate wages and unemployment rates for all study fields, and underestimate the salaries of individuals with no tertiary education. Using actual major choices data, we find that students with the information we provide are 10 percent more likely to change their actual college majors. Interestingly, the treatment effect is largely driven by the eleventh-grade students. Thus, too early intervention may be less effective. Furthermore, the spillover effect is significant but smaller than the impact of direct information.[6]

The structure of specialization revisions differs when we compare the intended and actual college major choices. 82 percent of the actual choice revisions are made by the students who did not revise their intended choices, i.e., their baseline and revised intended choices were identical. The treatment effect is 1 percentage points smaller in the actual choices sample compared to the intended choices. Unlike the treatment effect, the spillover effect is 3 percentage points higher in the actual choices sample. We argue that studies that consider only immediate effects of an intervention and ignore the final outcomes may not be accurately analyzing treatment effects on real-life decisions.

We find that the differences between the *actual and perceived unemployment rates* have a significant effect on actual major choices. At first glance, this result may be puzzling as these students changed their majors in favor of the specializations with high unemployment rates. Why would students revise their choices in this way? Students' perceived difference between the unemployment rates for the two choices they were considering was large, and so they opted for the major they thought offered significantly better chances of employment.[7] However, when they learned via the informa-

[5] In our experiment, the costs associated with the direct information provision were stemming from transportation costs, labor costs incurred for conducting the survey, and printing the leaflets and questionnaire.

[6] The spillover effect becomes insignificant in the full sample after controlling for covariates. However, the effect remains significant in the subsample of the eleventh-grade students.

[7] Consider a student with a baseline intended major choice of Medical sciences with an unemployment rate of 10%, who ultimately chooses the major 'Exact and Natural sciences', which has a higher unemployment rate of 12.6%. Hence, the actual cost of changing the major in the form of a higher unemployment rate is 2.6% (see Table 3.6, column 4). Prior to the intervention, students perceived that the cost of changing the major in this case was 5%, nearly twice as high in actuality (see Table 3.6, column 5).

tional leaflet that the gap between the two majors was not as large as they imagined, the cost of changing to the major they actually preferred was smaller than they had believed. Initially, this group of students overestimated the potential unemployment cost of changing their major. Thus, revision of the major toward the more desired specialization for these students would not result in a drastic decrease in their employment opportunities. We refer to this as 'the relative unemployment rate channel' to explain the pattern in college major revisions. In addition to this channel, preferences and other unobserved factors must be behind the complex decision-making behavior regarding college majors (Wiswall and Zafar, 2015a).

However, we do not find evidence that students revise their choices toward higher wages or higher expected earnings.[8] same is true for the differences between actual and perceived earnings. This can be explained by the relative importance of actual wages. For instance, a student may not find average earnings data relevant for her future earnings if she considers herself a high-ability student. Alternatively, students may perceive that earnings distributions by major will change considerably by the time they graduate. Third, students may consider average wages less informative as the calculations still include the individuals with the Soviet education. Students may logically assume that a current tertiary education offers better career prospects. There may still be other reasons that the population earnings figures may not necessarily be relevant and informative.

Our study is related to research evaluating the effects of information provision on belief updating and actual educational choices where agents have inaccurate information or hold biased beliefs. In particular, Jensen (2010) finds that high school students in the Dominican Republic underestimate the earnings of individuals who completed secondary school. Provision of information on the true returns to secondary school education[9]had large and significant positive effects on two outcomes – students revised their perceived returns upwards and completed about 0.2-0.35 more years of schooling. Similarly, Nguyen (2008) finds that the intervention improved students' school attendance and average test scores during the first few months following an experiment in Madagascar. Interestingly, Nguyen (2008) shows that a role model (a person from a poor/rich background presenting her/his success story) had a larger impact on student school attendance and performance than statistics provision. Wiswall and Zafar (2015a) show that students updated their beliefs on major-specific salaries after observing true earnings. Perceived earnings and abilities, along with heterogonous tastes, were the main drivers of specialization choices in a sample of New York University undergraduate students. Granguli et al. (2020) show that doctoral students were overly optimistic about their chances on the academic job market and updated their beliefs after information treatment. However, the study does not find any evidence of

[8]Expected earnings are calculated as the product of the wage and employment rate for any given college major. Note that the employment rate equals (1-unemployment rate).

[9]In these studies, actual (true population) salaries and unemployment rates are either given by the respective government statistics bureaus of a country, private organizations, or are calculated by the authors based on household surveys conducted prior to the experiment. The latter is usually used in cases of limited or no data availability (Jensen 2010, Nguyen 2008).

doctoral students changing their subsequent academic career plans (doing a postdoc or deciding on an academic job market placement). Conlon (2020) provided salary information to freshmen students at the Ohio State University. The author finds that 9 percentage points more students in the treatment group chose one of the majors about which they received information than respondents in the control group.

Our results have implications for policymakers – both direct and indirect information provision have effects on intended and actual major choices. Both treatment and spillover effects are driven by older students implying that early interventions are less effective. The treatment effect is consistently stronger than the spillover effect in both actual and intended choice samples. Additionally, we find that the composition of the changes, treatment, and spillover effects vary significantly in the actual and intended choices samples. Further research is needed to complement our findings on immediate and actual changes.

The remainder of the paper is organized as follows. Section 3.2 describes the data and field experiment, Section 3.3 presents the main results, and Section 3.4 concludes.

3.2 Field Experiment

3.2.1 Short Overview of the Georgian Education System

Georgia is a small country in the Caucasus region with a population of 3.7 million and a GDP per capita of $ 9,702 in 2017 (PPP adjusted).[10] The degree of urbanization is 58%. The capital of Georgia, Tbilisi, is the largest city, with a population of 1.1 million, and with over public 250 schools providing elementary, primary, and secondary education.

School education in Georgia consists of elementary (age 6-12), basic (age 12-15), and secondary (age 15-18) studies (Ministry of Education of Georgia). Students receive a Full General Certificate upon passing school-leaving examinations at the end of the twelfth grade. Students with a school-leaving certificate have access to the higher education. University admissions have been centrally administered by the National Assessment and Examination Center (NAEC) of Georgia since 2005. All students wishing to enter accredited universities have to pass standardized written exams conducted by NAEC. Note that entrance examination subjects vary by major. For instance, entering a university with a major in Economics and Business would require a student to pass four examinations: Georgian language and literature, mathematics, general skills, and foreign languages.

The demand for each specialization at accredited universities in 2017 appears in Table A1. The demand for each major is defined as being a student's first desired specialization choice. All accredited Georgian universities were able and willing to admit

[10]World Bank, https://data.worldbank.org/country/georgia [accessed 5 June 2019].

nearly 50,000 students, while there were about 40,000[11] applicants in 2017.[12] We aggregated the various university majors into six groups: (i) exact and natural sciences, (ii) medical sciences, (iii) economics and business, (iv) social sciences, (v) arts and humanities, and (vi) law. According to Table A1, the majority of applicants chose humanities, exact and natural sciences, and economics and business as their first college major choice in 2017.

3.2.2 Data

The experiment was conducted in three rounds in Tbilisi during 2017-2019. In the first round, 2015 students aged between 15 and 17 participated.[13] First round was administered at twenty-two randomly selected schools during regular school hours in April 2017. Students were asked to report their baseline intended college major choices, and their beliefs about what unemployment rates and earnings are for persons with a university diploma in that field. They were also asked to report on their individual and household characteristics in the baseline survey.[14] Each session lasted approximately 55 minutes.

The experiment was conducted on tenth and eleventh grade students. Twelfth grade students who intend to enter a university fill out their university applications in March every year. A student's university application is a combination of specialization and university choices submitted during the final year of secondary school. Although the formal decision about the major choice occurs in March, twelfth grade students make informal decisions at the beginning of their final year of studies. A student's informal major decision results in extensive private tutoring sessions in the subjects required for the unified entrance examinations. It is very common that students and their parents decide to pay additional fees for extensive tuition sessions for courses that are relevant to their college major choices. For instance, 78.3% of the students in our experiment reported that they either already had or intended to have a tutor to prepare for the unified examinations. Tutoring may increase their chances of being admitted to top universities and/or receiving merit-based state scholarships. As expected, the share of such students is higher in the eleventh grade (81.3%) than in the tenth grade (75.9%). This can be explained by the remaining time before the university enrollment - tenth grade students had about two years to go before making their major choices, hence they may have been less certain about their need to have a tutor. In contrast, eleventh grade students are about to start their preparation for the unified entrance examinations over the final year of their studies in a secondary school (twelfth grade). Accord-

[11] The number of applicants includes all students who were registered for standardized written exams conducted by NAEC and were applying for a university program in Georgia. It is impossible to know whether these students also apply to study programs abroad.

[12] Note that in countries where the demand exceeds supply, students might not be able to "freely" change the majors due to stringent competition and the effect of information provision might not be as prominent as in our experiment.

[13] Note that two students 18 years old.

[14] See Section 3.7.3 of the Appendix.

ing to common practice, eleventh grade students and their parents usually search for tutors in the spring and summer for the upcoming September.[15]

A second survey of the students was conducted one month later (May 2017). Similar to first round, students were again asked to report their specialization choices; we refer to these second round choices as *revised intended college major choices*. The first and second round surveys were conducted using a pen and a paper. A third follow-up survey on major choices was conducted in September 2018 and 2019, by which time the students' final major choices were realized, i.e., students were admitted to universities.[16] Applicants usually learn about their test scores and university admissions in late August, therefore September was the earliest possibility to track actual college major choices, the real-life outcomes in this case. In the third round, *actual major choices* were collected using telephone and email surveys, as students were no longer in the high schools where the experiment was originally administered.

The timeline of three experimental rounds appears in Table 3.1. Overall, we were able to obtain 95.9% follow-up responses in the May 2017 survey. In the third round, most of the responses were recorded via a phone communication - there were only four email responses that were not documented via phone call. This may be explained by low popularity of email communication, or students might have changed their school email addresses. In our experiment, 1,290 students provided their cell numbers, which is 67.4% of round-two observations.[17] We were able to track a large majority of student major choices. Indeed, the phone response rate was 89.7%. Overall, we were able to obtain follow-up information on 1,157 students in the September 2018 and 2019 phone survey – 27 students reported that they had not applied for the universities at all. Thus, we were able to track 1,130 students and record their major choices three times (baseline intended, revised intended and actual college major choices) for the period of 2017-2019. The overall attrition rate is 42%, hence, we further study whether the attrition is correlated with the treatment or spillover effect. Table 3.17 shows that neither treatment nor spillover effects are correlated with the attrition. However, we find that tenth-grade students are more likely to be missing in the final round (actual choices collection) than the eleventh-grade students. This effect is expected, as we followed up with eleventh- and tenth-grade students after one and two years, respectively.

Tables 3.2, 3.3[18] and 3.4 show that there were no systematic differences in covariates

[15] We did not consider students in their final year of studies (twelfth grade) in our experiment. Twelfth grade students are generally unlikely to change their majors for two reasons. Firstly, they have already attended tutor sessions in the subjects required for the major and hence, there are sunk costs in the form of tuition. Secondly, even if they wanted to change their majors, students would have little time to prepare for the new exam(s) for the different major.

[16] Students were also asked whether their desired major choices were different from the realized university major decisions that are dependent on test scores. Note that none of the students reported that they picked a different major choice due to the insufficient exam scores (Round 3). Thus, all the major choices were students' own decisions and were not driven by their exam scores.

[17] Note that students optionally filled in their cell numbers in the questionnaire in the first round.

[18] We also run the randomization checks in the actual choices sample – we do not find any statistical

across treatment, spillover, and control groups. Table 3.5 reports the school characteristics. These groups differ in terms of the information provision discussed below in detail.

3.2.3 The Intervention

In this section, we describe our experimental design to study the effects of direct and indirect information provision on college major choices. Our three experimental treatment groups differ with respect to the information provided to each group. Firstly, the schools were randomly divided into the control (C) and treated (T) schools. Students in the control schools (C) did not receive any information. Secondly, students in the treated schools were divided in treatment (TT) and spillover groups (TS).[19] Students in the TT group received information on earnings and unemployment rates by specialization; students in the spillover group did not receive any information. The information was provided in the form of a color-printed leaflet to each student in the TT group (The translation of the leaflet can be found in appendix 3.7.2). The leaflets remained with the students. The control group included students from seven schools, and treatment and spillover groups included students from fifteen schools. Classes in each grade in every treated school were randomly divided into treatment and spillover groups. Thus, the randomization unit was at the class level in the treated schools. Note that, for this reason, student characteristics in three experimental groups may differ. Overall, 1,429 students were surveyed in the treated schools and 586 students in the control schools. There were 752 and 677 students in the TT and TS groups. First, students were asked to report their baseline college major choices. Next, we elicited student beliefs about the average earnings and unemployment rates of university graduates from each field and collected other relevant data (baseline survey). After the baseline survey, the intervention took place.

At the end of the first survey session, each student in the TT group was given the information on earnings and unemployment by specialization, calculated by the authors based on a household survey conducted by the statistical office of Georgia in 2015 (see Table 3.6). Overall, 98.52% of the students in the TT group found the information leaflet helpful for their choice of major decisions (see Section 3.7.2 of the Appendix). In the second round, students were asked to state whether they discussed their major choices with their parents. More than 78% of students stated that they discussed their major choices with their parents in all three experimental groups.

To study whether information on earnings and employment affects their choices of major, we track the choices over three rounds – baseline intended, revised intended, and actual college major choices. We first measure the treatment effect by comparing

differences across control, spillover and treatment groups (see Table3.18).

[19]TT- students received an information leaflet in the treated schools; TS – students did not receive an information leaflet in the treated schools. Thus, by our design, students in TT group could reveal information on earnings and unemployment rates to their peers in the spillover group (TS). Note that both TS and TT classes were located in the same school building.

the revision of major choices across the TT and C groups. Further, we examine the major choices revision rate across the TS and C groups, to identify any spillover effects. We incentivized students to truthfully report their baseline major choices. Students were told that they would receive an email with the major specific information. The major specific information included details about university application procedures and deadlines, admission requirements, top universities, and degree of competition (chances of being admitted) for each major. We emphasized that the information was major specific, i.e., students would benefit by indicating their 'truly desired' specialization and would receive relevant information by email. The sample information was shown to students but not distributed at the beginning of the experiment. 98.17% students provided their email addresses and over 99% of students reported that they were interested in the major-specific information to be sent by email later. Thus, our incentivization scheme worked as intended. However, we are aware that some students might still misreport their major choices, particularly those who were less certain about entering the university at all.

Table 3.6 reports average monthly salaries and unemployment rates for each college major choice, including individuals with no university education. Students in the treatment group were provided with the information (see 3.7.2 of the Appendix). The earnings and unemployment figures were accompanied by an explanatory sheet explaining the differences in wages and employment likelihood for each major. Students were informed that they could ask questions straight away or send an email with a question if the leaflet was not clear. On the one hand, providing the unemployment rate could be interpreted as positive news for the students, because they overestimated unemployment for all major choices. On the other hand, providing actual earnings data could be perceived as negative news, because students overestimated wages for every major choice listed.

3.3 Experimental Results

First, we present the differences between student beliefs and actual data to scrutinize the motivation behind their college major choice revisions. Second, we investigate the effect of the information provided on major choices. In particular, we examine the patterns of college major choice revisions in treatment, spillover, and control groups. Third, we investigate channels rationalizing the revision of the major choices.

3.3.1 Perceived Earnings and Unemployment Rates

Do students hold accurate beliefs on earnings and unemployment rates? We start the analysis by presenting the key differences between the perceived and actual figures. Table 3.6 shows actual and perceived mean monthly wages and unemployment rates for individuals with and without tertiary education. First, individuals with a tertiary education earn about 59 percent more than workers with only a high school diploma. However, the difference is only 51 percent when comparing the expected wages that

considers the higher unemployment rate among individuals with a tertiary education. Workers with a university degree in *law, and economics and business administration* earn the most. Second, students systematically overestimate[20] earnings for each major except for the earnings of individuals with no university education. Their overestimation is the highest for individuals with degrees in *medical sciences* and least for graduates in exact and natural sciences. Unlike the findings in Jensen (2010) and Nguyen (2008), students in our sample perceive that returns to tertiary education are large. Overestimation of tertiary education returns could partly explain high enrollment rates in the universities. Unsurprisingly, the percentage of the labor force with tertiary education in Georgia is high, at 31 percent, higher than most advanced European countries. This figure is even more pronounced in urban areas, where every second worker has a higher education diploma (World Bank report 72824, 2013). Students hold nearly accurate beliefs regarding expected earnings for the following specializations: *exact and natural sciences, and arts and humanities*.

Third, students overestimate the unemployment rate for all workers. Students perceive that the highest unemployment is among individuals with no tertiary education, followed by workers with a degree in *arts and humanities*. Interestingly, the perceived unemployment rate (46 percent) for individuals with no university education is 4.5 times higher than the actual unemployment rate (8 percent). In fact, the individuals with no tertiary education have the lowest unemployment rate (Table 3.6).[21] One of the reasons for the overestimated unemployment rates may be connected to the peculiar employment structure in Georgia. Over 50 percent of workers are employed in the agricultural sector - contributing less than ten percent of the country's GDP. Rutkowski describes this strange phenomenon:*"while not contributing substantially to the economy overall, agriculture provides employment of last resort for those who cannot find jobs elsewhere, and eventually work as subsistence farmers"* (World Bank report 72824, 2013). Differences in employment trends are also observed in unemployment rates in the rural and urban areas – the latter being 28 percent, three times higher than in rural areas. This further reinforces the argument of the hidden unemployment in rural areas. Further, unlike the majority of European countries, highly educated individuals are more likely to remain unemployed over the long term in Georgia. For instance, over 40 percent of unemployed individuals have higher education, and highly educated workers account for over 70 percent of the long-term unemployed (World Bank report 72824, 2013).[22]

[20]Note that the beliefs were elicited before we provided the leaflet, to avoid contamination. High perceived returns in our sample can be ascribed to the experimental setting - the experiment was conducted in an urban area, where wages are generally higher than overall country wages.

[21]Rutkowski (2013) argues that a higher unemployment rate among university graduates is due to "overeducation" and a "skills gap" in Georgia. Overeducation implies that there are more persons with a university diploma than is demanded on the market. A "skills gap" implies that the graduates do not have the skills demanded by employers. With regard to unemployment among recent graduates, Rutkowski (2013) reports that the unemployment rate among young workers (15-29) is "...36 percent, more than twice as high as for primeage workers. And young workers (15-29) account for 40 percent of all unemployed."

[22]Individuals are considered long-term unemployed if they have been unemployed longer than twelve

The gap in the unemployment rate between workers with tertiary and secondary education is in sharp contrast with most EU countries. For instance, the EU28 unemployment rate for individuals with tertiary education in 2018 was only 3.9 percent, and 12.5 percent for individuals with no tertiary education.[23] However, workers with tertiary education in Georgia experience higher unemployment (13%) compared to workers with only secondary education (8%). Higher long-term unemployment among educated individuals and systematic underemployment for their skills are associated with losses in investments into human capital. Thus, providing the information about earnings and employment opportunities may help students to make more optimal educational choices.

3.3.2 Changes in the College Major Choices

First, we report the effects of information provision on intended major choices. We document the changes in the intended major choices across control, spillover, and treatment groups. Second, we present changes in the realized (actual) major choices. Our primary analysis is based on actual major choices, as they represent real-life outcomes, i.e., actual major choices collected after university admission decisions. Next, we explore the mechanism explaining the revision of major choices by looking at differences in perceived and actual earnings and unemployment rates for the baseline intended and actual major choices.

Do Students Revise Their Intended Major Choices Upon Observing Actual Earnings and Unemployment Rates? Figure 3.1 shows that students in treatment (TT) and spillover (TS) groups revise their majors more frequently than do their peers in the control schools. Thus, information provision both directly and indirectly alters the main outcome variable to a greater extent in the TT and TS groups than in the control group. Students in the treatment and spillover groups revise their major choices by 11 percent and 4 percent more, respectively, and both effects are significant at 5 percent. Thus, the information has a significant effect on intended college major choices reported by students a month after the intervention. Table 3.7 (columns 3 and 4) shows that the treatment and spillover effects remain robust after controlling for covariates.[24]

Next, we analyze the revision patterns in the treatment and spillover groups across two grades, and notice significant differences. Interestingly, students in the tenth grade, including those in the control group, revise their major choices more than eleventh grade students. This can be explained by less information availability or higher uncertainty about their future major choices. Why do revision rates differ by grade? Eleventh grade students had to decide about college majors within a year and, therefore, they may logically have considered their major choices seriously beforehand and they were more certain about their major choices. This is indicated by relatively lower

months according to ILO.

[23] Retrieved from Eurostat: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190920-1?inheritRedirect=true&redirect=%2Feurostat%2Fhome%3F

[24] The results remain significant in the probit model specification as well (Table 3.7, columns 5-6).

revision rates by the eleventh-grade students. By contrast, tenth grade students had nearly two years to choose a major, so their choices fluctuated more. Overall, the total revision rate across all three experimental groups in the tenth-grade students is 16 percent, compared to 13 percent in the eleventh grade. The revision rate differentials across the two grades is more salient for students in the control group. Indeed, Table 3.7 shows that 9 percent of tenth grade and 5 percent of eleventh grade students in the control group revised their majors. In fact, unstable choices undermined both the treatment and spillover effects in the sample of tenth grade students – the spillover effect is nearly zero; the treatment effect is significant but smaller than the one found in the sample of eleventh grade students. Thus, we conclude that changes in the intended major choices were more pronounced in the eleventh-grade students, and overall changes are also driven by older students.

Next, we present our analysis of the *actual college major choices*. Both treatment and spillover effects are calculated by comparing changes between the actual and baseline intended college major choices. In line with our findings on the intended choices, we find that the treatment effect is positive and statistically significant at the 1 percent level. Figure 3.2 shows that students in the treatment group revise their major choices 10 percent more often than their peers in the control group. Table 3.8 derives similar results – the treatment effect is more pronounced in the sample of eleventh grade students. Overall, the spillover effect is 7 percent and significant at the 10 percent level, however, the effect is stronger at 11 percent and statistically more significant at the 1 percent level among the eleventh-grade students. Furthermore, we find that 47 percent of the tenth-grade students revised their actual majors, compared to 23 percent of the eleventh-grade students. Hence, almost every second tenth grade student revised her/his choice. For this reason, there is a cleaner revision pattern across treatment, spillover and control groups for the eleven grade students. The treatment effect is 14 percent when controlling for covariates (Table 3.8). Thus, both the direct and indirect information have a significant and strong effect on actual specialization choices.

Our results shed light on the intervention's timing. Both treatment and spillover effects are largely driven by the eleventh-grade students. That is, both direct and indirect provision of the information, a year before the university entry date, has a larger impact on actual choices

Now we turn to the revision patterns in terms of the intended and actual changes in the college major choices. Are changes in the actual and intended college major choices consistent with each other; if a student revised her intended choice, did she also revise the actual choice? We find that the structure of revisions differs largely across intended and actual major choice samples. Most students who revised their actual choices compared to baseline, had not changed their intended choices.[25] 82 percent of the changes in the actual major choices were made by students whose baseline intended and revised intended choices were identical.[26] Thus, intended choices are less

[25]Had not changed their intended choices in round 2 but did make a change in round 3.

[26]Note that we recorded 1,913 intended choices (round 2) and 1130 actual major choices (round

suggestive in predicting the effect of information on real-life outcomes. We report the results based on real-life outcomes (actual major choices) below.

Result 1.

Students revise their major choices upon observing actual earnings and unemployment figures. Students with information are 10 percent more likely to revise their actual majors. The effect is significant and robust to all model specifications in the full sample. The treatment effect is more pronounced in the sub-sample of eleventh grade students.

Result 2.

The spillover effect is positive and significant in all model specifications in the subsample of eleventh-grade students, but the effect is insignificant in the whole sample after controlling for covariates. Thus, indirect information provision has a real impact on the choices of the older students.

3.3.3 Determinants of College Major Choice Revisions

Next, we explore the channels that explain the changes in college major choices. Students in the treatment group were given the leaflet displaying the monthly earnings and unemployment figures for each major (Refer to Section 3.7.2 of the Appendix). Existing literature emphasizes the role of expected earnings and employment opportunities when deciding between specializations (Wiswall and Zafar, 2015a). A specialization with higher wages and lower unemployment could make this major more attractive. Provision of the information is a mixture of good and bad news. Intuitively, the earnings statistics can be treated as negative news, as students perceived that wages were higher than the actual ones, however, the unemployment statistics should be treated as positive news, as students largely underestimated graduates' employment chances

Our analysis suggests that changes in the student specialization choices are explained by the differences between the actual and perceived unemployment rates. We refer to this as the *"relative unemployment rate"* channel.

How does this channel rationalize the changes in the college major choices? Consider students who revised their majors from medical sciences (baseline intended choice)

3). Could attrition drive the differences? Table 3.15 shows that there are no significant differences across treatment, spillover, and control groups for the students who did not report their actual choices (participated in the round 2, but did not participate in round 3). Moreover, the means in Table 3.15 are similar to those in Table 3.3. Next, we run an analysis of the intended choices sample on the round three sample and find that the treatment effect is significant but smaller than in the original round 2 sample (Table 3.16). Similarly, the spillover effect is insignificant in the whole sample but positive and significant in the subsample of eleventh-grade students. Thus, we do not find any evidence that attrition drives the differences between the analyses across the revised intended choices and actual choices data. Table 3.17 shows that the attrition is not correlated with the spillover or treatment effects. However, the attrition rate is 10% higher for tenth-grade students, which is intuitive – we tracked actual choices of the tenth-grade students after two years, as opposed to one year for the eleventh-grade students.

to the exact and natural sciences (actual choice). Table 3.6 reports the actual and perceived unemployment rates of individuals with a degree in medical sciences, 10% and 25%, respectively. The same figures for the exact and natural sciences diploma holders are 12.6% and 30%. This implies that the *actual cost*[27] of changing one's major from medical sciences to exact and natural sciences is 2.6%. This is in stark contrast with the perceived costs of the same change – indeed, the *perceived costs* of this change is 5%. Thus, students in our sample overestimated their cost of changing the major in the form of lower employment opportunities. In fact, they only would give up 2.6% if they chose *exact and natural sciences* instead of *medical sciences*. However, they perceived that the revision would be associated with an increase in their unemployment by 5%, much larger than the actual difference, 2.6%.

Figure 3.7 displays the fraction of students who revised their actual major choices toward one with a lower relative unemployment rate, defined as the difference between actual and perceived unemployment rates associated with the actual and baseline intended major choices, respectively.

Figure 3.7 shows the share of students whose revision (college major changes) behavior satisfies the following rule:

$$\Delta U_{Actual} - \Delta U_{Perceived} < 0$$

where U stands for the unemployment rate, and the differences between actual and perceived unemployment rates are defined as follows:

$$\Delta U_{Actual} = U_{Actual}(Actual\ Major) - U_{Actual}(Baseline\ Intended\ Major).$$

$$\Delta U_{Perceived} = U_{Perceived}(Actual\ Major) - U_{Perceived}(Baseline\ Intended\ Major).$$

The following rationale explains the students' revision behavior - they learned that they would not be as much at risk of unemployment as they had previously believed if they changed their majors. We find that a higher share of students follows this pattern in the treatment group than in the control group. Coefficient estimates in Table 3.10 suggest that 20 percent more students in the treatment group revise toward 'lower relative unemployment rate' compared to the control group; the effect is significant at 1 percent.[28] The effect is more pronounced at 30 percent in the sample of eleventh-grade students. Both coefficients remain robust after controlling for the covariates in all model specifications. Unlike with the treatment effect, he 'lower relative unemployment' argument does not explain the effect of indirect provision of information.

Result 3.

The revisions are driven by the differences between the perceived and actual unemployment rates across baseline and actual specialization choices. Therefore, changes in specialization choices can be explained by the differences between the perceived and actual employment opportunities.

[27] Cost is defined as the reduced chance of finding a job, i.e., higher unemployment rate.

[28] Note that the regression analysis is conducted on the sample of students whose actual college major choices differ from the baseline choices ones.

Surprisingly, we find no evidence of earnings explaining changes in the college major choices, i.e., students do not change their specializations toward higher wages. Moreover, we show that students do not change their choices toward majors with higher expected earnings and lower unemployment rates. An extensive analysis of all these channels with reference to appropriate tables and figures can be found in Section 3.8 of the Appendix.

3.4 Conclusion

This paper studies the effects of information provision on the college major choices of high school students in Georgia. We find that information strongly affects educational choices – 10 percent more students in the treatment group chose a different college major after information was provided. Interestingly, the treatment effect is more pronounced in the older students. We implement a novel experimental design and contribute to related literature by measuring the effects of indirect information provision. We find that the spillover effect is significant but smaller than the treatment effect. Similarly to the direct treatment effect, indirect provision of the information mainly affects the choices of older students. Our results suggest that both direct and indirect channels of information provision can be used to nudge individuals' behavior. However, from policy perspective, too-early intervention may be ineffective.

We argue that immediate effects of the information may not be translated into real-life choices. Our findings indicate that immediate changes in the intended choices are not necessarily linked to the final major choices. Interestingly, only 18 percent of the students who initially changed their intended choices did so again at the end, i.e., revised their actual college major choices. We conclude that analyzes based on immediate effects may be less informative of the effects of interventions on real-life outcomes. Further research is needed to supplement our findings on the immediate and actual changes in different experimental settings.

Our paper sheds light on the mechanisms through which information affects students' college major choices. We find that the differences between the actual and perceived unemployment rates have significant effects on major choices. This suggests that some students may have initially overestimated the cost of changing their college major, in the form of high unemployment rate. However, upon observing the information, they learned that actual unemployment is lower than they believed and changed their baseline major choice in the end. We do not find any evidence that students revise their choices toward majors associated with higher wages, higher expected earnings, or lower unemployment rates. Further, the differences between the actual and perceived earnings do not explain the revisions.

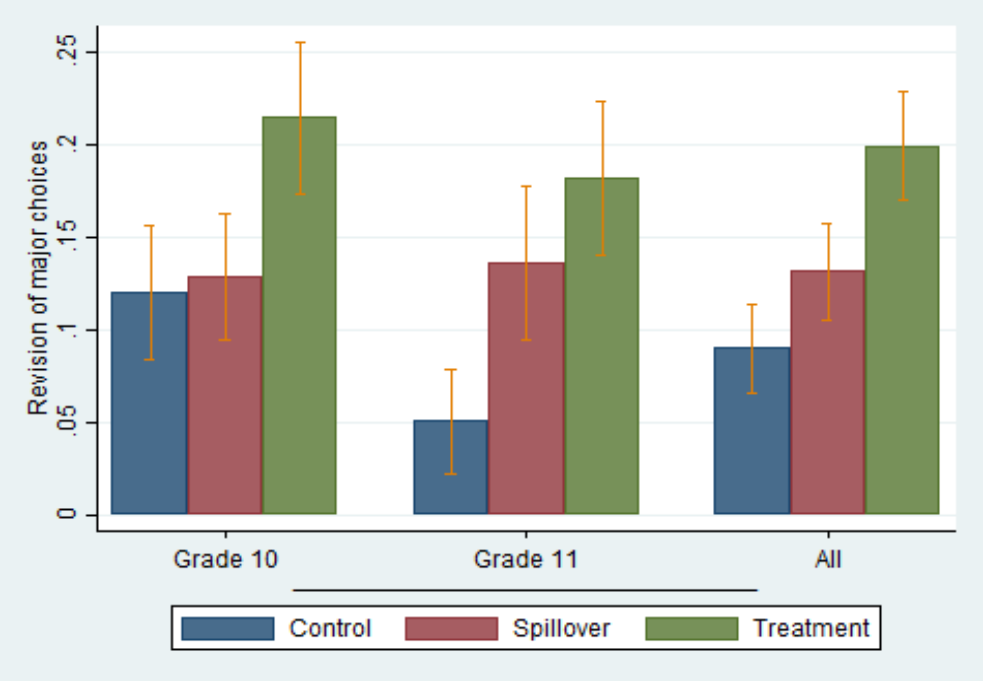
This study provides information about average wages and unemployment rates for each major, however, in reality, there are other factors that contribute to students' final decisions, not all of which would be measurable or observable. For instance, one could consider designing experiments providing the distribution of salaries and unem-

ployment, opportunities to work or continue studies, or work abroad opportunities, and information on the differences between urban and rural areas. Furthermore, non-pecuniary aspects of the specialization can be highly relevant to the students (Wiswall and Zafar, 2018). These aspects are interesting directions for future research.

3.5 Appendix A

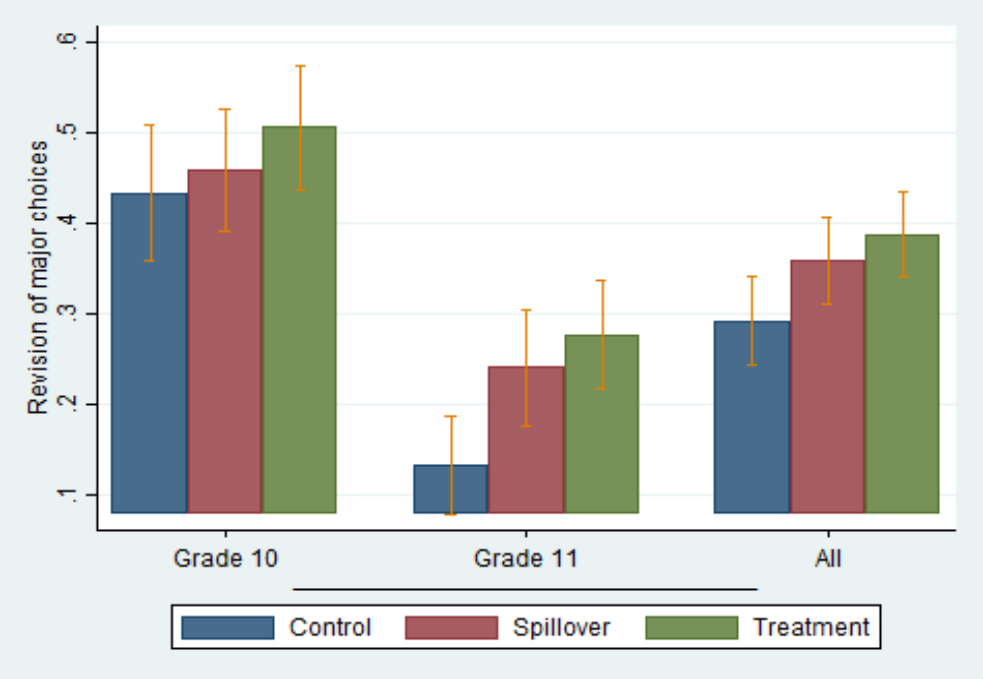
3.5.1 Figures

Figure 3.1: Revision of Intended College Major Choices



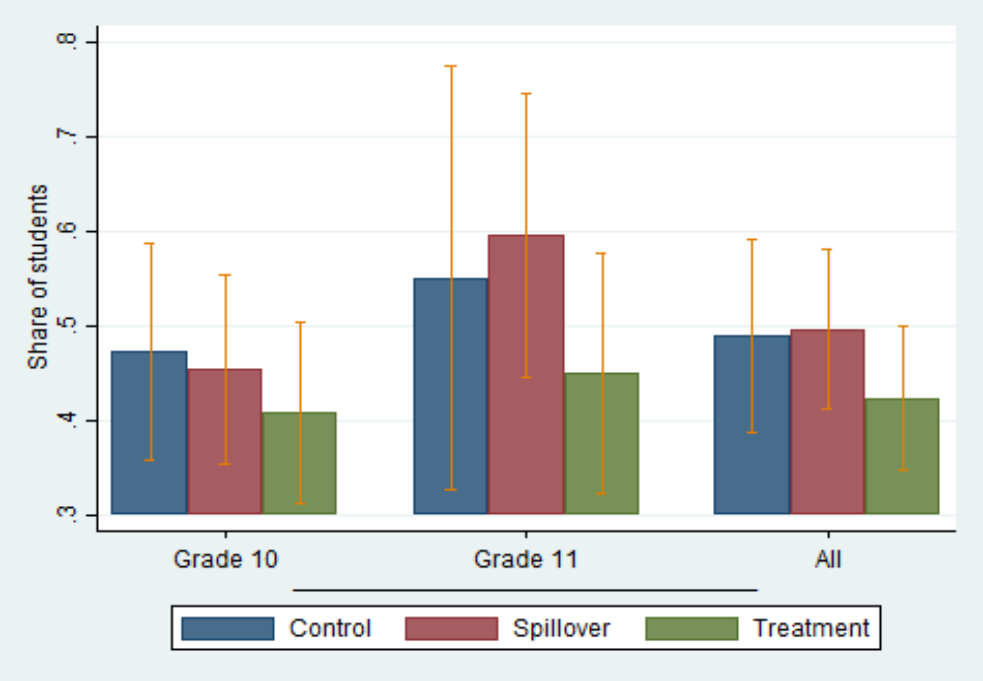
Notes: the figure shows revisions of the intended choices by the control (blue bars), spillover (red bars), and treatment groups (green bars). The revision rate represents the fraction students whose revised intended choices differ from their baseline intended major choices. The revision of the major choices is presented for the tenth grade, eleventh grade, and full sample. We find that students in the treatment group revise their intended major choices more often than do their peers in the control group. The difference is statistically significant at the $p < 0.01$ significance level (see Table 3.7).

Figure 3.2: Revision of Actual College Major Choices



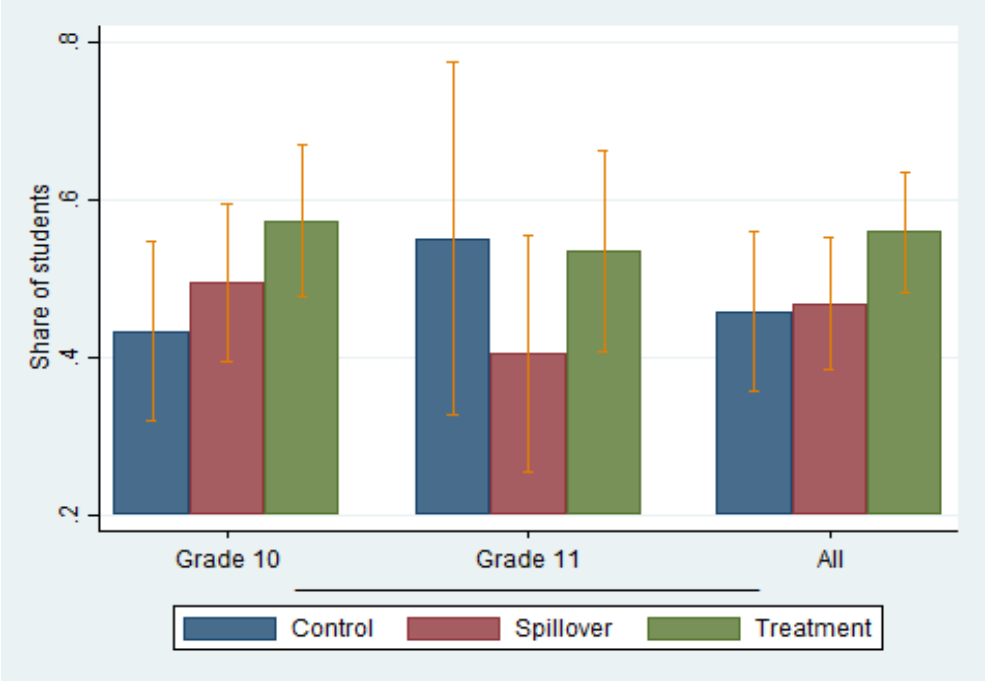
Notes: the figure shows revisions of the actual choices by the control (blue bars), spillover (red bars), and treatment groups (green bars). The revision rate represents the fraction students whose revised actual choices differ from their baseline intended major choices. The revision of the major choices is presented for the tenth grade, eleventh grade, and full sample. We find that students in the treatment group revise their intended major choices more often than do their peers in the control group. The difference is statistically significant at the $p < 0.01$ significance level (see Table 3.8).

Figure 3.3: Do Students Revise Their Actual Choices Toward College Majors Associated with Higher Wages?



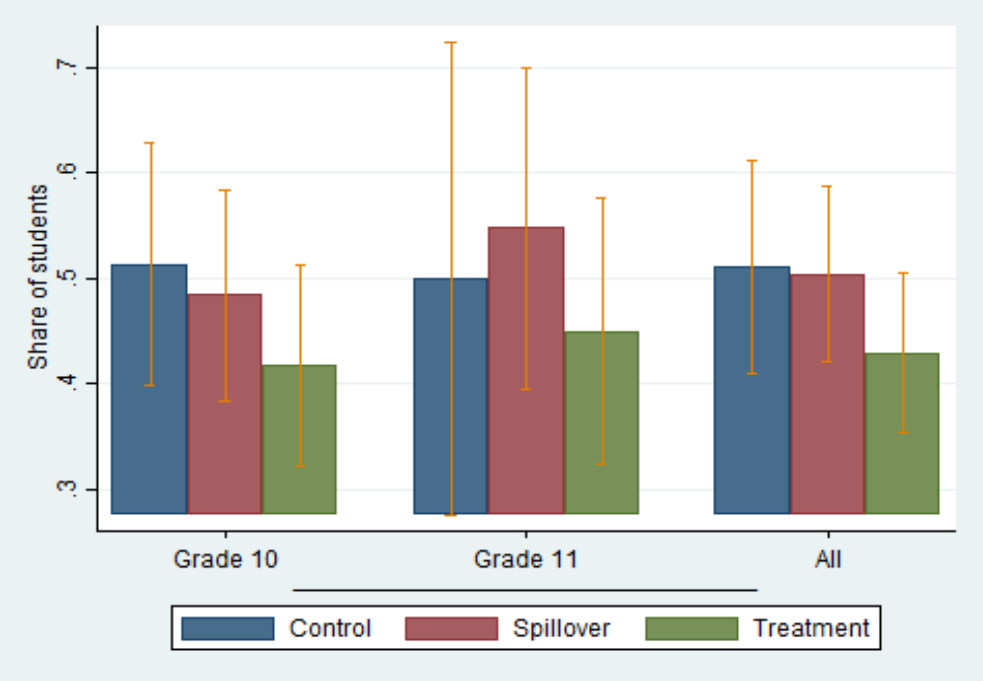
Notes: the figure shows the share of the students who revised their actual major choices toward those associated with higher wages in control (blue bars), spillover (red bars), and treatment groups (green bars). Note that the actual wages for each major are given in Table 3.6. The vertical bars represent the share of students for whom the real wage differences between the actual and baseline intended major choices are positive. About 40% of the informed students (treatment group) revise their specialization choices toward majors associated with higher wages – much less than the students in the control group. Indeed, the share of the students who revise their actual major choices toward those associated with higher wages is larger in the control group than in the treatment group. Thus, the treatment effect is negative and statistically insignificant at the $p < 0.05$ level for the eleventh-grade students.

Figure 3.4: Do Students Revise Their Actual Choices toward College Majors Associated with Lower Rates of Unemployment?



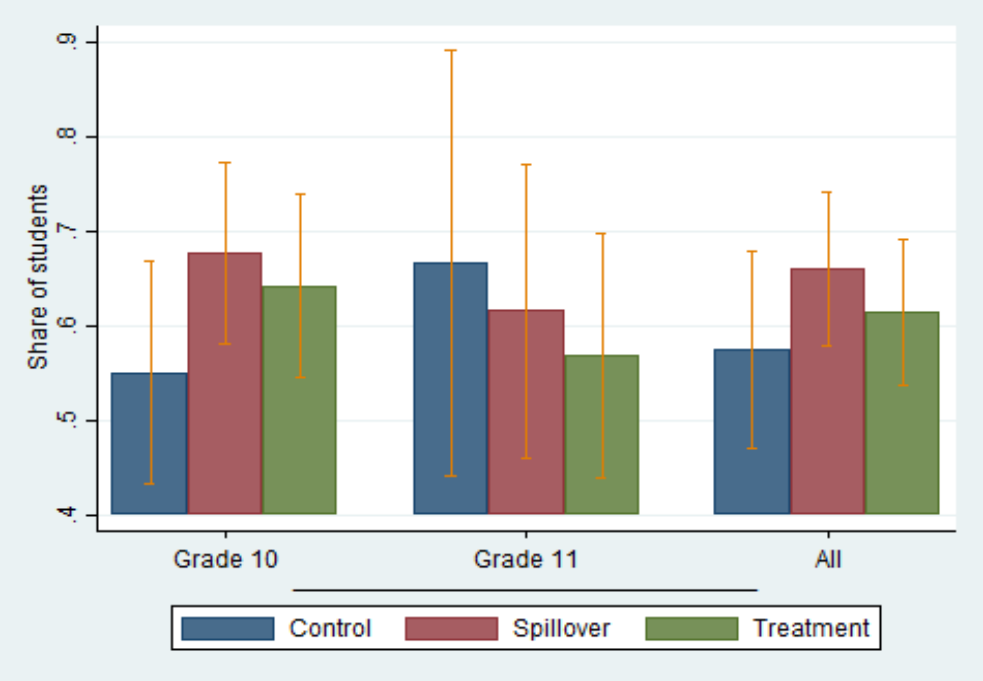
Notes: the figure shows the share of the students who revised their actual major choices toward majors associated with lower unemployment rates in control (blue bars), spillover (red bars), and treatment groups (green bars). Note that the actual unemployment rates for each major are given in Table 3.6. Nearly 11% more students revise toward majors with lower rates of unemployment in the treatment group than in the control group. Overall, the difference is statistically insignificant at the $p < 0.05$ level (see Table 3.9).

Figure 3.5: Do Students Revise Their Actual Choices toward College Majors Associated with Higher Expected Earnings?



Notes: the figure shows share of the students who revised their actual major choices toward majors associated with higher expected earnings in control (blue bars), spillover (red bars), and treatment groups (green bars). Expected earnings are calculated as the product of the wage rate and employment rate for each major. The employment rate for each specialization is calculated as one minus the unemployment rate. Note that expected earnings for each major are given in Table 3.6. Fewer of the informed students (treatment group) revise their specialization choices toward majors with higher expected earnings. By contrast, expected earnings are higher for students who revised in the control group than those in the treatment group. However, the difference is statistically insignificant at $p < 0.05$ level (see Table 3.9).

Figure 3.6: Revision of Actual College Choices toward College Majors Associated with Higher Relative Wages: Perceived vs Actual Wage Differences



Notes: Ththe figure shows share of the students who revised their choice toward majors associated with higher relative wages in control (blue bars), spillover (red bars), and treatment groups (green bars). Relative wage is defined as the difference between actual and perceived wages associated with actual and baseline intended major choices, respectively. Actual wages are the population mean earnings given in Table 3.6, while the perceived wages are measured in the baseline survey before the provision of the information. The vertical bar shows the share of students whose revision behavior satisfies the following condition:

$$\Delta W_{Actual} - \Delta W_{Perceived} > 0$$

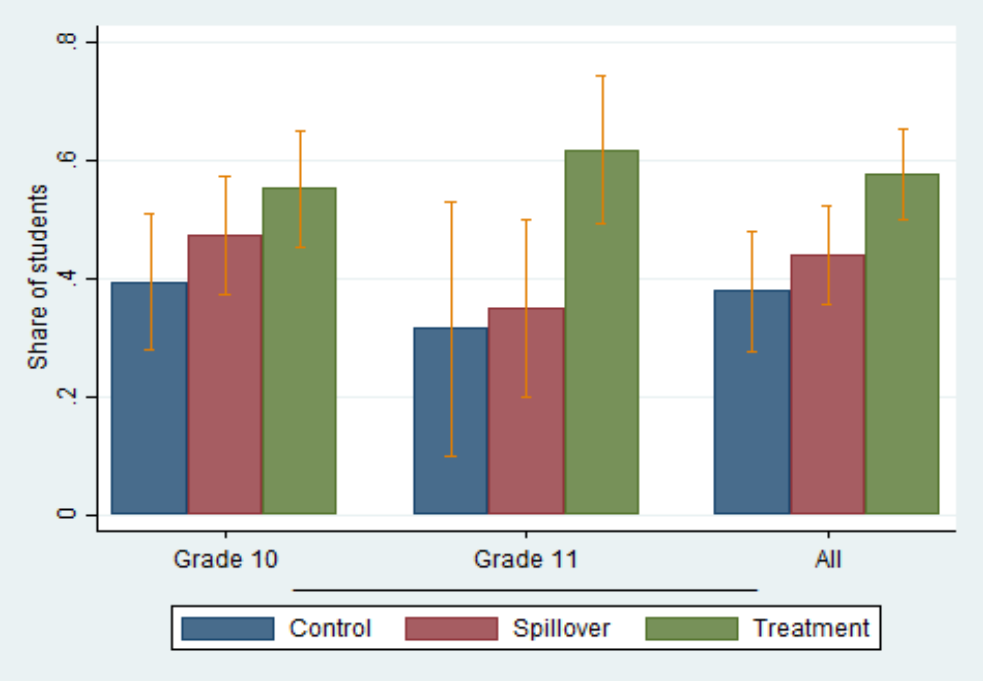
where W stands for the wage and the differences between actual and perceived wages are defined as follows:

$$\Delta W_{Actual} = \frac{W_{Actual}(Actual\ Major) - W_{Actual}(Baseline\ Intended\ Major)}{W_{Actual}(Baseline\ Intended\ Major)}$$

$$\Delta W_{Perceived} = \frac{W_{Perceived}(Actual\ Major) - W_{Perceived}(Baseline\ Intended\ Major)}{W_{Perceived}(Baseline\ Intended\ Major)}$$

The following mechanism explains the students' revision behavior - they learned that they would not be likely to face significantly lower earnings by changing their specialization as they had initially perceived. We find that a higher share of students follows this pattern in the treatment group than in the control group, however, this difference is insignificant (see Table 3.9).

Figure 3.7: Revision of Actual College Choices toward College Majors Associated with Lower Relative Rates of Unemployment: Perceived vs Actual Unemployment Differences



Notes: the figure shows share of students who revise their major toward those associated with lower relative unemployment rate in control (blue bars), spillover (red bars), and treatment groups (green bars). Relative unemployment rate is defined as the difference between actual and perceived unemployment rates associated with the actual and intended baseline major choices respectively. Actual unemployment rates are the population unemployment rates given in Table 3.6, while the perceived unemployment rates are measured in the baseline survey before the provision of the information. The vertical bar shows the share of students whose revision behavior satisfies the following rule:

$$\Delta U_{Actual} - \Delta U_{Perceived} < 0$$

where U stands for the unemployment rate and the differences between actual and perceived unemployment rates are defined as follows:

$$\Delta U_{Actual} = U_{Actual}(Actual\ Major) - U_{Actual}(Baseline\ Intended\ Major)$$

$$\Delta U_{Perceived} = U_{Perceived}(Actual\ Major) - U_{Perceived}(Baseline\ Intended\ Major)$$

We find that a higher share of students follows this pattern in the treatment group than those in the control group, i.e., perceived unemployment differences exceed the actual ones. The following mechanism explains the students' revision behavior - they learned that they would not sacrifice much of their employment opportunities by changing their specialization, as they had initially perceived. Overall, 20% more students revise toward lower unemployment rates in the treatment group than in the control group. This difference is statistically significant at $p < 0.01$ level in all model specifications (see Table 3.10).

3.5.2 Tables

Table 3.1: Timeline of the Experiment

	Round 1	Round 2	Round 3	
	Baseline Intended Choices *Information Intervention*	Revised Intended Choices	Actual Choices	
	April 2017	May 2017	September 2018	September 2019
	(1)	(2)	(3)	(4)
Grade 10	Yes	Yes	No	Yes
Grade 11	Yes	Yes	Yes	No
Total	2015	1913	543	587

Notes: columns (1), (2), (3) and (4) report the number of student responses in rounds 1-3. Both tenth-grade and eleventh-grade students were surveyed in May and April 2017. In the baseline survey, twenty students either did not report any specialization choice or selected the 'no university' choice, thus we recorded 1,995 responses with stated college major choices. In the second round, we collected 1,913 revised intended college major choices. Revised intended choices are their updated intended choices. In the third round, we were able to follow-up 543 grade 10 and 587 grade 11 students (1,130 in total) and collect actual major choices.

Table 3.2: Comparison of the Means in the Baseline Sample

	Control	Spillover	Treatment	F-test p-value
Age	16.17	16.15	16.21	0.29
	(0.67)	(0.67)	(0.67)	
% of male students	45.6	44.49	47.85	0.43
	(49.85)	(49.73)	(49.99)	
Number of brothers	0.65	0.68	0.62	0.39
	(0.89)	(0.74)	(0.72)	
Number of sisters	0.66	0.59	0.66	0.15
	(0.81)	(0.68)	(0.78)	
% of students having a tutor	79.08	78.5	81.61	0.31
	(40.71)	(41.12)	(38.77)	
% of students having a computer	90.75	91.71	91.92	0.75
	(29)	(28.1)	(27.26)	
Subjective ranking in the school	36.77	35.30	33.82	0.23
	(31.45)	(30.63)	(28.25)	
Beliefs about own earnings*	1,174.62	1,070.75	1,074.09	0.23
	(1,342)	(1,127)	(1,114)	
Class Size	17.55	14.61	15.83	0.24
	(6.6)	(14.61)	(7.51)	
Observations	744	672	579	

Notes: standard deviations are in parentheses beneath mean estimates in columns (1)-(3); Column (4) reports the p-value of an F-test testing the null hypothesis that means are equal across control, spillover, and treatment groups. Data are from the baseline survey of tenth and eleventh grade students, conducted by the authors in April 2017. Control and spillover groups did not receive any information, the treatment group received earnings, and unemployment figures. Treatment and spillover groups both represent the treated schools, hence the students from treatment groups could spread the information to their peers in the spillover group.

$*$ Beliefs about their own potential earnings are measured in Georgian Lari (GEL) and represent the student's expected monthly salaries after university graduation.

Table 3.3: Comparison of the Means for the Major Choices and Beliefs in the Baseline Sample

Educational Attainment	Baseline Major Choice				Beliefs on Monthly Earnings (GEL)				Beliefs on Unemployment Rate (%)			
	Control	Spillover	Treatment	F-test p-value	Control	Spillover	Treatment	F-test p-value	Control	Spillover	Treatment	F-test p-value
No Uni. Education	NA	NA	NA	NA	373	373	392	0.32	47.51	45.19	45.10	0.04
					(339.45)	(220.23)	(232.78)		(18.48)	(18.84)	(19.18)	
Exact and Natural Sc.	14.51%	15.77%	14.78%	0.80	907	928	1,459	0.16	29.87	30.06	29.47	0.81
	(35.25)	(36.48)	(35.52)		(552.22)	(673.13)	(703.64)		(16.82)	(17.13)	(17.45)	
Medical Sciences	15.54%	15.03%	15.59%	0.95	1,336	1,482	1,459	0.02	24.52	24.96	24.72	0.89
	(36.26)	(35.76)	(36.3)		(878.26)	(1017.88)	(845.91)		(16)	(16.76)	(16.06)	
Econ. and Business	28.84%	28.87%	28.90%	1.00	1,627	1,682	1,760	0.08	27.21	27.38	28.01	0.67
	(45.34)	(45.35)	(45.36)		(928.24)	(1099.79)	(853.15)		(17.16)	(17.5)	(17.26)	
Social Sciences	7.77%	9.52%	7.39%	0.31	1,176	1,206	1,248	0.29	30.61	30.18	29.38	0.44
	(26.8)	(29.38)	(26.18)		(762.68)	(842.03)	(853.15)		(17.51)	(18.03)	(17.8)	
Art and Humanities	13.82%	14.14%	16.40%	0.34	808	832	878	0.05	35.02	33.54	34.34	0.39
	(34.54)	(34.87)	(37.05)		(509.77)	(482.58)	(576.33)		(19.31)	(18.04)	(19.41)	
Law	19.52%	16.67%	16.94%	0.35	1,515	1,498	1,635	0.02	30.11	28.30	28.82	0.22
	(39.67)	(37.3)	(37.53)		(928.17)	(934.68)	(1023.75)		(18.88)	(18.49)	(18.42)	
Obs.	579	672	744		534	649	723		564	666	733	

Notes: standard deviations are in parentheses beneath mean estimates in columns (1)-(3), (5)-(7) and (9)-(11); Columns (4), (8) and (12) report p-values for a F-test testing the null hypothesis that the means are equal for all three groups. Data are from the baseline survey of tenth and eleventh grade students, conducted by the authors in April 2017.

Table 3.4: Comparison of the Means for the Parental Education in the Baseline Sample

Educational Attainment	**Mother's Education**				**Father's Education**			
	Control	Spillover	Treatment	F-test p-value	Control	Spillover	Treatment	F-test p-value
No Uni. Education	6.22%	6.11%	5.94%	0.98	1.58%	3.93%	3.51%	0.04
	(24.17)	(23.97)	(23.65)		(12.48)	(19.44)	(18.42)	
Exact and Natural Sc.	11.05%	11.33%	11.34%	0.98	32.28%	26.74%	28.11%	0.09
	(31.38)	(31.72)	(31.72)		(46.8)	(44.29)	(44.98)	
Medical Sciences	24.18%	25.34%	26.45%	0.64	5.26%	4.98%	6.08%	0.64
	(42.85)	(43.53)	(44.14)		(22.35)	(21.78)	(23.91)	
Econ. and Business	17.79%	18.93%	14.71%	0.09	22.63%	22.51%	22.03%	0.96
	(38.28)	(39.2)	(35.44)		(41.88)	(41.79)	(41.47)	
Social Sciences	12.78%	11.18%	14.98%	0.10	19.65%	21.00%	18.65%	0.54
	(33.42)	(31.53)	(35.71)		(39.77)	(40.76)	(38.98)	
Art and Humanities	24.18%	22.95%	19.70%	0.12	8.07%	8.46%	8.38%	0.97
	(42.85)	(42.08)	(39.8)		(27.26)	(27.85)	(27.73)	
Law	3.97%	4.17%	6.88%	0.02	10.53%	12.39%	13.24%	0.32
	(19.55)	(20.01)	(25.33)		(30.72)	(32.97)	(33.92)	
Obs.	579	671	741		570	662	740	

Notes: standard deviations are in parentheses beneath mean estimates in columns (1)-(3), (5)-(7); Columns (4) and (8) report p-values for a F-test testing the null hypothesis that the means are equal for all three groups. Data are from the baseline survey of tenth and eleventh grade students, conducted by the authors in April 2017.

Table 3.5: Comparison of the Means: School Characteristics

School Characteristics	Control Schools	Treated Schools	t-test *p-value*
Total number of students	1693.97	1553.33	0.58
	(671.62)	(482.83)	
Total number of teachers	106	98	0.60
	(44.11)	(26.8)	
% of Schools located in the city center	33.12	38.08	0.75
	(18.37)	(39.04)	
Class size	21.95	18.60	0.17
	(13.58)	(8.81)	
Observations	7	15	

Notes: standard deviations are in parentheses beneath mean estimates in columns (1)-(2); Column (3) reports p-values for a t-test testing the null hypothesis that the means are equal for all three groups. The data cover the schools where the experiment was carried out in April 2017. The data on the total number of students and teachers were retrieved from the website of the Georgia Ministry of Education in 2017. The data on locations and class sizes were collected by the authors.

Table 3.6: Actual vs Perceived Earnings and Unemployment Rates in the Baseline Sample

Educational Attainment	Mean Earnings			Unemployment Rate			Expected Earnings		
	Actual	Belief	Bias	Actual	Belief	Bias	Actual	Belief	Bias
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
No University Education	504	381	-25%	8.3%	46%	450%	462	206	-55%
Tertiary Education	802	1,280	60%	13.1%	29%	123%	697	921	31%
Exact and Natural Sciences	771	940	22%	12.6%	30%	137%	673	660	-2%
Medical Sciences	673	1,432	113%	10%	25%	149%	606	1,078	78%
Economics and Business	890	1,696	91%	19.2%	28%	43%	719	1,229	71%
Social Sciences	872	1,213	39%	13.3%	30%	125%	756	849	12%
Art and Humanities	654	843	29%	8.5%	34%	303%	599	554	-7%
Law	953	1,555	63%	15.1%	29%	92%	809	1,104	36%

Notes: columns (1)-(2) report the actual and perceived mean monthly earnings in Georgia. Columns (4)-(5) report the actual and perceived unemployment rates. Columns (7)-(8) report the expected monthly earnings calculated as the product of mean monthly earnings and employment rates. Employment rates are calculated as one minus the unemployment rate. Both actual and perceived earnings are given in Georgian Lari, and the average exchange rate in 2017 was approximately $1=2.4 GEL. Mean monthly earnings and unemployment rates for individuals with tertiary education are calculated as the weighted average earnings and unemployment rates of individuals having a degree in one of the majors: exact and natural sciences, medical sciences, economics and business administration, social sciences, arts and humanities, and law. Columns (3), (6) and (9) calculate the difference between the perceived and actual figures in percentage terms. The bias is calculated as follows: $Bias = \frac{Belief - Actual}{Actual} * 100$. Actual earnings and unemployment rates are calculated using the 2015 Household Survey conducted by the National Statistics Office of Georgia. For the calculation of earnings, we considered only full-time employees. Unemployment rates are defined in line with the International Labor Organization (ILO) strict criteria (see page 6). https://ilo.org/wcmsp5/groups/public/—dgreports/—stat/documents/publication/wcms_675155.pdf

Table 3.7: Revision of Intended College Major Choices

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.11***	0.13***	0.10***	0.12***	0.10***	0.16***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.04)
Spillover	0.04**	0.09***	0.04*	0.09***	0.05**	0.13***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.04)
Grade10		0.07**	0.04**	0.10***	0.04**	0.13***
		(0.03)	(0.02)	(0.02)	(0.02)	(0.04)
Treatment ×		-0.04		-0.04		-0.09**
Grade10		(0.04)		(0.04)		(0.04)
Spillover ×		-0.08*		-0.10***		-0.13***
Grade10		(0.04)		(0.03)		(0.04)
Covariates†	No	No	Yes	Yes	Yes	Yes
Constant	0.09***	0.05**	0.01	-0.01		
	(0.01)	(0.02)	(0.05)	(0.06)		
Observations	1,913	1,913	1,668	1,668	1,668	1,668
R^2	0.02	0.02	0.04	0.04		

Notes: (1)-(4) Linear probability models, (5)-(6) probit models (marginal effects). Sample: 10^{th} and 11^{th} grade students who reported their intended major choices. Dependent variable: categorical variable coded 1 if a student's revised intended major choice differs from her/his baseline intended college major choice. Standard errors in parentheses. Robust standard errors clustered by class for the linear probability models. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
† Covariates: gender, age, beliefs on population earnings and unemployment rate by specialization, beliefs about personal earnings upon university graduation, baseline intended specialization choice, number of siblings, a dummy variable indicating whether a student has a private tutor, beliefs about their own ranking, parental education, class size.

Table 3.8: Revision of Actual College Major Choices

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.10***	0.14***	0.09**	0.14***	0.09**	0.16***
	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)
Spillover	0.07*	0.11**	0.04	0.12***	0.04	0.14***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Grade10		0.30***	0.26***	0.35***	0.25***	0.36***
		(0.05)	(0.03)	(0.05)	(0.03)	(0.07)
Treatment ×		-0.07		-0.09		-0.13
Grade10		(0.07)		(0.07)		(0.08)
Spillover ×		-0.08		-0.15**		-0.17**
Grade10		(0.07)		(0.07)		(0.09)
Covariates†	No	No	Yes	Yes	Yes	Yes
Constant	0.29***	0.13***	0.25**	0.20**		
	(0.03)	(0.04)	(0.1)	(0.09)		
Observations	1,130	1,130	995	995	995	995
R^2	0.01	0.07	0.1	0.11		

Notes: (1)-(4) Linear probability models, (5)-(6) probit models (marginal effects). Sample: 10^{th} and 11^{th} grade students who reported their actual major choices. Dependent variable: categorical variable coded 1 if a student's actual major choice differs from her/his baseline intended college major choice. Standard errors in parentheses. Robust standard errors clustered by class for the linear probability models. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
† Covariates: gender, age, beliefs on population earnings and unemployment rate by specialization, beliefs about personal earnings upon university graduation, first round reported specialization choice, number of siblings, a dummy variable indicating whether a student has a private tutor, beliefs about their own ranking, parental education, class size.

Table 3.9: Determinants of Actual College Major Choice Revisions: Wage, Unemployment Rate, Expected Earnings, and Relative Wages

	Actual Wage		Actual Unemployment Rate		Actual Expected Earnings		Relative Wage	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-0.07	-0.1	0.1	-0.02	-0.08	-0.05	-0.03	-0.12
	(0.06)	(0.13)	(0.06)	(0.13)	(0.06)	(0.13)	(0.07)	(0.13)
Spillover	0.01	0.05	0.01	-0.15	-0.01	0.05	0.05	-0.11
	(0.07)	(0.14)	(0.07)	(0.14)	(0.07)	(0.14)	(0.07)	(0.14)
Grade10		-0.08		-0.12		0.01		-0.17
		(0.13)		(0.13)		(0.13)		(0.13)
Treatment ×		0.03		0.16		-0.05		0.09
Grade10		(0.15)		(0.15)		(0.15)		(0.15)
Spillover ×		-0.06		0.21		-0.08		0.2
Grade10		(0.16)		(0.16)		(0.16)		(0.16)
Constant	0.49***	0.55***	0.46***	0.55***	0.51***	0.50***	0.59***	0.72***
	(0.05)	(0.11)	(0.05)	(0.11)	(0.05)	(0.11)	(0.05)	(0.12)
Observations	396	396	396	396	396	396	372	372
R^2	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Notes: linear probability models. Sample: 10^{th} and 11^{th} grade students whose actual major choices differ from their baseline intended major choices. Dependent variable: (1)-(2) a categorical variable coded 1 if a student changed her/his specialization choice toward one associated with a higher wage, and 0 otherwise; (3)-(4) a categorical variable coded 1 if a student changed her/his specialization choice toward one associated with a lower unemployment rate, and 0 otherwise; (5)-(6) a categorical variable coded 1 if a student changed her/his specialization choice toward one associated with a higher expected earning, and 0 otherwise; (7)-(8) a categorical variable coded 1 if a student changed her/his specialization choice toward one associated with a relatively higher wage, and 0 otherwise. Standard errors in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Table 3.12 displays the same analysis with the dependent variable being the differences in actual wages, unemployment rates, expected earnings, and relative wages. Table 3.13 displays the same analysis with the dependent variable being the percentage differences in actual wages, unemployment rates, expected earnings, and relative wages.

Table 3.10: Determinants of Actual College Major Choice Revisions: Relative Unemployment Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	0.20***	0.30**	0.24***	0.40***	0.06***	0.05*	0.08***	0.07**
	(0.07)	(0.13)	(0.06)	(0.12)	(0.02)	(0.03)	(0.02)	(0.03)
Spillover	0.06	0.03	0.10*	0.06	0.01	-0.01	0.01	-0.02
	(0.07)	(0.14)	(0.06)	(0.14)	(0.02)	(0.03)	(0.02)	(0.03)
Grade10		0.08	0.14	0.22		-0.02	0	-0.03
		(0.13)	(0.1)	(0.14)		(0.03)	(0.02)	(0.02)
Treatment ×		-0.14		-0.24*		0.01		0.02
Grade10		(0.15)		(0.13)		(0.04)		(0.04)
Spillover ×		0.05		0.07		0.04		0.06
Grade10		(0.16)		(0.14)		(0.04)		(0.04)
Covariates†	No	No	Yes	Yes	No	No	Yes	Yes
Constant	0.38***	0.32***	0.04	-0.06				
	(0.05)	(0.11)	(0.21)	(0.23)				
Observations	385	385	334	334	1,119	1,119	995	995
R^2	0.03	0.03	0.18	0.2				

Notes: (1)-(4) Linear probability models. Sample: 10^{th} and 11^{th} grade students whose actual major choices differ from the baseline intended major choices. Dependent variable: a categorical variable coded 1 if a student changed her/his specialization choice toward one associated with a relatively lower unemployment rate, and 0 otherwise. Standard errors in parentheses: robust standard errors clustered by school. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(5)-(8) Ordered probit models, marginal effects for switching toward lower relative unemployment rate. Sample: 10^{th} and 11^{th} grade students who reported their actual major choices. Dependent variable: a categorical variable coded 1 if a student changed her/his specialization choice toward one associated with a relatively lower unemployment rate, -1 if a student changed her/his specialization toward one associated with a relatively higher unemployment rate, and 0 if a student did not change her/his specialization. The table reports marginal effects only for switching toward a major associated with lower relative unemployment rate.
† Covariates: gender, age, beliefs about personal earnings upon university graduation, first round reported specialization choice, number of siblings, a dummy variable indicating whether a student has a private tutor, beliefs about own ranking, parental education, class size.

3.6 Appendix B

Additional Tables

Table 3.11: Offered Places and Demand for College Majors

Educational Program	Offered Places	1st choice	1st choice (%)
	(1)	(2)	(3)
Exact and Natural Sciences	10,868	9,550	23.56%
Medical Sciences	2,917	3,264	8.05%
Economics and Business	14,575	8,807	21.73%
Social Sciences	4,267	2,314	5.71%
Arts and Humanities	10,955	11,413	28.16%
Law	6,121	5,182	12.79%
Total	49,703	40,530	

Notes: the table shows the supply of each specialization (offered places) by accredited universities in Georgia and the demand for each major (first desired choice stated by the applicants) in 2017. Column (1) reports the maximum number of places offered by the accredited universities in Georgia. Column (2) reports the number of applicants willing to continue their studies with a given major choice. Column (3) reports the demand for each major in percentage terms. Note that top ranked universities are highly selective and competition is high, although the overall number of offered places exceed the demand. Columns (1) and (2) are constructed based on the information provided by NAEC.

Table 3.12: Determinants of Actual College Major Choice Revisions: Differences in Wages, Unemployment Rates, Expected Earnings and Relative Wages

	Actual Wage		Actual Unemployment Rate		Actual Expected Earnings		Relative Wage	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-10.92	17.72	-0.94	0.72	-1.51	10.45	-108.02	47.15
	(22.46)	(44.9)	(0.81)	(1.63)	(14.59)	(29.17)	(167.02)	(336.34)
Spillover	25.71	63.68	0.09	1.79	21.8	41.08	109.98	155.44
	(23.16)	(47.24)	(0.84)	(1.71)	(15.04)	(30.69)	(171.77)	(355.21)
Grade10		39.24		1.74		20.46		242.57
		(43.82)		(1.59)		(28.47)		(329.93)
Treatment ×		-35.68		-2.19		-13.9		-182.64
Grade10		(52.13)		(1.89)		(33.87)		(389.87)
Spillover ×		-49.38		-2.22		-25		-34.03
Grade10		(54.33)		(1.97)		(35.3)		(406.7)
Constant	-3.88	-34.77	0.48	-0.89	-7.15	-23.26	246.06*	53.68
	(17.89)	(38.88)	(0.65)	(1.41)	(11.62)	(25.26)	(133.36)	(293.82)
Observations	396	396	396	396	396	396	372	372
R^2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Notes: OLS in all columns. Sample: 10^{th} and 11^{th} grade students whose actual major choices differ from their baseline major choices. Dependent variable: (1)-(2) the actual wage difference between the actual and baseline major choices; (3)-(4) the actual unemployment rate difference between the actual and baseline major choices; (5)-(6) the actual expected earnings difference between the actual and baseline major choices; (7)-(8) the relative wage difference between the actual and baseline major choices. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.13: Determinants of Actual College Major Choice Revisions: Percentage Differences in Wages, Unemployment Rates, Expected Earnings and Relative Wages

	Actual Wage		Actual Unemployment Rate		Actual Expected Earnings		Relative Wage	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-1.22	2.65	-4.2	4.95	-0.31	1.88	-8.2	-9.4
	(2.92)	(5.84)	(6.71)	(13.41)	(2.14)	(4.28)	(16.15)	(32.59)
Spillover	3.23	8.04	1.94	10	3.08	6.27	13.18	10.93
	(3.02)	(6.15)	(6.92)	(14.11)	(2.21)	(4.5)	(16.61)	(34.42)
Grade10		5.62		11.22		3.63		-2.61
		(5.7)		(13.09)		(4.18)		(31.97)
Treatment ×		-4.74		-11.72		-2.57		1.2
Grade10		(6.79)		(15.57)		(4.97)		(37.78)
Spillover ×		-6.17		-10.11		-4.09		2.87
Grade10		(7.07)		(16.23)		(5.18)		(39.41)
Constant	0.32***	0.32***	0.32***	0.32***	0.32***	0.32***	0.32***	0.32***
	(2.33)	(5.06)	(5.34)	(11.61)	(1.7)	(3.71)	(12.9)	(28.47)
Observations	396	396	396	396	396	396	372	372
R^2	0.01	0.01	0	0	0.01	0.01	0.01	0.01

Notes: OLS in all columns. Sample: 10^{th} and 11^{th} grade students whose actual major choices differ from their baseline major choices. Dependent variable: (1)-(2) the actual wage difference (in %) between the actual and baseline intended major choices; (3)-(4) the actual unemployment rate difference (in %) between the actual and baseline intended major choices; (5)-(6) the actual expected earnings difference (in %) between the actual and baseline intended major choices; (7)-(8) the relative wage difference (in %) between the actual and baseline intended major choices. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3.14: Do Baseline Beliefs Predict the Changes in the Major Choices?

	Actual major choices		Baseline intended major choices	
	(1)	(2)	(3)	(4)
Treatment	0.0818*	0.0927*	0.14***	0.12***
	(0.05)	(0.05)	(0.03)	(0.02)
Spillover	0.03	0.00	0.07**	0.06***
	(0.05)	(0.06)	(0.03)	(0.02)
Unemp. Bias[a]	0.000	0.001	0.002**	0.002*
	(0.00)	(0.00)	(0.00)	(0.00)
Treatment ×	0.001	-0.000	-0.002*	-0.002
Unemp. Bias	(0.00)	(0.00)	(0.00)	(0.00)
Spillover ×	0.003	0.003	-0.002	-0.002
Unemp. Bias	(0.00)	(0.00)	(0.00)	(0.00)
Covariates[b]	No	Yes	No	Yes
Constant	0.2843***	0.2776***	0.063***	0
	(0.03)	(0.1)	(0.02)	(0.05)
Observations	1,108	995	1881	1668
R^2	0.01	0.11	0.02	0.04

Notes: Linear probability models. (1)-(2) Sample: 10^{th} and 11^{th} grade students who reported their actual major choices. The dependent variable: a categorical variable coded 1 if a student's actual major choice differs from the baseline intended choice. (3)-(4) Sample: 10th and 11th grade students who reported their intended major choices. Dependent variable: a categorical variable coded 1 if a student's intended major choice differs from the baseline one. Robust standard errors clustered by class in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[a] *Unemp. Bias*: variable Unemployment bias is defined as a difference between the perceived and true unemployment rate (in percentage points) for the baseline college major. Note that the beliefs were elicited before the leaflet was provided. *Unemp. Bias* × *Treatment (Unemp. Bias* × *Spillover*) stands for the interaction term between the unemployment bias and the Treatment (Spillover) dummy variable.

[b] Covariates: gender, age, beliefs about personal earnings upon university graduation, baseline college major choice, number of siblings, a dummy variable indicating whether a student has a private tutor, beliefs about their own ranking, parental education, class size.

Table 3.15: Comparison of the Means in the Attrition Sample

Educational Attainment	Baseline Intended Major Choice				Beliefs on Monthly Earnings (GEL)				Beliefs on Unemployment Rate (%)			
	Control	Spillover	Treatment	F-test p-value	Control	Spillover	Treatment	F-test p-value	Control	Spillover	Treatment	F-test p-value
No Uni. Education	NA	NA	NA	NA	350	374	356	0.35	48.28	43.89	44.32	0.01
					(214.22)	(212.01)	(187.01)		(17.81)	(19.47)	(19.55)	
Exact and Natural Sc.	14.79%	15.79%	14.86%	0.93	832	884	1,288	0.50	30.08	29.47	27.73	0.21
	(35.57)	(36.53)	(35.63)		(469.2)	(612.43)	(621.19)		(16.92)	(16.83)	(16.58)	
Medical Sciences	15.95%	15.09%	15.48%	0.96	1,205	1,405	1,288	0.03	24.17	24.10	24.32	0.99
	(36.69)	(35.86)	(36.23)		(768.64)	(977.05)	(739.62)		(15.24)	(16.38)	(16.09)	
Econ. and Business	29.18%	28.07%	28.79%	0.96	1,571	1,695	1,593	0.30	27.15	27.81	27.62	0.90
	(45.55)	(45.01)	(45.35)		(894.95)	(1062.39)	(810.97)		(16.82)	(18.15)	(16.85)	
Social Sciences	7.78%	10.18%	6.81%	0.31	1,095	1,121	1,137	0.82	30.00	30.32	28.90	0.58
	(26.84)	(30.29)	(25.23)		(726.45)	(773.9)	(810.97)		(16.86)	(17.79)	(18.19)	
Art and Humanities	13.62%	14.04%	17.03%	0.44	774	785	835	0.31	35.14	33.01	32.51	0.23
	(34.37)	(34.8)	(37.65)		(493.33)	(407.05)	(588.93)		(19.88)	(17.77)	(19.29)	
Law	18.68%	16.84%	17.03%	0.83	1,405	1,431	1,504	0.37	30.10	27.43	27.38	0.16
	(39.05)	(37.49)	(37.65)		(838.48)	(819.37)	(933.14)		(19.32)	(18.88)	(18.61)	
Obs.	257	285	323		231	273	316		252	283	320	

Notes: Sample: 10^{th} and 11^{th} grade students who were present in the baseline survey but have not reported their actual college major choices. Standard deviations are in parentheses beneath mean estimates in columns (1)-(3), (5)-(7) and (9)-(11); Columns (4), (8) and (12) report p-values for a F-test testing the null hypothesis that the means are equal for all three groups. Data are from the survey of tenth and eleventh grade students who were present in the baseline survey round, but have not reported their actual choices throughout the final stage of the survey.

Table 3.16: Revision of Intended College Major Choices in the Actual Choices Sample

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.06***	0.06*	0.05**	0.05	0.05**	0.06
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.04)
Spillover	0.01	0.06*	0.00	0.06**	0	0.07*
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.04)
Grade10		0.07**	0.05**	0.08**	0.05***	0.09**
		(0.03)	(0.02)	(0.03)	(0.02)	(0.04)
Treatment ×		0.02		0.02		-0.01
Grade10		(0.04)		(0.05)		(0.05)
Spillover ×		-0.10**		-0.10**		-0.12**
Grade10		(0.04)		(0.04)		(0.05)
Covariates [a]	No	No	Yes	Yes	Yes	Yes
Constant	0.06***	0.03	0.00	-0.01		
	(0.02)	(0.02)	(0.05)	(0.06)		
Observations	1,130	1,130	995	995	995	995
R^2	0.01	0.02	0.04	0.05		

Notes: (1)-(4) Linear probability models, (5)-(6) probit models (marginal effects). Sample: 10^{th} and 11^{th} grade students who reported their actual major choices. Note that this table is identical to Table 4 with the difference of the sample. This table analyzes the intended choices of the students who reported their college major choices on all three occasions: in the baseline survey, intended choices survey, and actual choices survey. Dependent variable: categorical variable coded 1 if a student's revised intended major choice differs from her/his baseline intended major choice. Robust standard errors in parentheses. Robust standard errors clustered by class for the linear probability models. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[a] Covariates: gender, age, beliefs on population earnings and unemployment rate by specialization, beliefs about personal earnings after university graduation, baseline intended specialization choice, number of siblings, having a private tutor, beliefs about their own ranking, parental education, class size.

Table 3.17: Is Attrition Correlated with the Treatment or Spillover?

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.01	-0.02	0.03	0.03	0.03	0.03
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)
Spillover	-0.02	-0.03	0	0.03	0	0.03
	(0.03)	(0.04)	(0.04)	(0.05)	(0.03)	(0.05)
Grade10		0.10**	0.11***	0.13***	0.11***	0.13**
		(0.04)	(0.03)	(0.05)	(0.03)	(0.06)
Treatment ×		0.03		0		0
Grade10		(0.06)		(0.06)		(0.08)
Spillover ×		0.01		-0.05		-0.05
Grade10		(0.06)		(0.06)		(0.07)
Covariates [a]	No	No	Yes	Yes	Yes	Yes
Constant	0.42***	0.36***	0.28***	0.27***		
	(0.02)	(0.03)	(0.07)	(0.07)		
Observations	1,913	1,913	1,668	1,668	1,668	1,668
R^2	0	0.01	0.05	0.05		

Notes: (1)-(4) Linear probability models, (5)-(6) probit models (marginal effects). Sample: 10^{th} and 11^{th} grade students who reported their revised intended major choices. Dependent variable: categorical variable coded 1 if a student's actual major choice is missing (attrition) and 0 otherwise. Robust standard errors in parentheses. Robust standard errors clustered by class for the linear probability models. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[a] Covariates: gender, age, beliefs on population earnings and unemployment rate by specialization, beliefs about personal earnings after university graduation, baseline intended specialization choice, number of siblings, having a private tutor, beliefs about own ranking, parental education, class size.

Table 3.18: Comparison of the Means in the Actual Choices Sample

Educational Attainment	Baseline Major Choice				Beliefs on Monthly Earnings (GEL)				Beliefs on Unemployment Rate (%)			
	Control	Spillover	Treatment	F-test p-value	Control	Spillover	Treatment	F-test p-value	Control	Spillover	Treatment	F-test p-value
No Uni. Education	NA	NA	NA	NA	392	373	351	0.17	46.89	46.15	45.70	0.70
					(409.45)	(226.29)	(225.62)		(19.01)	(18.33)	(18.89)	
Exact and Natural Sc.	14.29%	15.76%	14.73%	0.85	964	959	1,333	0.09	29.70	30.49	30.83	0.68
	(35.05)	(36.49)	(35.48)		(602.45)	(713.12)	(643.19)		(16.76)	(17.35)	(18)	
Medical Sciences	15.22%	14.99%	15.68%	0.96	1,436	1,537	1,333	0.01	24.80	25.60	25.03	0.80
	(35.97)	(35.74)	(36.4)		(942.42)	(1044.31)	(778.07)		(16.61)	(17.03)	(16.06)	
Econ. and Business	28.57%	29.46%	28.98%	0.97	1,670	1,673	1,577	0.33	27.26	27.07	28.31	0.56
	(45.25)	(45.64)	(45.42)		(952.04)	(1127.48)	(733.42)		(17.46)	(17.02)	(17.59)	
Social Sciences	7.76%	9.04%	7.84%	0.77	1,237	1,267	1,113	0.02	31.11	30.07	29.74	0.58
	(26.8)	(28.72)	(26.91)		(784.89)	(884.21)	(733.42)		(18.03)	(18.23)	(17.51)	
Art and Humanities	13.98%	14.21%	15.91%	0.71	833	866	756	0.01	34.92	33.94	35.76	0.40
	(34.73)	(34.96)	(36.62)		(521.31)	(528.67)	(454.54)		(18.87)	(18.26)	(19.41)	
Law	20.19%	16.54%	16.86%	0.38	1,600	1,547	1,446	0.10	30.12	28.94	29.95	0.64
	(40.2)	(37.2)	(37.49)		(984.17)	(1008.42)	(912.47)		(18.56)	(18.2)	(18.21)	
Obs.	322	387	421		303	376	407		312	383	413	

Notes: the sample consists of the 10^{th} and 11^{th} grade students who reported their actual major choices. Standard deviations are in parentheses beneath mean estimates in columns (1)-(3), (5)-(7) and (9)-(11); Columns (4), (8) and (12) report p-values for a F-test testing the null hypothesis that the means are equal for all three groups. Data are from the survey of tenth and eleventh grade students who reported their actual major choices.

3.7 Appendix C

3.7.1 Appendix C1

College major fields (as seen by respondents)

1. **exact and natural sciences**: mathematics, computer science, physics, chemistry, biology, biochemistry, geography, geology, ecology, electrical and mechanical engineering, transportation, agriculture.

2. **medical sciences:** medicine, pharmacy, dentistry, public health.

3. **economics and business:** economics, business administration, tourism, management, marketing, accounting.

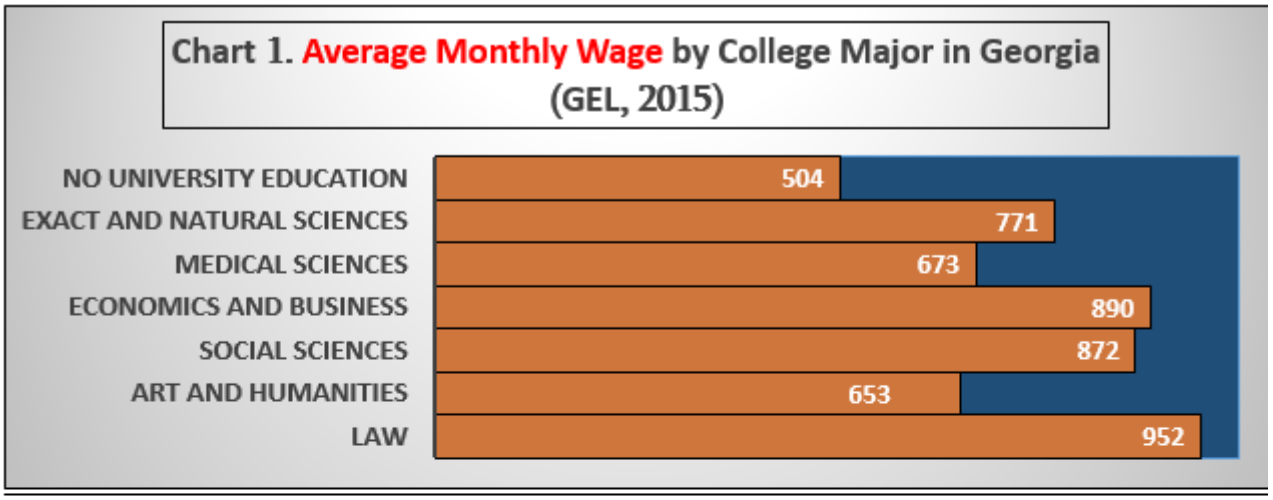
4. **Social Sciences:** sociology, politics, journalism, media and communication, political studies, international relations.

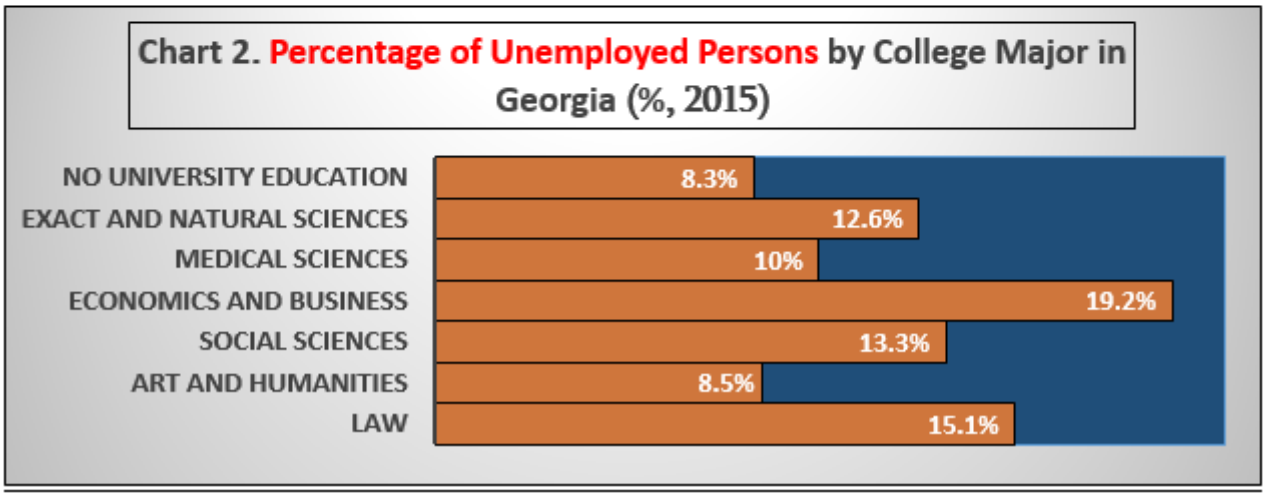
5. **art and humanities:** philosophy, history, archeology, ethnology, cultural studies, art history, language studies, pedagogical studies, sports, drama, choreography.

6. **law:** international law, public law, criminal law, civil law.

3.7.2 Appendix C2

Information Leaflet*





* All the information is based on data retrieved from the Georgian National Statistical Office (2015). This leaflet and the survey questionnaire were translated from Georgian by the authors.

Information about the Charts on the Leaflet

Chart 1 Shows average monthly wages of full-time employed persons for each college major in Georgia

Chart 1 should be read as follows:

- In Georgia, full-time employed persons with ***no university degree***, on average, earn ***504 GEL per month***
- In Georgia, full-time employed persons with a ***university diploma in exact and natural sciences***, on average, earn ***771 GEL per month***
- In Georgia, full-time employed persons with ***a university diploma in medical sciences***, on average, earn ***673 GEL per month***
- In Georgia, full-time employed persons with a ***university diploma in economics and business administration***, on average, earn ***890 GEL per month***
- In Georgia, full-time employed persons with a ***university diploma in social sciences***, on average, earn ***872 GEL per month***
- In Georgia, full-time employed persons with a ***university diploma in art and humanities***, on average, earn ***654 GEL per month***
- In Georgia, full-time employed persons with a ***university diploma in law***, on average, earn ***952 GEL per month***

Chart 2 the percent of unemployed persons by university major in Georgia

An unemployed person is defined as a person aged 15 or older, who:
a) has not been employed during a given week
b) has actively sought employment in the prior four weeks
c) is available to start a job within next two weeks

Chart 2 should be read as follows**:**

- In Georgia, ***8.3%*** of persons with ***no university degree*** are unemployed
- In Georgia, ***12.6%*** of persons with a ***university diploma in exact and natural sciences*** are unemployed
- In Georgia, ***10%*** of persons with a ***university diploma in medical sciences*** are unemployed
- In Georgia, ***19.2%*** of persons with a ***university diploma in economics and business administration*** are unemployed
- In Georgia, ***13.3%*** of persons with a ***university diploma in social sciences*** are unemployed
- In Georgia, ***8.5%*** of persons with a ***university diploma in art and humanities*** are unemployed
- In Georgia, ***15.1%*** of persons with a ***university diploma in law*** are unemployed

3.7.3 Appendix C3: Survey Questionnaire

Round 1 (Baseline Intended College Major Choices)

Please read each question and respond carefully. Depending on your response to Question 2, we will provide you with detailed information on:

- The university admission process for the college major *of your choice*
- The competitiveness of the college major *of your choice*
- Any international exchange programs available for the college major *of your choice*

There are four questions. Please respond to all the questions. If any question is unclear, please raise your hand.

1. Are you planning to apply to a university upon graduating from high school?
   - ☐ Yes
   - ☐ No

The following questions pertain to your college major choice. A detailed description of each major can be found in appendix A1. From the list below, please select your top desired college major choice. Note that, based on your college major choice, we will provide you with detailed information on the university admission process, competitiveness (number of applications vs offered places), and availability of exchange programs.

2. Please select your top desired college major from the list below. Please select only one major.
   - ☐ Exact and Natural Sciences
   - ☐ Medical Studies
   - ☐ Economics and Business Administration
   - ☐ Social Sciences
   - ☐ Arts and Humanities
   - ☐ Law

The following questions pertain to **your opinions** about earnings and unemployment for each major.

3. In your opinion, among all individuals with a university diploma, what is the average amount that you believe these workers currently earn per month from full-time hired employment?

Example: In Georgia, a person with a university diploma in medical studies earns, on average, X GEL per month from full-time hired employment.

College Major	Average Monthly Salary from Full-time Hired Employment in Georgia (GEL)
Exact and Natural Sciences	
Medical Studies	
Economics and Business Administration	
Social Sciences	
Arts and Humanities	
Law	

4. In your opinion, among all individuals with a university diploma, what is the percentage of unemployed individuals for each specialization?
   An unemployed person is defined as a person aged 15 or older, who:
   a) has not been employed during a given week
   b) has actively sought employment in the prior four weeks
   c) is available to start a job within next two weeks

Example: In Georgia, X% of persons with a university diploma in arts and humanities is unemployed.

College Major	Unemployment Rate (%)
Exact and Natural Sciences	
Medical Studies	
Economics and Business Administration	
Social Sciences	
Arts and Humanities	
Law	

Post-Experimental Questionnaire

1. Do you have a laptop or personal computer at home?

   ☐ Yes
   ☐ No

2. How many siblings do you have?

   Number of Sister(s): _____ Number of Brother(s): _____

3. What college major does your father have?

   _____

4. What college major does your mother have?

   _____

5. Which district of Tbilisi do you live in?

   _____

6. Are you or your family considering hiring a tutor to help you prepare for the Unified National Exams?

   ☐ Yes
   ☐ No

7. In this question, ranking is measured by a number from 1 to 100, with 1 indicating the highest rank and 100 indicating the lowest rank.

   On a ranking scale of 1-100, where do you think you would rank in terms of your scores from the Unified National Exams when compared to all individuals applying to university that year?

   _____

8. Imagine you just graduated from your desired major and you were working full time. What do you believe is the average amount in GEL that you would earn per month from full-time hired employment?

   Example: You believe that right after university graduation, you would earn X GEL from hired employment.

   _____

Round 2 (Revised Intended College Major Choices)

Please read each question and respond carefully. Depending on your responses, we will provide you with detailed information on:

- The student admission process at universities for the major
- Chances of being admitted for the major
- Availability of international exchange programs for the major
- Other relevant information

This questionnaire contains three questions. Please respond to all the questions. If any question is unclear, please raise your hand.

1. Are you planning to apply to a university upon graduating from high school?

    ☐ Yes
    ☐ No

The following questions pertain to your college major choice. A detailed description of each major can be found in appendix 1. From the list below, please select/mark your top desired major. Note that based on your major choice, we will provide you with detailed information on the university admission process, the number of applicants and available places, availability of exchange programs, and other relevant information.

2. Have you discussed your future major choice with your parents over the last month?

    ☐ Yes
    ☐ No

3. Please select your top desired major from the list below. Please select only one major.

    ☐ Exact and Natural Sciences
    ☐ Medical Studies
    ☐ Economics and Business Administration
    ☐ Social Sciences
    ☐ Arts and Humanities
    ☐ Law

Round 3 (Actual College Major Choices)

The phone survey script

Hello Mr./Ms. *[Name]*. You participated in our survey on college major choices a year ago (two years ago for Grade 10s). Thank you for your participation. Would you have a few minutes to answer our questions?

1. Have you been admitted to a university?

   ☐ Yes
   ☐ No

2. What major are you going to study at university?

   _____

3. Is your current major choice different from your desired major choice?

   _____

Thank you for your responses, your time is very much appreciated. We wish you good luck with your future studies!

3.8 Appendix D

Determinants of the College Major Choices (Supplementary Analysis)

Do students revise toward the college majors associated with higher wages? Figure 3.3 displays the fraction of students who revised their actual major choices toward those associated with higher wages. The vertical bars represent the share of students for whom the real wage differences between the final and baseline specialization choices are positive. If higher wages were the driver for the college major changes, then one would expect that more students in the treatment and spillover groups would revise toward majors associated with higher wages. However, coefficient estimates in Table 3.9 show the specialization revision patterns across the final and baseline major choices are not explained by higher wages.[29] We also check whether the absolute or percentage differences in actual wages play a role - Tables 3.12 and 3.13 derive similar results. Next, we investigate the extent to which revisions are driven by differences in employment opportunities by major.

The revisions are not driven by the differences in the wages between the baseline and actual specialization choices. Therefore, changes in the college major choices cannot be explained by the wage differentials.

Do students revise their major choices toward majors associated with lower unemployment rates? Figure 3.4 displays the fraction of students who revised their actual major choices toward those associated with lower unemployment rates. The vertical bars represent the share of students for whom the real unemployment rate differences between the actual and baseline specialization choices are negative. If employment opportunities were the driver of the revisions in the majors, then more students in the treatment and spillover groups would revise their majors toward those associated with lower unemployment rates. Coefficient estimates in Table 3.9 suggest that more students in the treatment group revise toward majors associated with lower unemployment rates than in the control group, however the effect is insignificant. Do the absolute or percentage differences in unemployment rates explain the revisions? Tables 3.12 and 3.13 illustrate that neither percentage nor absolute differences in actual unemployment rates explain the changes in the specialization choices. Next, we investigate the extent to which revisions are driven by the differences in the expected earnings.

The revisions are not driven by the differences in the employment opportunities between the baseline and actual specialization choices. Therefore, changes in the specialization choices cannot be explained by the differences in unemployment rates.

Do students revise their major choices toward majors associated with higher expected earnings? Figure 3.5 displays the fraction of students who revised their actual major choices toward higher expected earnings. The vertical bars represent the share of

[29]The coefficient estimates in column 2 is negative but insignificant at 5% level. Note that we do not find any significant effect of the actual wages on intended choice revisions. Thus, neither intended nor the actual major choice revisions are driven by differences in actual wages.

students for whom the expected earning differences between the actual and baseline specialization choices are positive. We do not find any evidence of expected earnings explaining the change in the actual college major choices. Coefficient estimates in Table 3.9 derive similar results.[30] Thus, we conclude the expected earning differences between the two majors do not play a role. What are the other determinants, if actual wages and unemployment rates are not decisive for students when making their decisions? We explore the role of perceived actual wages and unemployment rates as a potential determinant. Next, we investigate the extent to which revisions are driven by the differences between perceived and actual wages.

The revisions are not driven by the differences in the expected earnings between the baseline and actual specialization choices. Therefore, changes in the college major choices cannot be explained by the expected earning differentials.

Do students revise their major choices toward majors associated with higher relative wages? Figure 3.6 displays the fraction of students who revised their actual major choices toward higher relative wages. Relative wage is defined as the difference between actual and perceived wages associated with the actual and baseline specialization choices, respectively. As an example, consider the students who revised their majors from economics and business (baseline) to exact and natural sciences (actual). Table 3.6 reports the actual and perceived wages of individuals with a degree in economics and business, 890 GEL and 1,696 GEL, respectively. In contrast, exact and natural sciences diploma holders actually earn 771 GEL, while students perceived that the wage was 940 GEL. Thus, students overestimated the cost of changing the specialization. In fact, one would only give up 119 GEL if choosing exact and natural sciences instead of economics and business. However, students in our sample perceived that the revision would be associated with a reduction in the wage of 756 GEL, much larger than the actual difference, 119 GEL.

Figure 3.6 the share of students whose revision behavior satisfies the following condition:

$$\Delta W_{Actual} - \Delta W_{Perceived} > 0$$

where W stands for the average monthly wage and the differences between actual and perceived wages are defined as follows:

$$\Delta W_{Actual} = \frac{W_{Actual}(Actual\ Major) - W_{Actual}(Baseline\ Intended\ Major)}{W_{Actual}(Baseline\ Intended\ Major)}$$

$$\Delta W_{Perceived} = \frac{W_{Perceived}(Actual\ Major) - W_{Perceived}(Baseline\ Intended\ Major)}{W_{Perceived}(Baseline\ Intended\ Major)}.$$

The following rationale explains the students' revision behavior - they learned that they did not have to sacrifice as much earnings by changing their specialization as they perceived. If the differences between the actual and perceived earnings were

[30] Tables 3.12 and 3.13 show that the results remain the same in the alternative model specifications where the dependent variable is either the actual or percentage difference in the expected earnings.

the driver of the specialization choices, then one would expect that more students in the treatment and spillover groups would revise their majors toward higher relative wages compared to the students in the control group. Coefficient estimates in Table 3.9 suggest that this is not the case.

The revisions are not driven by the differences between the perceived and actual wages across the baseline and actual major choices. Therefore, changes in the specialization choices cannot be explained by the differences between the perceived and actual wages.

Bibliography

[1] Abbott, A., Silles, M. "Determinants of international student migration." *The World Economy, Vol. 39/5, 621-635.* 2016.

[2] Altbach, P., Reiszberg, L., de Wit, H. "Responding to Massification Differentiation in Postsecondary Education Worldwide." Sense Publishers. The Netherlands. 2017.

[3] Altbach, P., Reiszberg, L., Rumbley, L. "Trends in Global Higher Education: Tracking an Academic Revolution." *UNESCO.* 2009.

[4] Andrabi, T., Das, J., Khwaja, A. I. "Report Cards: The Impact of Providing School and Child Test Scores on Educational Markets." *American Economic Review, 107(6), 1535-1563.* 2017.

[5] Arcidiacono, P., Hotz, V. J., Kang, S. "Modeling College Major Choices Using Elicited Measures of Expectations and Counterfactuals." *Journal of Econometrics, 166(1), 3–16.* 2012.

[6] Attanasio, O., Kaufmann, K. "Educational Choices, Subjective Expectations, and Credit Constraints." *NBER Working Paper No. 15087*. 2009.

[7] Atkinson, C. "Does Soft Power Matter? a Comparative Analysis of Student Exchange Programs." *Foreign Policy Analysis 6, 1-22.* 2010.

[8] Balch, A., Börjesson, M., Shen, W., De Wit, H. "Mobile Talent? The Staying Intentions of International Students in Five EU Countries." *SVR GmbH.* 2012.

[9] Banerjee, A. "Contracting Constraints, Credit Markets, and Economic Development." *In Advances in Economics and Econometrics: Theory and Applications. Eighth World Congress of the Econometric Society 3, 1-46.* Cambridge. 2003.

[10] Beffy, M., Fougère, D., Maurel, A. "Choosing the Field of Study in Post-secondary Education: Do Expected Earnings Matter?" *Review of Economics and Statistics, 94(1), 334–347.* 2012.

[11] Berkes, J., Frauke P., Spiess, C. K., Weinhardt, F. "Information Provision and Postgraduate Studies." *IZA Discussion Paper No. 12735.* 2019.

[12] Bettinger, E. P., Terry Long, B., Oreopoulos, P., Sanbonmatsu, L. "Information in College Decisions: Results from the H&R Block FAFSA Experiment." *Quarterly Journal of Economics, 127(3),1205–1242.* 2012.

[13] Betts, J. R. "What do students know about wages? Evidence from a Survey of Undergraduates." *Journal of Human Resources, 31(1), 27–56.* 1996.

[14] Bhagwati, J.N., Hamada, K. "The Brain Drain, International Integration of Markets for Professionals and Unemployment: a Theoretical Analysis." *Journal of Development Economics 1, 19-42.* 1974.

[15] Bleemer, Z., Zafar, B. "Intended college attendance: Evidence from an Experiment on College Returns and Costs." *Journal of Public Economics, 157, 184-211.* 2018.

[16] Bursztyn, L., González, A.L., Yanagizawa-Drott, D. "Misperceived Social Norms: Women Working Outside the Home in Saudi Arabia." *American Economic Review, 110(10), 2997- 3029.* 2020.

[17] Budría, S., Telhado-Pereira, P. "Educational Qualifications and Wage Inequality: Evidence for Europe." *Revista de Economia Aplicada 19(56).* 2005.

[18] Bureau of Intelligence and Research. Independent States in the World. U.S. Department of State. Available at https://www.state.gov/s/inr/rls/4250.htm. 2014.

[19] Cai, Y., Kivistö, J. "Tuition Fees for International Students in Finland: Where to Go from Here?" *Journal of Studies in International Education 17: 55-78.* 2011.

[20] Celik, S. "Turkey's Ministry of National Education Study-abroad Program: is the MoNE Making the Most of its Investment?" *The Qualitative Report 17, 1-31.* 2012.

[21] Central Intelligence Agency."The World Factbook." *CIA Library.* Available at http://www.state.gov/s/inr/rls/4250.htm. 2013.

[22] Conlon, J. J. "Major Malfunction: A Field Experiment Correcting Undergraduates' Beliefs about Salaries." *Journal of Human Resources, Forthcoming.* 2020.

[23] DAAD and British Council. "The Rationale for Sponsoring Students to Undertake International Study: an Assessment of National Student Mobility Scholarship Programmes." *German Academic Exchange Service and British Council.* 2014.

[24] Dai, T., Liu, X., Biancen, X. "Brain Drain Reversal and Return Subsidy." *Journal of Comparative Economics 43, 443–455.* 2015.

[25] Davies, J. B.., Sandström, S., Shorrocks, A., Wolff, E. "The World Distribution of Household Wealth." *World Institute for Development Economic Research. Discussion Paper No. 2008/03.* 2008.

[26] Dabla-Norris, E., Kochhar, K., Suphaphiphat, N., Ricka, F., Tsounta, E. "Causes and Consequences of Income Inequality: A Global Perspective." *International Monetary Fund, June 2015 SDN/15/13.* 2015.

[27] de Boer H., Jongbloed B. ”A Cross-National Comparison of Higher Education Markets in Western Europe.” *In: Curaj A., Scott P., Vlasceanu L., Wilson L. (eds) European Higher Education at the Crossroads. Springer, Dordrecht.* 2012.

[28] Delpierre, M., Verheyden, B. ”Student and Worker Mobility under University and Government Competition.” *Journal of Public Economics 110: 26-41.* 2014.

[29] Demange, G., Fenge, R, Uebelmesser, S. ”Competition in the Quality of Higher Education: the Impact of Student Mobility.” *International Tax and Public Finance.* 2020.

[30] Devesa, D.R., Blom, A. ”Comparing Student Loan Programs in Latin America and Beyond: Key Indicators.” *World Bank Note.* 2007.

[31] De Ville, P., Martou, F., Vanderberghe, B. ”Cost-benefit Analysis and Regulatory Issues of Student Mobility in the EU.” *European Journal of Education, Vol. 31, No. 2.* 1996.

[32] Dinkelman, T., and Martínez A, C. ”Investing in Schooling in Chile: The Role of Information about Financial Aid for Higher Education.” *Review of Economics and Statistics, 96(2), 244-257.* 2014.

[33] Docquier, F., Rapoport, H. ”Skilled Migration: the Perspective of Developing Countries.” *In Skilled Migration: Prospects, Problems and Policies.* New York. 2008.

[34] Driouchi, A. ”Economics of Migration of Students from the Arab Region to OECD Countries.” *MPRA Paper No. 58830.* 2014.

[35] Dustmann, C., Okatenko, A. ”Out-migration, Wealth Constraints, and the Quality of Local Amenities.” *Journal of Development Economics 110, 52-63.* 2014.

[36] Edwards, D., Coates, H., Friedman, T. "A Survey of International Practice in University Admissions Testing." *Higher Education Management and Policy, vol. 24/1.* 2012.

[37] Eggert, W., Krieger, T., Meier, V. ”Education, Unemployment and Migration.” *Journal of Public Economics 94, 354-362.* 2010.

[38] Eicher, J. ”The Costs and Financing of Higher Education in Europe.” *European Journal of Education: Vol. 33, No. 1.* 1998.

[39] Edelstein R.J., Douglas, J. A. ”Comprehending the International Initiatives for Universities: a Taxonomy of Modes of Engagement and Institutional Logics.” *CSHE.19.12.* 2012.

[40] European Commission/EACEA/Eurydice. ”National Student Fee and Support Systems in European Higher Education – 2018/19.” *Eurydice – Facts and Figures. Luxembourg: Publications Office of the European Union.* 2018, 2020.

[41] European Migration Network (EMN). ”Immigration of International Students to the EU.” *Brussels: European Migration Network.* 2012.

[42] European Migration Network (EMN). ”Attracting and Retaining International Students in the EU.” *Brussels: European Migration Network.* 2019.

[43] European Parliament. ”Higher Education Entrance Qualifications and Exams in Europe: A Comparison.” *European Parliament Report.* 2014.

[44] EU Immigration Portal. retrieved from http://ec.europa.eu. 2017.

[45] European Social Survey (ESS). ”Attitudes towards Immigration and their Antecedents: Topline Results from Round 7 of the European Social Survey.” *Immigration Portal.* Available at http://ec.europa.eu. 2017.

[46] Flyer, F. ”The Influence of Higher Moments of Earnings Distributions on Career Decisions.” *Journal of Labor Economics, 15(4), 689-713.* 1997.

[47] Franck, B., Owen, R.F. ”Human Capital Formation, International Labor Mobility and the Optimal Design of Educational Grants.” *HAL Working Paper No. 01158239.* 2015.

[48] Gaddie, K. ”Policy Mobilities in the Race for Talent: Competitive State Strategies in International Student Mobility. ” *Trans Inst Br Geogr, 40: 235-248.* 2014.

[49] Galland, O., Oberti, M. ”Higher education students in contemporary France.” *Journal of Education Policy 15 (1):105-116.* 2000.

[50] Garritzman, J. L. ”The Political Economy of Higher Education Finance. The Politics of Tuition Fees and Subsidies in OECD Countries, 1945–2015.” *Basingstoke: Palgrave Macmillan.* 2016.

[51] Gérard, M. ”Financing Bologna: Which Country will Pay for Foreign Students?” *Education Economics. 15., 4, 441-454.* 2007.

[52] Gordon, R., Li, W. ”Tax structures in developing countries: Many puzzles and a possible explanation.” *Journal of Public Economics 93: 855–866.*2009.

[53] Granguli, I., Gaulé, P., and Čugalj, D. V. ”Biased Beliefs and Entry into Scientific Careers.” *Upjohn Institute Working Paper, 20-334.* 2020.

[54] Gungor N.D., Tansel A. ”Brain Drain from Turkey: an Investigation of Students’ Return Intentions.” *Applied Economics 40, 3069-3087.* 2015.

[55] Guruz, K. ”Higher Education and International Student Mobility in the Global Knowledge Economy.” *State University of New York: SUNY Press.* 2008.

[56] Haaland, I. K., Roth, K., and Wohlfart, J. ”Designing Information Provision Experiments.” *CESifo Working Paper No. 8406.* 2020.

[57] Hastings, J. S., Neilson, C. A., Ramirez, A., and Zimmerman, S. D. ”(Un)informed College and Major Choice: Evidence from Linked Survey and Administrative Data.” *Economics of Education Review, 51, 136–151.* 2016.

[58] Hastings, J. S., Neilson, C. A., and Zimmerman, S. D."Are Some Degrees Worth More than Others? Evidence from College Admission Cutoffs in Chile." *NBER Working Paper No. 19241*. 2013.

[59] Hastings, J. S., Neilson, C. A., and Zimmerman, S. D. "The Effects of Earnings Disclosure on College Enrollment Decisions." *NBER Working Paper No. 21300*. 20153.

[60] Hastings, J. S., and Weinstein, J. M. "Information, School choice, and Academic Achievement: Evidence from Two Experiments." *Quarterly Journal of Economics, 123(4),1373–1414*. 2008.

[61] Haupt A., Krieger T., Lange, T. 'A Note on Brain Gain and Brain Drain: Permanent Migration and Education Policy." *CESIFO Working Paper No. 3154*. 2010.

[62] Haupt, A., Krieger, T., and Lange, T. "Competition for the International Pool of Talent." *Journal of Population Economics 29: 1113-1154*. 2016.

[63] Luijten-Lub A., Van der Wende M., Huisman J. "On Cooperation and Competition: A Comparative Analysis of National Policies for Internationalisation of Higher Education in Seven Western European Countries." *Journal of Studies in International Education, 9(2):147-163*. 2005.

[64] Jensen, R. "The (perceived) Returns to Education and the Demand for Schooling." *Quarterly Journal of Economics, 125(2), 515–548*. 2010.

[65] Kirkeboen, L. J., Leuven, E., and Mogstad, M. "Field of Study, Earnings, and Self-selection." *Quarterly Journal of Economics, 131(3),1057–1111*. 2016.

[66] Kuptsch, C. and Pang, EF. "Competing for Global Talent." *Research Collection Lee Kong Chian School Of Business*. 2006.

[67] Kwok, V., Leland, H. "An Economic Model of the Brain Drain." *American Economic Review 72, 91-100*. 1982.

[68] Lam, Q., Oste, D. "Portable State Grants and Loans: an Overview and their Contribution to Outgoing Student Mobility." *ACA Papers on International Cooperation in Education*. Bonn. 2013.

[69] Lange, T. "Return Migration of Foreign Students and Non-resident Tuition Fees." *Journal of Population Economics 26:703–718*. 2013.

[70] Le, T. "Are Student Flows a Significant Channel of R&D Spillovers from the North to the South?" *Economic Letters 107, 315–317*. 2010.

[71] Lergetporer, P., Schwerdt, G., Werner, K., West, M. R., and Woessmann, L. "How Information Affects Support for Education Spending: Evidence from Survey Experiments in Germany and the United States." *Journal of Public Economics, 167, 138–157*. 2018.

[72] Lien, D. "Asymmetric Information and the Brain Drain." *Journal of Population Economics 6, 169-180*. 1993.

[73] Loyalka, P., Liu, C., Song, Y., Yi, H., Huang, X., Wei, J., Zhang, L., Shi, Y., Chu, J., and Rozelle, S. "Can Information and Counseling Help Students from Poor Rural Areas Go to High School? Evidence from China." *Journal of Comparative Economics, 41(4), 1012-1025.* 2013.

[74] Machabeli, G., Andguladze, N., Bregvadze, T., and Apkhazava, R. "Effects of Tertiary Education on the Formation of the Labor Force." *International Institute for Education Policy, Planning and Management Report.* 2013.

[75] Manski, C. F. "Measuring Expectations." *Econometrica, 72 (5), 1329–1376.* 2004.

[76] Mapping European Union Member States Higher Education External Cooperation Programmes and Policies. Available at http://www.mapping-he.eu/. 2010.

[77] Marcucci, P., N, Johnstone, B. D. "Tuition Fee Policies in a Comparative Perspective: Theoretical and Political Rationales." *Journal of Higher Education Policy and Management 29.* 2007.

[78] McGrath, C., Henham, M., Corbett, A., Durazzi, N., Frearson, M., Janta, B.,Kamphuis, B.W., Katashiro, E., Brankovic, N., Guerin, B., Manville, C., Schwartz, I., Schweppenstedde, D. "Higher Education Entrance Qualifications and Exams in Europe: A Comparison." *European Union, RR-574-EP*. 2014.

[79] Mechtenberg, L., Strausz, R. "The Bologna Process: How Student Mobility Affects Multi-cultural Skills and Educational Quality." *Int Tax Public Finance 15: 109–130.* 2008.

[80] McGrath, C. H., Frearson, M. "Admission Systems and Student Mobility: A Proposal for an EU-Wide Registry for University Admission." *Foro de Educación, 14(21)*. 2016.

[81] Moed, H., F. "A Critical Comparative Analysis of Five World University Rankings." *Scientometrics*. 2016.

[82] Montmarquette, C., Cannings, K., and Mahseredjian, S. "How do Young People Choose College Majors?" *Economics of Education Review, 21(6), 543–556.* 2002.

[83] National Student Fee and Support Systems in European Higher Education in European Higher Education. Available at http://eacea.ec.europa.eu/. 2015

[84] Nguyen, T. "Information, Role Models and Perceived Returns to Education: Experimental Evidence from Madagascar." *MIT Working Paper.* 2008.

[85] OECD. "Education at a Glance." *OECD.* Paris. 2011.

[86] OECD. "Education at a Glance." *OECD.* Paris. 2014.

[87] OECD. "Education at a Glance." *OECD.* Paris. 2018.

[88] OECD. "Education at a Glance." *OECD.* Paris. 2020.

[89] OECD. "International Migration Outlook." *OECD.* Paris. 2014.

[90] OECD. "Tertiary Education for the Knowledge Society: Equity, Innovation, Labour Market, Internationalisation." *OECD*. Paris. 2008.

[91] OECD. "Universal Basic skills: What Countries Stand to Gain." *OECD*. Paris. 2015.

[92] Oreopoulos, P., and Dunn, R. "Information and College Access: Evidence from a Randomized Field Experiment." *Scandinavian Journal of Economics, 115(1), 3-26*. 2013.

[93] Orr, D., Usher, A., Atherton, G., Cezar, H., and Geanta, I. "Study on the Impact of Admission Systems on Higher Education Outcomes Volume I: Comparative Report Vol. I." *Publications Office of the European Union*. 2017.

[94] Perna, L.W., Orosz K., Gopaul, B., Jumakulov, Z., Ashirbekov, A., Kishkentayeva, M. "Promoting Human Capital Development: A Typology of International Scholarship Programs in Higher Education." *Educational Researcher 43, 63-73*. 2014.

[95] Rosenzweig, M.R. "Higher Education and International Migration in Asia: Brain Circulation." *In Higher Education and Development, 59-84. The World Bank*. Washington, D.C. 2008.

[96] Rutkowski, J. "Georgia Skills Mismatch and Unemployment." *World Bank Report 72824*. 2013.

[97] Salmi, J. "Student Loans in an International Perspective: The World Bank Experience." *LAC Human & Social Development Group Paper Series No 1*. 2003.

[98] Sanchez-Serra, D., Marconi, G. "Increasing International Students' Tuition Fees: The Two Sides of the Coin." *International Higher Education. No 92. pp: 13-14*. 2018.

[99] Shen H., Ziderman A. "Student Loans Repayment and Recovery: International Comparisons." *Higher Education 57, 315-333*. 2009.

[100] Siow, A. "Occupational Choice under Uncertainty." *Quarterly Journal of Economics, 52(3),631-645*. 1984.

[101] Spilimbergo, A. "Democracy and Foreign Education." *American Economic Review 99, 528-543*. 2009.

[102] Stark, O., Helmenstein, C., Prskawetz, A. "A Brain Gain with a Brain Drain." *Economics Letters 55, 227–234*. 1997.

[103] Stark, O., Helmenstein, C., Prskawetz, A. "Human Capital Depletion, Human Capital Formation, and Migration: a Blessing in a 'Curse'?" *Economics Letters 60, 363–367*. 1998.

[104] Stark, O., Wang, Y. "Inducing Human Capital Formation: Migration as a Substitute for Subsidies." *Journal of Public Economics 86, 29–46*. 2002.

[105] Stark O., Zakharenko, R. ”Differential Migration Prospects, Skill Formation, and Welfare.” *Review of International Economics 20, 657-673.* 2012.

[106] THE. ”Times Higher Education.” https://www.timeshighereducation.com/world-university-rankings/2017/world-ranking. 2017.

[107] The International Comparative Higher Education Finance and Accessibility Project. Available at http://gse.buffalo.edu/org/inthigheredfinance/. 2015.

[108] Teichler, U. ”German Higher Education in the European Context.” *International Higher Education. No 30.*. 2003.

[109] The World and All its Voices. ”France to boost tuition fees for international students.” http://en.rfi.fr/20181120-france-boost-fees-foreign-students-bid-competitiveness/. 2018.

[110] The World Bank. ”Financing Higher Education in Africa.” Washington, D.C. 2010.

[111] The World Bank. ”World Bank Open Data.” https://data.worldbank.org/. 2020.

[112] Times Higher Education. ”Why Germany educates international students for free.” https://www.insidehighered.com/news/2017/04/27/germany-sees-benefits-educating-international-students-free. 2017.

[113] UNESCO. ”Financing Education in Sub-Saharan Africa: Meeting the Challenges of Expansion, Equity and Quality.” Paris. 2011.

[114] UNESCO. ”Student Loans Schemes in Mauritius: Experience, Analysis and Scenarios.” Paris. 2006.

[115] Usher, A., Cervenan, A. ”Global Higher Education Rankings.” *Toronto, ON: Educational Policy Institute.* 2005.

[116] Van Bouwel, L., Veugelers, R. ”The Determinants of Student Mobility in Europe: The Quality Dimension. *European Journal of Higher Education, 3(2): 172–190.* 2013.

[117] Varghese, N.V., 2012. ”Globalization of Higher Education and Cross-border Student Mobility. UNESCO. Paris.

[118] Vedder, R. "Going Broke by Degree. Why College Costs too Much." *Washington, DC: The American Enterprise Institute Press.* 2004.

[119] Vidal J. ”The Effect of Emigration on Human Capital Formation.” *Journal of Population Economics 11, 589-600.* 1998.

[120] Wiswall, M., and Zafar, B. ”Determinants of College Major Choice: Identification Using an Information Experiment.” *Review of Economic Studies, 82(2),791–824.* 2015a

[121] Wiswall, M., and Zafar, B. "How do College Students Respond to Public Information about Earnings?" *Journal of Human Capital, 9(2), 117–169.* 2015b.

[122] Wiswall, M., and Zafar, B."Preference for the Workplace, Investment in Human Capital, and Gender." *Quarterly Journal of Economics, 133(1), 457–507.* 2018.

[123] Woodhall M. "Student Loans in Developing Countries: Feasibility, Experience and Prospects for Reform." *Higher Education 23, 347.* 1992.

[124] Zafar, B. "College Major Choice and the Gender Gap." *Journal of Human Resources, 48(3), 545–595.* 2013.

[125] Zarkin, G. "Occupational Choice: An Application to the Market for Public School Teachers." *Quarterly Journal of Economics, 100(2), 409-446.* 1985.

[126] Ziderman, A. "Student Loans Schemes in Practice: Global Perspectives." *In Student Financing of Higher Education: A Comparative Perspective. International Studies in Higher Education series.* Routledge. 2013.