Migration Opportunities, College Enrollment and College Major Choice

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Abstract: I explore how migration opportunities affect college enrollment and major choice in migrant-sending countries in the presence of open borders. My identification strategy exploits exogenous variation in migration costs during the 2004 European Union (EU) enlargement to compare enrollment in newly admitted sending countries and incumbent destination countries. I use microlevel data from the EU Labor Force Survey and an event study framework to show that college enrollment in new states increased 15-25% in anticipation of better migration opportunities, and up to 30% once borders opened. College students in new states were more likely to enroll in college majors related to occupations with labor shortages in destination countries. To disentangle the effects of migration costs and wages on enrollment, I develop a model of college major choice with a migration option. Counterfactual policy experiments indicate that sending country enrollment is highly sensitive to migration penalties, but less sensitive to domestic college wage increases.

JEL Codes: F22, I23, I25, J24, J61, O15
Keywords: International migration, human capital accumulation, college major choice, economic development, open borders

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1 Introduction

One of the main reasons people migrate is to find better job opportunities with higher earnings. For individuals in lower income countries, the wage gains from international migration can be especially large (e.g., Clemens 2011, Kennan 2013, Kennan 2017). Consequently, lower income migrant-sending countries have worried about the negative effects of emigration on domestic economic growth. These worries are reflected in a long-standing academic literature on whether migration leads to brain drain or brain gain (e.g., Bhagwati and Hamada 1974, Mountford 1997, Beine, Docquier, and Rapoport 2008, Shrestha 2017, Abarcar and Theoharides 2021). Moreover, migrant-receiving countries[1] often address labor market shortages by making occupation-specific immigration easier. Such occupation-specific migration opportunities can in turn lead to mismatch between the types of skills available and needed in labor markets in sending countries, further hampering economic development. With international migration on the rise, governments in sending countries have proposed various policies to fight brain drain and labor shortages, such as skill-specific wage subsidies and migration penalties. It is then important to understand how migration interacts with human capital accumulation under different settings, and evaluate the effectiveness of proposed policies.

In this paper I explore the effects of migration opportunities on college enrollment and major choice among youth in sending countries when international borders are removed. With closed borders and skill-biased immigration policies, one could increase their chances of migrating by acquiring more education and destination-specific skills. Yet, empirical evidence on the effects of migration on human capital accumulation in sending countries has been mixed (e.g., Beine, Docquier, and Rapoport 2008, McKenzie and Rapoport 2011, Abarcar and Theoharides 2021, Khanna and Morales 2021). Moreover, we have no evidence on how migration affects human capital accumulation in open border settings, which are increasingly present in much of Europe. Without borders, one could expect human capital accumulation in sending countries to decrease as skill-biased migration incentives weaken. To address these gaps, I ask the following: first, do better migration opportunities increase or decrease tertiary enrollment and attainment in sending countries when borders are removed? Second, do these improved migration opportunities affect college major choice? Finally, how effective are different policies in shaping college enrollment and major choice in sending countries?

To answer these questions, I exploit exogenous variation in migration costs that occurred

[1] Throughout the paper, I use "migrant-receiving", "host" and "destination" countries interchangeably to describe countries that have attracted large stocks of international migrants. Likewise, I use "migrant-sending", "sending" or "origin" countries interchangeably to describe countries that experience large population outflows.

during the 2004 European Union (EU) enlargement. In 2004, eight Central and Eastern European countries (hereafter new member states, or NMS) joined the EU and its incumbent 15 Western EU member states (EU15). Borders between NMS and EU15 states were subsequently removed, decreasing migration costs for both NMS and EU15 citizens. Because NMS had substantially lower income and higher unemployment rates relative to EU15 states, it was expected that migration costs would decrease more for NMS than for EU15, resulting in large East-West migration flows. To confirm that the opening of borders did indeed have large effects on East-West migration, I use data from the EU Labor Force Survey (LFS) to calculate detailed annual bilateral migration flows. I find that migration flows of NMS citizens from NMS to EU15 states increased sharply after 2004 and more than tripled by 2006. EU15 to NMS flows of EU15 citizens did not match the increase. This exercise provides evidence that migration opportunities increased drastically for NMS citizens upon EU accession but did not change for EU15 citizens.

In my empirical framework, I use EU LFS data on 21 countries between 1998 and 2013, and a difference-in-differences (DID) and event study methods. Specifically, I assign eight new member states to the treated group and 13 EU15 states to the comparison group. The choice of pre and post-period is guided by the structure of the EU accession process: while NMS joined the EU in 2004, their accession negotiations successfully concluded in 2002, so changes in behavior could have occurred as early as 2002. I thus consider nationals (both stayers and emigrants) that reach the traditional college enrollment and attainment age after 2002 as the treated cohorts. Those that would have made enrollment and attainment decisions before 2002 serve as the comparison cohots.

I find that removing barriers to migration increased the probability of overall college enrollment among 20–24 year old NMS youth by 15-25% percent just in anticipation of lower migration costs between 2002 and 2004. Once borders opened, I find that NMS college enrollment rates increase by over 30%. I further find that college attainment rates of 25–29 year old NMS citizens increased by over 20% four years after EU accession, but did not change in anticipation of open borders. Because EU member states enjoy the free movement of goods, services and capital flows, I explore whether mechanisms beyond the freedom of movement explain these reduced-form results. To this end, I collect data on GDP growth, trade growth, FDI inflows, unemployment rates, remittances, consumer expectations, as well as tertiary education system characteristics for all countries in my sample. I conduct several exercises where I include pre-accession macroeconomic controls or lags of time-varying controls to net out the effects of local demand on enrollment and attainment. The results are robust in every exercise, implying

that domestic economic conditions and expectations about how the economy will evolve do not explain the increase in enrollment rates in NMS countries. I further address concerns that there may have been spillovers to the comparison countries by limiting the comparison group to EU15 countries that were not top destinations for immigrants, and to countries that had relatively low unemployment rates. In both cases, the results remain unchanged. Finally, I use a triple difference framework where the third difference consist of older cohorts. This framework allows me to further control for time-varying country characteristics other than the migration channel (as older cohorts are less likely to migrate). The results are again robust, which leads me to conclude that migration opportunities were driving enrollment decisions more than any other factors.

I further explore whether the removal of migration barriers incentivized NMS students to enroll in college majors that were highly demanded in destination countries. The incentive to pick specific majors comes from sector and occupation-specific exceptions to temporary labor movement restrictions that EU countries imposed between 2004 and 2011. Most EU15 countries temporarily restricted NMS citizens from accessing their labor markets *unless* NMS citizens worked in occupations with labor shortages, such as IT, engineering, health, and services. I investigate whether NMS enrollment increased in these majors post-EU accession using event study and triple difference frameworks. I find that in anticipation of EU accession, NMS enrollment increased 45% in IT, 30% in engineering and service-related fields, and almost 60% in health-related degrees. NMS enrollment decreased in less transferable degrees, such as teaching. These findings indicate that lower migration costs and occupation-specific labor shortages in destination countries incentivized NMS students to enroll in fields that provide entry in highly demanded occupations in destination countries.

The analysis so far indicates that even with open borders, individuals in sending countries increase their college enrollment and pick college majors that are better aligned with labor demand in destination countries. However, the reduced form estimates do not allow me to separately measure the effect on enrollment that comes from wage differentials and the effect from a change in migration costs. Separately identifying the effects of wage differentials and migration costs on college enrollment and major choice allows one to test the effectiveness of various counterfactual policies. To that end, I next develop a model of individual college enrollment and major choice that accounts for migration costs. In this simple model, high school graduates choose between four college majors and the labor force. Their utility depends on ability, gender, major and location-specific expected wages, and major-specific migration costs should they decide to emigrate. To estimate the model, I use data on Poland and the UK

as the sending and receiving countries. I focus on two young Polish cohorts defined based on wehther they make their major decision pre or post-EU accession. I estimate model parameters in two steps. In the first step, I exploit the 2004 EU accession to estimate major and time-specific migration costs. In the second step, I use these migration costs to estimate the remaining model parameters via simulated method of moments.

I analyze the effects of two sets of counterfactual policies motivated by public policy debates related to brain drain in sending countries. First, I investigate how enrollment rates would change if all emigration from Poland to the UK were restricted. Counterfactual results show that enrollment rates would fall by 30% compared to enrollment under open borders. If instead only the college-educated are prohibited from emigrating, enrollment rates would fall by 40% relative to open borders. Much of the drop in enrollment comes from decreased enrollment in social sciences, arts, and health-related degrees. By analyzing these extreme restrictions, I am able to showcase the bounds of how sensitive college enrollment decisions are to changes in migration costs. If college migration costs were to increase by 10,000 euros—the average annual gross earnings of college graduates in Poland in 2002—college enrollment rates would still be 14% lower relative to open borders.

In the second set of counterfactuals, I test the effectiveness of earning subsidies and penalties on shaping college enrollment choices. These counterfactual policies are motivated by sending countries' proposals to give wage subsidies to educated returning migrants, as well as proposals to tax the foreign income of emigrants as a way to recoup taxpayers' investments in those migrants. When expected college earnings in Poland double for each person, college enrollment rates increase by only 2% relative to open borders. If instead Poland were to impose a wage penalty of 25% on foreign earnings of its citizens regardless of skill, college enrollment in Poland would decrease by 16%. Overall, these results show that enrollment rates in Poland are more sensitive to changes in pull factors, such as migration costs and foreign wage changes, than to changes in domestic wages.

This paper makes three main contributions. First, I contribute to our understanding of how migration policies affect skill accumulation in the context of open borders. A large theoretical literature has proposed models consistent with both brain drain and brain gain (Bhagwati and Hamada 1974, Bhagwati and Rodriguez 1975, Mountford 1997, Docquier and Rapoport 2012, Djajic, Docquier, and Michael 2019). Most of the recent empirical studies have focused on how migration affects human capital accumulation at lower education levels, finding mixed results (McKenzie and Rapoport 2011, Yang 2011, Batista, Lacuesta, and Vicente (2012), Dinkelman and Mariotti 2016, de Brauw and Giles 2017, Pan 2017, Shrestha 2017, Theoharides 2017).

A few empirical papers use cross-country comparisons to investigate the effect of migration on the stock of highly educated workers, finding ambiguous results (e.g., Beine, Docquier, and Rapoport 2008, Docquier, Faye, and Pestieau 2008, Beine, Docquier, and Defoort 2011). Very few papers explore how migration opportunities affect individual college enrollment (Girsberger 2017, Navarro and Zhou 2018, Chand and Clemens 2019). Similarly, there are only two papers that causally identify the effects of migration policies on specific major choices of individuals in sending countries: Abarcar and Theoharides (2021) explores enrollment in nursing programs in the Philippines in response to aggressive US nursing recruitment, whereas Khanna and Morales (2021) investigates sorting into IT occupations in India in response to changes in H1-B quotas.[2] In addition to the evidence being mixed, all evidence comes from either internal migration incentives, or international migration in a closed borders context. I add to this literature in two ways: first, I exploit an open borders experiment to causally identify how easing emigration affects understudied yet important outcomes for sending countries—college enrollment and major choice. Second, I study these effects within the context of open borders, where traditional immigrant recruitment policies might have less bite because one can freely cross international borders.

By showing that migration opportunities are an important factor in the college major decision, I speak to a growing literature that studies the determinants of college major choice.[3]. The literature has considered the role of expected lifetime earnings, ability, subjective beliefs, and non-pecuniary returns in major choice decisions (e.g., Berger 1988, Altonji 1993, Arcidiacono 2004, Beffy, Fougere, and Maurel 2012, Wiswall and Zafar 2015, Patnaik et al. 2020), unemployment rates and industry fluctuations (e.g., Blom, Cadena, and Keys 2021, Han and Winters 2020), as well as college admission policies (Bordon and Fu 2015). Most recently, Patnaik (2021) studies how major-specific pricing, family income and financial constraints affect major choice in a sample of US college students. Another strand of literature looks how migration rates are affected by college majors, but take major choices as given (e.g., Ransom 2016, Winters 2017). I propose an alternative model of college major choice, where the novelty is that migration costs affect the major decision separately from expected earnings and ability. My model results demonstrate that it is important to consider both local and global returns to a major when

[2] di Maria and Lazarova (2012) uses cross-sectional cross-country comparisons to evaluate the effect of migration on the enrollment in science and technology college majors, and finds that migration prospects positively affect the type of skills acquired in developing countries. Amuedo-Dorantes, Furtado, and Xu (2019) looks at college major choices of international students in the US after a change in US migration policy. It finds that the STEM OPT extension increased the likelihood that international students at US colleges major in STEM fields.

[3] For a thorough review of the literature, see Altonji, Arcidiacono, and Maurel (2016) and Patnaik, Wiswall, and Zafar (2020).

modeling the major choices of populations in relatively lower-income regions. While my paper focuses on international migration opportunities, migration incentives could be driving college decisions even across regions within a country.[4]

Finally, by focusing on skill accumulation, my paper sheds new light on the benefits of open border policies. As such, my results add to a growing literature on the benefits of open borders and the gains from removing migration barriers. Several papers estimate that easing emigration could more than double world GDP (Hamilton and Whalley 1984, Moses and Letnes 2004, Iregui 2005, Klein and Ventura 2007, Kennan 2013). Clemens (2011) summarizes the scarce literature on the efficiency gains from removing emigration barriers and concludes that we leave "trillion dollar bills on the sidewalk" by having closed borders.[5] Moreover, the efficiency gains from removing migration barriers is several orders of magnitude larger than liberalizing trade and capital flows (Clemens 2011). Kennan (2017) further estimates these gains within the European Union, and finds large net gains from migration accruing to citizens of new member states (both stayers and migrants). This past literature focuses on the efficiency gains of removing migration barriers. I instead look at how open borders and associated migration opportunities incentivize young potential migrants to invest in their education. Since economic growth is largely determined by the skill of the labor force, I show that global productivity gains from open borders may be even larger once we account for the endogenous response of skill accumulation.

2 Institutional background on the 2004 EU enlargement

In this section I describe the 2004 EU accession timeline, EU freedoms, and temporary migration restrictions, and discuss how the institutional setting and policy changes inform my empirical approach.

In May 2004, ten Central, Eastern and Southern European countries joined the European Union (EU). These new member states (NMS) were Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia. The number of countries increased from 15 to 25, and the EU population increased by 75 million, representing the largest enlargement since the establishment of the EU in 1958.[6] Figure 1 presents a map of NMS (in yellow) and

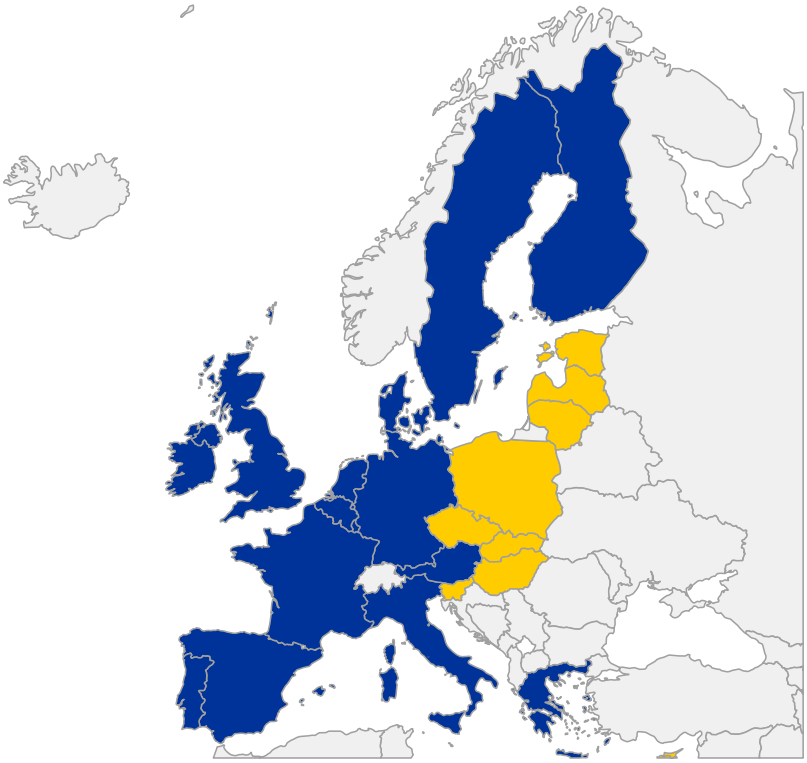
[4] Anstreicher (2021) studies how migration opportunities influence intergenerational income mobility in the US, and finds that college attendance drops by 30% if nobody is allowed to move across states.

[5] For a more recent review of the literature, see Dustmann and Preston (2019).

[6] The 15 incumbent countries in 2004 were Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Bulgaria and Romania joined the EU in 2007, and Croatia joined in 2013. The United Kingdom withdrew from the EU in January 2020.

incumbent EU15 countries (in blue).

Figure 1. European Union 2004 Enlargement



Notes: The map shows in yellow the ten new member states (NMS) entering the EU in 2004: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia. The existing 15 member states (EU15) are in blue: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

2.1 Three Stages of EU accession

Joining the EU requires a lengthy process which can be divided into three stages. In the first stage, a country becomes a candidate for EU membership. In the second stage, a candidate country begins accession negotiations, during which the candidate country adopts EU laws and reforms needed to meet the accession criteria, known as the Copenhagen criteria. These reforms require a candidate country to have a functioning market economy, institutions that guarantee democracy, human rights, the rule of law, and protection of minorities, as well as capacity to implement EU laws. In the final stage, once the candidate country has met the Copenhagen criteria, the country ends the accession negotiations and signs the Accession Treaty. Most countries that joined the EU in 2004 had started negotiations in 1998, finalized

negotiations in 2002, and signed the Accession Treaty in 2003.[7]

The length of the timeline is important for my empirical approach because it shows that NMS were formally invited to join the EU in 2002, thus NMS citizens could have anticipated the accession more than a year before the May 2004 accession date. Such anticipation could in turn affect decision-making of NMS citizens as early as 2002.[8] My research design will compare outcomes before and after negotiations ended in 2002.

2.2 The Four Freedoms of the European Single Market

EU member states form an economic and political union and are tied into a single market. The "four freedoms" guaranteed by the single market are the movement of goods, capital, services, and people. The free movement of persons implies the freedom to live, study, work or start a business in any of the EU countries. In particular, the free movement of labor implies that any EU national can look for employment and be employed in any EU country as if she is a national of that country.

Most importantly for my research design, most barriers to trade and capital movements between old and new member states were removed well before the 2004 accession date. Thus, the remaining change that took place in 2004 was the movement of people:

> "A major uncertainty surrounding the May 2004 EU enlargement process was the effect it would have on East-West migration flows, in terms of the actual numbers moving across borders and of the economic impact of those flows on the sending and receiving EU Member States. Indeed, the free movement of workers constituted the principal change in economic integration after accession, as barriers to trade, FDI and other capital movements had already been largely removed in the run-up to enlargement." *(European Commission Report, 2009)*.

The freedom of movement being the principal change in 2004 suggests that one can use the 2004 accession to study the effects of removing migration barriers. Moreover, because changes in East-to-West migration flows were the primary concern, this implies that the removal of migration barriers had a larger impact on the migration opportunities of NMS than EU15 nationals.

[7] All NMS held national referendums for EU accession between March and September 2003. All referendum results were favorable to EU accession.

[8] Adda, Pinotti, and Tura (2021) shows that new marriages among NMS and Italian citizens declined after negotiations end, providing further evidence that EU accession became highly certain once negotiations conluded, and NMS citizens adjusted their decisions accordingly.

Table 1. Transitional provisions end dates and sectoral exceptions

Receiving country	Labor market restrictions until:	Industry and occupation exceptions to market restrictions
Austria	May 2011	Hospitality, catering, construction, mechanics
Denmark	May 2009	IT, nurses, teachers, personal services
Finland	May 2006	IT, construction, food and restaurants
France	July 2008	IT, construction, hotels, catering
Germany	May 2011	Engineers, IT, health, construction, administrative
Italy	July 2006	Agriculture, tourism, construction, family care
Netherlands	May 2007	Health, construction, commercial services

Notes: This table shows the lifting of labor movement restrictions by EU15 countries for NMS nationals, as well as the sectors exempt from these labor movement restrictions.

2.3 Temporary Labor Movement Restrictions and Occupation-Specific Exceptions

Because EU15 countries were worried about the effects of a large influx of migrants on their domestic labor markets, the 2003 Accession Treaty allowed EU15 countries to impose restrictions on labor movement from NMS for up to seven years. These restrictions, also referred to as transitional provisions, included limited access to social welfare, imposed quotas on the number of residence and work permits issued to NMS nationals, and introduced rules that gave NMS nationals no more rights than non-EU nationals. Ireland, Sweden and the UK were the only countries that did not restrict the free movement of labor in the 2004 enlargement. In all other EU15 countries, NMS nationals had to apply for a work permit, take a labor market test, or their prospective employer had to provide proof that natives were not available for that position.

While most old EU15 countries applied some level of labor movement restrictions, most also made exceptions to the transitional rules to address domestic labor shortages. Some countries explicitly listed sectors and occupations which would be exempt, and others applid exemptions discretionally. Based on information from the European Commission and various national and OECD reports, I identify sectors and occupations with labor shortages for most EU15 countries. Table 1 presents these sectoral and occupational exemptions for a subset of EU15 countries. Of the occupations requiring high-skilled labor, IT and health were most often exempt from labor movement restrictions. In addition, service-related occupations across EU15 had a high demand for workers and thus were granted exemptions. Importantly, these exemptions reflect labor market shortages present when the transitional arrangements were announced in the 2003 Accession Treaty. Thus, it is possible that NMS nationals responded to these exemptions to labor movement restrictions by acquiring skills to match sector-specific labor demand in EU15 destination countries.

3 Data

To estimate the effect of open borders on human capital investment decisions, I use microlevel data from the European Union Labor Force Survey (EU LFS). The EU LFS is a large representative household sample survey that provides detailed quarterly information on labor force participation for people aged 15 and over. The survey is conducted by the national statistical institutes in every EU member state, four candidate countries and three countries of the European Free Trade Association (EFTA), and the data are then centrally processed by Eurostat. While the survey has been conducted since 1983 for older member states, it is only available since 1997 for countries joining in 2004. One of the main appeals of the EU LFS is that the data are harmonized, which makes it suitable for cross-country comparisons. In addition to rich information on labor outcomes, EU LFS also provides information on age in five-year bins, sex, educational attainment and participation, and a person population weight. It further provides information on country of birth, nationality, and detailed country of residence one year prior to the survey. While the survey is designed as a rotating panel, the data available to researchers are further anonymized and thus cross–sectional. I next describe how I construct the main outcomes of interest.

3.1 Identifying immigrants and calculating migration flows

To explore whether EU accession had a sizeable effect on migration rates from NMS to EU15, I use information on prior country of residence and nationality to identify immigrants in the EU LFS. For confidentiality purposes, nationality is provided in four main groups: national of the country of residence, EU15 national, NMS national, and other nationality.[9] Prior to 2004, there were three nationality groups only: national of the country of residence, EU15, and non-EU15 national. I split the non-EU15 nationality group into NMS and other nationality using the 2004 distribution of nationalities. That is, I assume that the share of NMS nationals in non-EU15 nationals prior to 2004 is identical to the share of NMS nationals in non-EU15 nationals in 2004. I validate this assumption by comparing my migration flow measure against international migration statistics from the UK Office of National Statistics, and find that the correlation is over 0.9.[10] The detailed country of prior residence, nationality groups, demographic

[9] In practice, the nationality group "Other" is broken down by finer nationality groups corresponding to broad world regions. For my purposes, these finer subgroupings are irrelevant and thus combined into one Rest-of-the-World nationality.

[10] I use data from the UK International Passenger Survey (IPS), which breaks down migrant inflows by citizenship group and country of last residence. I retrieve the number of non-British citizens that resided in an NMS country prior to migrating to the UK. Figure A1 plots NMS inflows I calculate using EU LFS, along with 95% confidence

and education information allow me to calculate gross migrant bilateral flows by year of migration, nationality, gender, age, and level of education. These detailed migration flows allow me to account migrants towards their country of origin rather than country of residence, thus correcting for selective migration.

3.2 Tertiary enrollment and attainment

To construct a measure of tertiary enrollment, I use information on the highest degree attained and on participation in education and training. The highest degree attained follows the International Standard Classification of Education (ISCED) and allows the researcher to distinguish between primary, secondary, post-secondary non-tertiary, and tertiary education.[11] Data on participation in education allows me to distinguish between enrollment in regular education and participation in training programs that our outside the formal education sector. Using these data, I create an indicator of tertiary enrollment that reflects if an individual was ever enrolled in a tertiary degree. In other words, the enrollment indicator equals one if an individual had already obtained a tertiary degree, or if they had not yet obtained a tertiary degree but were enrolled in a tertiary program in the four weeks prior to the survey.

Because the EU LFS does not provide information on dropping out of tertiary programs without obtaining a degree, my enrollment measure underestimates the number of people that have ever enrolled in a tertiary program. To assuage concerns about the impact of dropouts on my analysis, I focus on the cohort of 20–24 year olds as this is the traditional age for attending tertiary education in most EU countries. By doing so, I address the possibility that students take a long time to complete a degree in a discontinuous fashion. My college enrollment measure is the number of 20–24 year olds in a given country of origin and survey year that reported being enrolled in a tertiary degree, or had alrady completed their degree, as a percent of the respective birth cohort.

Measuring college attainment in the EU LFS is straightforward. I create an indicator that equals one if an individual has a tertiary degree, and use population weights to calculate the number of individuals in a given country of origin, survey year and age bin that have obtained a tertiary degree. While most tertiary programs can be completed in three to five years, in practice students take longer to complete their degrees. The theoretical degree duration also

intervals provided by the UK IPS. The important thing is to compare inflows before 2004. My migration flow measures are largely within the 95% confidence bounds of the IPS estimates, and the correlation is 0.94.

[11] A further breakdown allows one to distinguish between types of tertiary education, such as short-cycle tertiary, long cycle tertiary (similar to 4-year Bachelor's degree and Master's programs in the US), and PhD. Because data on current enrollment levels does not distinguish between different tertiary sublevels, in my analysis I combine all tertiary degrees into one group.

varies by degree, with some medical degrees taking six years to complete. To accomodate for these differences in theoretical and practical length of study, I focus on the cohort of 25–29 year olds in each survey year. My college attainment measure is the number of people who have completed a tertiary degree before the age of 30, as a percent of the respective birth cohort.

3.3 Tertiary enrollment and attainment by fields of study

To explore the effect of open borders and transitional arrangements on the choice of field of study, I use EU LFS information on field of study for those who have completed a tertiary degree, and those who are currently enrolled in a tertiary degree. Fields of study are combined in nine broad groups: Teaching and Education; Humanities and Arts; Social Sciences, Business and Law; Life Sciences, Physical Sciences, Mathematics and Statistics; Information and Communication Technology (IT); Engineering, Manufacturing and Construction; Agriculture and Veterinary; Health and Social Services; and Services.[12]

One hurdle to constructing outcomes of interest by field is that the EU LFS started collecting information on field of study in 2003, after EU negotiations ended in 2002. To address this issue, I use the retrospective nature of the EU LFS to extend the sample before 2003. To measure attainment by field, I use the cohort of 25-29 year olds to calculate the number of degree holders by field after 2003. To calculate the number of degree holders by field before 2003, I use the cohort of 30-34 year olds in survey years 2003–2007 since these cohorts were 25–29 years old in years 1998–2002. Because 30–34 year olds have five additional years to complete their degrees compared to the 25–29 year olds, and thus could have higher completion rates by construction, I use the year when the individual completed their degree to determine whether a 30–34 year-old had indeed obtained their degree when they were 25–29 years old. To measure enrollment, I use a similar approach, but focus on the cohort of 20–24 year olds to calculate field-specific enrollment after 2003, and the cohort of 25–29 year olds to calculate enrollment between 1998-2002.

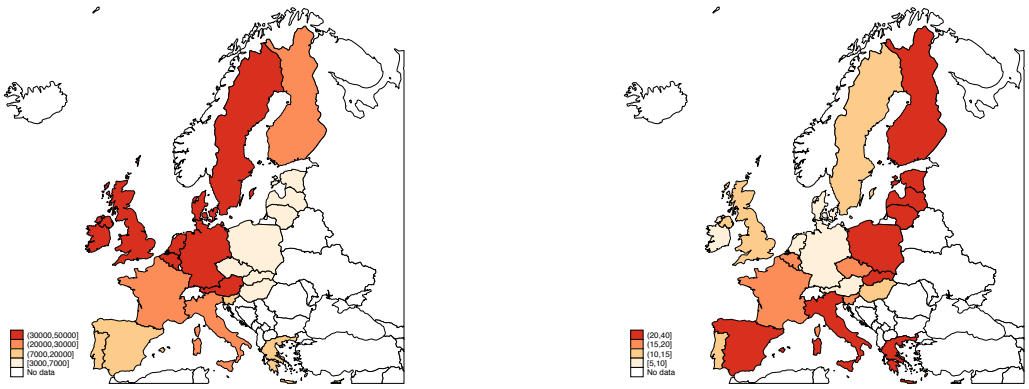
3.4 Supplementary data

I complement the EU LFS data with macroeconomic and education-related variables provided by the OECD, UNESCO, Eurostat, and the World Bank. I collect data on GDP growth, FDI flows, trade, youth unemployment, remittances, consumer expectations, tertiary education system structure, and tertiary education spending as percent of GDP. Finally, I calculate average

[12] Service fields include tourism and management, sports and leisure, environmental conservation and protection, criminology, police academy, military, civil security, and nautical science.

Figure 2. Income and Unemployment disparities in NMS and EU15

Average annual gross earnings **Unemployment rate among 20–29 year olds**



Notes: The left panel shows average annual gross earnings between 2001 and 2003, measured ineuros. The right panel shows the unemployment rate of 20–29 year olds in each country. Darker shades indicates higher values of the outcome of interest. Lighter shades in the left panel indicate lower annual earnings, and darker shades in the right panel indicate higher unemployment rates.

earnings by country, year, age, gender and educational attainment from the EU Structure of Earnings Survey (EU SES). EU SES is a representative enterprise survey conducted every four years since 2002 in most European countries. For each worker, it collects information on age, gender, education level, occupation, and monthly gross wages in national currency. I convert wages to euros using exchange rates provided by Eurostat.

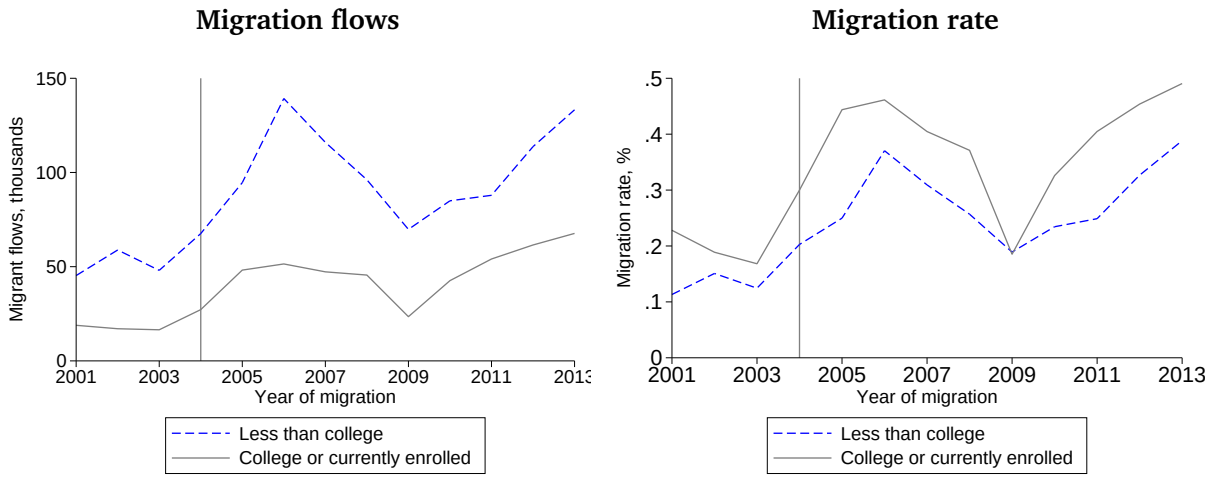
3.5 Sample selection and summary statistics

The final sample is a panel of 21 countries—eight NMS and 13 EU15—from 1998 to 2013.[13] I calculate the percent of a birth cohort that were ever enrolled in a tertiary degree and that completed a tertiary degree using all nationals (both stayers and emigrants) of a country. I combine my country-year level data on outcomes with country-year level macroeconomic variables, consumer expectations, and tertiary education characteristics.

First, NMS and EU15 countries had very different standards of living in the run-up to EU enlargement. The left panel of Figure 2 shows annual average gross earnings across NMS and EU15 countries right before 2004. The right panel shows unemployment rates of 20–29 year olds in each country. With the exception of Slovenia, the average NMS citizen earned only 20% of average annual earnings of the average EU15 citizen. 20–29 year old NMS citizens faced

[13] I exclude Malta and Cyprus from the treated group. EULFS data on Malta starts after 2009, and Cyprus is unusual in that more than 50% of students study abroad. Malta and Cyprus were also treated differently from other new member states in that they were not subject to any temporary labor movement restrictions. I also exclude Ireland and Luxembourg because of missing data for my variables of interest.

Figure 3. NMS-to-EU15 Migration Flows



Notes: The left panel shows migration flows of NMS citizens from NMS to EU15 countries, in thousands. The right panel shows migration rates by education level, $MigRate_{kt} = \frac{M_{kt}}{M_{kt}+N_{kt}}$. M_{kt} is the number of emigrants in skill group k and year t shown in the left panel, and N_{kt} is the number of stayers for the same skill group and year. The blue dashed line plots migration flows and rates for NMS citizens with less than a college degree. The solid gray line plots migration flows for NMS citizens who have a college degree or were in the process of obtaining one.

over 30% unemployment rates, much higher than most EU15 countries. These large income and unemployment disparities between NMS and EU15 were the main reasons countries were concerned about mass migration from NMS to EU15, and many studies attempted to predict East-to-West migration flows (e.g., Fihel et al. 2015, Lang 2008).

To show that EU accession did indeed greatly reduce migration costs for NMS nationals, the left panel in Figure 3 plots absolute migration flows of NMS nationals from NMS to EU15 countries, separately by education level. Before 2004, about 70,000 NMS nationals emigrated from NMS to EU15 countries. After 2004, NMS migrant flows peaked at just shy of 200,000, a three-fold increas from pre-accession levels. Migration flows increased both for NMS nationals with no college degree, and for those who had some college or a college degree. The right panel of Figure 3 plots migration rates by education level, $MigRate_{kt} = \frac{M_{kt}}{M_{kt}+N_{kt}}$, where M_{kt} is the number of emigrants in skill group k and year t shown in the left panel, and N_{kt} is the number of stayers for the same skill group and year. The migration rate for people with at least some college is larger than that for people with less than a college degree both before and after 2004. This is evidence that international migration was easier for highly educated individuals both before and after EU accession. The migration rate of less educated NMS nationals also increases sharply. While international migration remained easier for those with some tertiary education, migration for those those with a high school degree became relatively

Table 2. Summary statistics

	NMS 1998-2001	NMS 2002-2013	EU15 1998-2001	EU15 2002-2013
Ever enrolled at 20-24	26.79	41.02	32.73	40.17
Degree at 25-29	16.45	25.19	25.51	32.86
Enrollment by field of study				
Education and Teaching	3.68	3.67	3.35	3.67
Arts and Humanities	1.20	3.19	1.88	4.12
Social Sciences, Business, Law	11.98	16.05	14.15	16.39
Natural Sciences	1.35	2.36	2.91	3.42
IT	1.45	2.62	1.85	2.13
Engineering	4.43	6.37	5.84	6.58
Agriculture and Vet	1.00	1.11	0.87	0.89
Health	1.99	3.19	5.76	6.59
Services	1.65	3.03	1.75	2.26

Notes: This table shows the average enrollment and attainment rates for NMS (treated) and EU15 (comparison) countries, before EU accession negotiations ended (1998-2001) and after negotiations (2002-2013). Enrollment rates are expressed as the percent of the 20–24 year old birth cohort that has ever enrolled. Attainment rates are expressed as the percent of a 25–29 year old birth cohort that has obtained a college degree.

easier following the opening of borders.

Finally, Table 2 provides summary statistics on the main tertiary education outcomes of interest, broken down by treatment status and time period. Following the different stages of EU accession, I select 1998-2001 to be pre-intervention period and 2002-2013 the post-intervention period. Given the differences in migration opportunities for NMS and EU15 nationals, I assign NMS to the treated group and EU15 to the comparison group. Columns 1 and 2 show mean outcomes for treated countries before and after the intervention, and columns 3 and 4 show means for the comparison countries. Enrollment rates among 20-24 year olds in NMS increased from 27% to 41% (a 52% increase), while in EU15 countries the enrollment rate increased from 33% to 40% (20% increase), indicating a convergence between NMS and EU15 countries. The attainment rate among 25-29 year olds increased from 16% to 25% in NMS (56% increase), compared to 26% to 33% in EU15 (27% increase). Turning to enrollment rates by college major, enrollment of 20-24 year olds increased across all fields in both NMS and EU15, with the exception of education and teaching in NMS. However, NMS enrollment had larger gains in social sciences, engineering, health, services, and IT. For example, NMS enrollment in IT increased from 1.4% to 2.6%, whereas in EU15 it increased from 1.8% to 2.1%.

4 Empirical strategy

To identify the effect of open borders and changes in migration opportunities on human capital investment decisions, I use differene–in–differences (DiD) and event study frameworks. Guided

by the institutional setting described in Section 2 and country differences shown in Section 3, I assign NMS to the treatment group, and use EU15 countries to the comparison group. I further assign cohorts making college decisions before 2002 to be the untreated cohorts, and those making decisions after 2002 to be the treated cohots.

In my DiD analysis, I split the post-treatment period into an anticipation period between 2002 and 2004, and an open borders period from 2005 to 2013. Formally, I estimate the following model:

$$Y_{ct} = \lambda_c + \delta_t + \gamma_1 \mathbb{1}(c \in NMS, t \in (2002, 2004)) + \gamma_2 \mathbb{1}(c \in NMS, t \in (2005, 2013)) + \epsilon_{ct} \quad (1)$$

Y_{ct} is a measure of enrollment in tertiary programs or tertiary degree attainment for origin country c and a given age cohort in year t. The coefficients of interest are γ_1 which captures the change in outcomes in NMS versus EU15 countries that is associated with the anticipation of EU accession, and γ_2 which captures the change in outcomes associated with realized EU accession. λ_c captures time–invariant country characteristics that are correlated with education outcomes, such as the existence of strong higher education tradition, or societal norms and expectations regarding the value of higher education. δ_t is a year effect which captures time–varying characteristics that are common across countries. For example, δ_t would capture common effects of the 2009 financial crisis, or similar trends in the desirability of a tertiary degree.

The key identifying assumption in a difference–in–differences strategy is that the control group provides a good counterfactual for how the outcome would have evolved in the treated group in the absence of treatment. To test for parallel trends, I use an event study approach. Formally:

$$Y_{ct} = \sum_{\tau=1998, \tau \neq 2001}^{\tau=2015} \phi_\tau \mathbb{1}(c \in NMS) \mathbb{1}(t = \tau) + \lambda_c + \delta_t + \epsilon_{ct} \quad (2)$$

The sum in Equation (2) is a collection of interactions between a treatment indicator which equals one for NMS countries, and year dummies. Following the EU accession timeline, I omit the year 2001 which is equivalent to setting ϕ_{2001} to zero. The main coefficient of interest is ϕ_τ, which captures the differences in outcomes in treated versus comparison countries in year τ relative to year 2001. Because ϕ_τ captures the effect of anticipated or realized 2004 enlargement on educational outcomes, one would ideally observe small and statistically insignificant coefficients before the treatment year. This would imply that outcomes in treated and comparison countries were evolving in parallel, and that there were no anticipatory changes

in behavior among NMS cohorts before 2002.

My research question requires that I isolate the effect of migration opportunities from other changes that may have occurred during the EU accession process and that could be correlated with my outcomes of interest. Because joining the EU is a complex event that affects the economy of both new and old states, there are many factors beyond changes in migration costs that may be picked up by ϕ_τ. For example, if other changes correlated with the outcome occurred in the treated group right around EU accession, it is unclear how much of the estimated effect is due the the change in migration opportunities versus other events. Since EU member states enjoy the free movement of goods, services, and capital within the internal market, one might worry that these macroeconomic shocks to NMS economies could have affected educational investments for all sorts of reasons unrelated to migration opportunities. For example, EU15 firms could have outsourced jobs to NMS countries as NMS wages were much lower, potentially leading to an increase in NMS labor demand for college-educated workers.

These concerns are partially addressed by the fact that both trade and capital restrictions were lifted before the accession negotiations started in 1998 (see Section 2). Thus, the effect of increased trade and capital flows on NMS economies should have already been felt before accession. However, I further address these concerns in four ways. First, I run the following DiD specification with various macroeconomic characteristics as dependent variables:

$$Y_{ct} = \lambda_c + \delta_t + \gamma \mathbb{1}(c \in NMS, t \geq 2004) + \epsilon_{ct} \tag{3}$$

Table 3 presents estimates of γ from Equation (3). The estimates show that NMS FDI inflows, export and import growth on average did not change after EU accession. This is again unsurprising given that trade and capital flows were liberalized before accession negotiations even began. In addition, the coefficient on the youth unemployment rate is negative but imprecisely estimated. These results help assuage concerns that domestic labor market conditions changed significantly after EU accession and could be driving the results.

Second, to further address concerns that the DiD estimates are picking up behavioral responses to domestic labor market conditions rather than migration opportunities, I modify my baseline specification to control for country-specific pre-accession macroeconomic characteristics. Third, I control for lagged time-varying macroeconomic variables, consumer expectations and tertiary education supply proxies. This exercise is in the spirit of mediation analysis and the goal is to net out the effects of time-varying domestic labor market and higher education conditions on educational investments. Fourth, I use a triple difference approach which extends the DiD

Table 3. Balance of covariates

	(1) $\frac{FDI}{GDP}$	(2) ΔExports	(3) ΔImports	(4) UR
2004-2013	0.589	0.918	-0.356	-1.853
	(1.116)	(1.413)	(1.959)	(2.032)
Mean outcome	3.915	8.011	9.398	20.004

Notes: This table reports estimates if γ from Equation (3), where each column is a different outcome. The pre-period is 1998–2003 and includes the 21 countries used in the main sample. NMS countries are treated and EU15 countries are comparison countries. Column 1 shows results for FDI inflows as percent of GDP. Columns 2 and 3 show results for growth of exports and imports as percent of GDP, respectively. Column 4 show results for the unemployment rate of 20–29 year olds. Wild bootstrap standard errors clustered at the country level are in parentheses. *,**,*** represent 10%, 5%, 1% significance levels.

approach by comparing outcomes of young relative to old cohorts in a third difference. The idea behind using older cohorts in a triple difference is that older cohorts are affected by changes in domestic labor market conditions due to EU accession, but are not affected by migration opportunities since older people are less likely to migrate.

Finally, it is also possible that students in the comparison countries changed their college decisions in anticipation of an immigrant influx. For instance, if EU15 youth expected a large inflow of college-educated NMS workers, EU15 youth might expect college wages to decrease and thus decide against attending college. In this case, the estimates would overstate the effect of migration prospects on tertiary education investments. However, numerous public debates show that, if anything, EU15 countries expected a large inflow of low-skilled workers (eg. the "Polish plumber"). Thus, it is more likely that EU15 students enrolled in college in anticipation of low-skilled NMS immigrants, thus biasing the DiD estimates towards zero.[14] Nevertheless, to address this concern further, I run two sensitivity analyses where I restrict the comparison group to subsets of EU15 countries that were less likely to receive large waves of NMS immigrants.

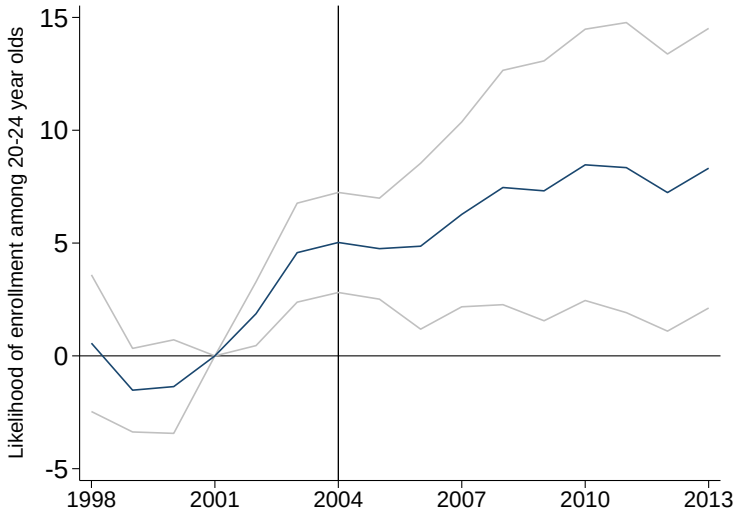
5 Results

5.1 College enrollment and attainment

I begin by showing the effect of open borders on the likelihood of having enrolled in a tertiary program for the cohort of 20-24 year olds. Figure 4 plots estimates of ϕ_τ from Equation (2) without any additional controls. First, the graph shows that there is no statistically significant pre-trend leading up to the closing of EU negotiations in 2002, thus satisfying the parallel

[14] Jackson (2018) finds that an influx of less skilled immigrants increases college enrollment of natives in the US.

Figure 4. Enrollment among 20-24 year olds



Notes: This figure plots estimates of ϕ_τ from Equation (2) with no additional controls. The outcome variable is the percent of a 20–24 year old birth cohort in a given year that has ever enrolled in college. The blue line plots point estimates of ϕ_τ. The gray lines present 90% confidence intervals based on wild bootstrap standard errors. The coefficient in 2001 is normalized to 0. The y-axis value shows the percentage point increase in a given year relative to 2001. NMS are treated countries, and EU15 are comparison countries. The vertical line at 2004 marks EU accession.

trends condition. Second, there is a clear increase in the probability that a 20-24 year old has enrolled in a tertiary program after EU negotiations end in 2002. Specifically, NMS students were about 5 percentage points more likely to enroll in college in 2004 relative to 2001. This 5 percentage point increase represents a 18% increase in enrollment from the pre-period level of 27%. Since NMS joined the EU in 2004, the fact that we see positive estimates as early as 2002 shows that enrollment among NMS nationals responded in anticipation of the open border policy.[15]

The positive effect of open borders on tertiary enrollment persisted for many years, reaching over 10 percentage points in the 2010s, or a 37% increase from the pre-period enrollment levels. While these effects might seem large, they are smaller compared to estimates in Chand and Clemens (2019) which finds over 50% increase in college enrollment in response to exit options for high-skilled Indo-Fijians. My estimates are also small in comparison to Abarcar and Theoharides (2021), which finds an increase of 156% in nursing enrollment in the Philippines in response to better nursing migration opportunities towards the US. Overall, young NMS nationals increased their tertiary enrollment in statistically and economicially significant ways,

[15]These findings of an anticipatory change in behavior are in line with Adda, Pinotti, and Tura (2021) which finds that marriage rates among EU15 and NMS nationals decreases as soon as NMS accession to the EU became almost certain with the closing of negotiations.

Figure 5. Attainment among 25-29 year olds

Notes: This figure plots estimates of ϕ_τ from Equation (2) with no additional controls. The outcome variable is the percent of a 25–29 year old birth cohort in a given year that has obtained a college degree. The blue line plots point estimates of ϕ_τ. The gray lines present 90% confidence intervals based on wild bootstrapped standard errors. The coefficient in 2001 is normalized to 0. The y-axis value shows the percentage point increase in a given year relative to 2001. NMS are treated countries, and EU15 are comparison countries. The vertical line at 2004 marks EU accession.

both in anticipation of their country joining the EU, as well as after they became EU citizens and could freely migrate.

Since the returns to obtaining a college degree are higher than for having some college experience but no diploma, I next explore whether tertiary degree attainment was affected by open borders in the same way as tertiary enrollment. Figure 5 plots ϕ_τ coefficients from Equation (2) without any additional controls. The left-hand-variable is the percent of a 25-29 year old cohort in a given year that has obtained a college degree. The figure shows slight downward pre-trends leading up to the 2002 closing of negotiations. Yet, after the closing of accession negotiations in 2002, there is a reversal in trend and attainment levels among 25-29 year olds begin to increase. The event study coefficient are positive and statistically significant between 2007 and 2011, implying that the open borders policy increased tertiary attainment among nationals in NMS by almost 5 percentage points relative to the attainment rate in 2000 and relative to EU15 nationals. This is a 30% increase relative to the pre-treatment period mean of 16.4%. Since a tertiary degree takes at least 3-4 years to complete, it is unsurprising that the positive and significant effects on attainment show up 3 years after EU accession. However, given the slight downward pre-trend, I am cautious in interpreting these results as strong evidence of increased NMS attainment in response to open borders.

Table 4. Did local labor demand, expectations, and college reforms drive enrollment?

	(1) No controls	(2) Macro baseline	(3) Macro lags	(4) Expectations	(5) Bologna Process	(6) Edu. spending	(7) Triple Dif.
2002-2004	4.403***	4.716***	5.660***	4.443***	4.298***	4.332***	6.609***
	(1.052)	(1.483)	(1.241)	(1.472)	(1.436)	(1.436)	(1.320)
2005-2013	7.583***	10.038***	11.647***	9.337***	8.549***	8.711***	10.263***
	(2.733)	(3.113)	(2.289)	(2.136)	(2.357)	(2.366)	(2.603)
Obs.	336	336	336	336	336	336	672
Mean outcome				26.79			

Notes: This table presents estimates of γ_1 and γ_2 from Equation (1), where the outcome is the percent of a 20–24 year old birth cohort that ever enrolled measured at the country-year level. Column 1 is the baseline specification with no additional controls. Column 2 adds macroeconomic controls measured in 1998 and interacted with year dummies. Column 3 instead adds one-year lags of time-varying macro covariates (GDP growth, trade growth, FDI inflows as % of GDP, remittances as % of GDP, and the unemployment rate of 20–29 year olds). Column 4 additionally controls for one-year-ahead consumer expectations of the unemployment rate, personal financial situation, overal economic conditions, and inflation. Column 5 additionally controls for the percent of tertiary students that are studying under the Bologna 3-tier higher education system. Column 6 additionally controls for one year lags of tertiary education spending as % of GDP. Column 7 shows triple difference estimates from Equation (4), where 50-54 year olds are used as the third difference. Average NMS enrollment between 1998-2001 is 26.8%. Wild bootstrap standard errors clustered at the country level are in parentheses. *,**,*** represent 10%, 5%, 1% significance levels.

Mechanisms driving tertiary degree enrollment and attainment

EU accession affects the macroeconomy of joining states in significant ways through trade and capital flow liberalization, as well as through the freedom of movement of workers. Which aspect of the open border policy were young NMS nationals responding to? In this section, I present evidence that the dominant mechanism through which open borders affected tertiary degree investments among nationals in NMS countries is through improved migration opportunities resulting from EU accession.

To this end, Table 4 shows estimates from alternative specifications of Equation (1). As before, the base period is 1998–2001, the anticipation period is 2002–2004, and the post-accession period is from 2005–2013. The treated group includes 8 NMS, while the comparison group includes 13 EU15 countries. Column 1 shows estimates without any additional controls and is equivalent to the event study results shown in Figure 4. Specifically, anticipation of EU accession increased tertiary enrollment among 20-24 year old NMS nationals by 4.4 percentage points, while the opening of borders increased it by an average of 7.6 percentage points.

Macroeconomic conditions varied widely across new and old member states before EU enlargement, which could have affected enrollment and attainment decisions independently of EU accession. To control for this possiblity, column 2 controls for GDP growth, export growth, FDI inflows, remittances, and the youth unemployment rate in 1998, interacted with year dummies. GDP, export growth and FDI inflows can increase enrollment and attainment through their effect on job creation in the country of origin. Remittances have been found to increase

enrollment in education by aleviating financial constraints (e.g., Yang 2011, Gibson, McKenzie, and Stillman 2011, Dinkelman and Mariotti 2016, Theoharides 2017). While tertiary education in most EU countries is predominantly administered in public institutions and is therefore free, remittances could increase tertiary attendance by removing the need to work for pay. Finally, high youth unemployment could be pushing young people into tertiary education (e.g., Dellas and Sakellaris 2003, Long 2004, Bell and Blanchflower 2011, Hoxby and Brown 2015). The estimates in the anticipatory period are similar to the baseline estimates in column 1, and those in the post-accession period increase to 10 percentage points. Thus, prior macroeconomic conditions and financial constraints were not the main drivers of college investment decisions in NMS countries.

The difference–in–differences estimates would be biased if labor market conditions in NMS evolved differently from conditions in EU15 countries and in a way that increased the likelihood of tertiary enrollment and completion in NMS. For example, if FDI flows to NMS increased the demand for skilled labor after EU accession, enrollment could increase in response to domestic labor demand. To net out the effects of domestic labor market conditions on NMS enrollment, in column 3 I include time-varying lagged macroeconomic controls. While the post-accession effect is four percentage points larger than the baseline effect, the anticipatory effect is not statistically significantly different from the baseline estimate in column 1. This suggests that time-varying lagged macroeconomic conditions were not the main mechanisms behind the increase in tertiary enrollment.

Another possibility is that tertiary enrollment in NMS responded to expectations about domestic economic conditions brought about by EU accession. For example, if NMS youth expected better domestic job opportunities due to large outmigration of college-educated workers, they could have been more likely to enroll in college. In column 4, I additionally control for average consumer expectations about personal financial situation, general economic situation, prices and unemployment one year ahead. Again, the anticipatory estimates are robust to controlling for consumer expectations.

Another source of bias could be the introduction of a higher education policy that changes the structure of tertiary education in NMS but not in EU15 countries. One such policy was brought by the Bologna Declaration, which ensured comparability of higher-education qualifications across the European Higher Education Area (EHEA). Among other changes, EHEA participating countries agreed to implement a three-cycle higher education system, with clear distinction between bachelor's, master's and doctoral degrees. In some countries, these changes effectively shortened the time to a bachelor's degree. While the agreement was signed by all NMS and

EU15 countries before 2001, the rollout occurred at different times.[16] To account for the effects of the differential implementation of the Bologna process on enrollment, column 5 additionally controls for the share of tertiary students that are studying within a three-cycle system at the country and year level. As before, the anticipatory estimates remain robust, suggesting that the Bologna process implementation does not explain the increase in tertiary enrollment among NMS nationals.

Another higher education policy that could bias the estimates is the so-called massification of higher education that took place in NMS in the mid to late 1990s. The transition from a centralized to a market economy was accompanied by an expansion of higher education, including the establishment of private higher education institutions.[17] Tertiary enrollment in NMS could have increased as a result of an increase in the supply of university seats and regardless of EU accession prospects, thus biasing the estimates upward. While I do not have data on the number of university seats for the countries in my sample, in column 6 I proxy for changes in supply by controling for lags of tertiary education spending as percent of GDP and the student-to-academic staff ratio. The estimates are similar to the baseline estimates. Since column 6 includes controls for macroeconomic conditions, consumer expectations, degree of Bologna process implementation, and tertiary education supply, the robustness of the estimates suggests that these mechanisms do not drive the enrollment effects resulting from either anticipation of EU accession or the actual opening of borders.

Finally, I use a triple difference model which allows me to control for country-year effects, thus absorbing any remaining omitted variables. Specifically, I extend the DiD specification to include the cohort of 50-54 year olds as a third difference:

$$\begin{aligned} Y_{act} = {} & \gamma_1 NMS_c * Young_a * Anticipation_t + \gamma_2 NMS_c * Young_a * PostEU_t + \\ & \alpha_1 NMS_c * Anticipation_t + \alpha_2 NMS_c * PostEU_t + \alpha_3 NMS_c * Young_a + \\ & \alpha_4 Young_a * Anticipation_t + \alpha_5 Young_a * PostEU_t + \lambda_c + \delta_t + \zeta_a + \epsilon_{act} \end{aligned} \quad (4)$$

Here, NMS_c is an indicator for the treated countries, $Anticipation_t$ equals one for years 2002–2004, $PostEU_t$ equals one for years 2005–2013, and $Young_a$ equals one for young people and zero for 50-54 year olds who are nationals of country c. The rationale for using 50-54 year olds rests on the fact that older people are less likely to migrate. While 50-54 year olds could benefit from changes in domestic labor market conditions after EU accession, they are

[16] Some countries (eg. Lithuania) already had a three-cycle system in place, while others implemented it much later (eg. Germany in 2010).

[17] By the late 2000s, Poland had one of the largest private university sectors worldwide, and approximately one third of tertiary students were attending a private university.

less likely to be affected by the freedom of movement when borders open. Consequently, it is unlikely that their decisions respond to migration opportunities. Column 7 of Table 4 reports estimates of γ_1 and γ_2. The conclusion remains intact: young NMS nationals increased their enrollment by 6.6 percentage points in anticipation of better migration opportunities, and by 10.3 percentage points post-EU accession.

While the estimates so far suggest that the increase in NMS enrollment is not explained by realized and expected domestic labor market conditions, it could be the case that there are spillovers to the comparison group which would bias the estimates upward. EU15 countries were wary of a large influx of NMS immigrants after 2004, and it is possible that young EU15 nationals also changed their college investment decisions. For example, if EU15 nationals expected a large influx of highly skilled NMS immigrants to increase competition and decrease wages for high skilled jobs, then they could have become less likely to enroll in college. In this scenario, the DiD estimate would have an upward bias. Based on numerous news articles and reports by the European Commission, EU15 countries largely feared an influx of less educated migrants, which would have increased competition for lower skilled jobs. Using US data, Jackson (2018) shows that an increase in the stock of low skilled immigrants incentivizes natives to invest in more schooling. If that finding holds in the EU context, it would imply that my DiD estimates are biased towards zero.

Nevertheless, I address concerns of spillovers to EU15 countries in two ways. First, I exclude the most popular EU15 destination countries for NMS immigrants from the comparison group. Based on the immigrant stock before 2004, these countries include Austria, Germany, France, Italy, Spain, and the UK.[18] Column 1 of Table 5 reports results using the remaining EU15 countris as comparison. The estimates are very similar to the baseline results, implying that spillovers to the comparison group are not driving the effects of open borders on enrollment.

Next, I address further concerns about spillovers by limiting the comparison group to EU15 countries with relatively low youth unemployment rates. I therefore exclude Greece, Italy, Spain, and Finland from the comparison group. It is possible youth in these four countries worried about the effects of even a modest immigrant influx on the already scant employment opportunities for young people. In that case, enrollment in these comparison states could have increased in light of immigrant competition for low skilled jobs, or it could have decreased because of immigrant competition for scarce high skilled jobs. Column 2 of Table 5 shows the estimates using this alternative comparison group, and shows that they are very robust. In sum,

[18] Germany and Austria received the largest share of NMS migrants before EU enlargement. Consequently, they were the initiators and main proponents for transitional agreements that would allow them to keep their labor markets closed for up to seven years post EU accession.

Table 5. Enrollment: spillovers to comparison group and triple difference

	(1) Exclude top EU15 dest.	(2) Exclude high UR EU15
2002-2004	4.238***	4.598***
	(1.415)	(1.026)
2005-2013	6.706*	8.284***
	(3.851)	(2.230)
Obs.	240	272
Mean outcome	26.79	

Notes: This table presents estimates of γ_1 and γ_2 from Equation (1) with no additional controls. The outcome is the percent of a 20–24 year old birth cohort that ever enrolled in college measured at the country-year level. Column 1 limits the comparison group to EU15 countries that were not top destinations for immigrants before EU accession—Austria, Germany, France, Italy, Spain and the UK are excluded. Column 2 limits the comparison group to EU15 countries that did not have high unemployment rates for 20–29 year olds—Greece, Finalnd, Italy and Spain are excluded. Average NMS enrollment between 1998-2001 is 26.8%. Wild bootstrap standard errors clustered at the country level are in parentheses. *,**,*** represent 10%, 5%, 1% significance levels.

potential spillovers to the comparison group do not explain the increase in NMS enrollment either in anticipation of EU accession or after it.

Taken together, Figure 4, Table 4 and Table 5 show that both the anticipation and implementation of open borders had large and positive effects on tertiary enrollment among young NMS nationals. More importantly, these positive effects cannot be explained by domestic economic conditions, trade and capital flows, expectations about economic conditions, or changes to the tertiary education system. Neither can they be explained by spillovers to the comparison group. Because the freedom of movement was the last freedom to be unlocked by EU accession, and because migration opportunities affect young people disproportinately more than older cohorts, the triple difference estimates strongly suggest that tertiary enrollment decision of young NMS nationals were affected by migration opportunities rather than local economic conditions. The strongest evidence that NMS college enrollment decisions were primarily driven by migration opportunities comes from the highly robust positive and statistically significant anticipatory estimates, as only the knowledge of future migration possibilities changed between 2002 and 2004.

Turning to tertiary attainment, Table 6 repeats a subset of the exercises presented in Table 4 and Table 5 for the cohort of 25-29 year olds. The left-hand-side variable is the percentage of 25-29 year olds that have obtained a tertiary degree. Because it takes at least 3-4 years to

Table 6. Attainment: mechanisms and spillovers

	(1) No controls	(2) Macro baseline	(3) Country-year lags	(4) Triple Dif.	(5) Exclude top EU15 dest.	(6) Exclude high UR EU15
2002-2004	-1.532	-1.716	-0.185	0.715	-0.914	-2.021
	(1.306)	(1.922)	(1.196)	(1.177)	(1.536)	(1.390)
2005-2013	2.371	3.333	4.402**	5.125**	1.912	2.487
	(2.462)	(3.351)	(1.971)	(2.358)	(3.041)	(2.385)
Obs.	336	336	336	672	240	272
Mean outcome			16.45			

Notes: This table presents estimates of γ_1 and γ_2 from Equation (1), where the outcome is the percent of a 25–29 year old birth cohort that has obtained a college degree, measured at the country-year level. Column 1 is the baseline specification with no additional controls. Column 2 adds macroeconomic controls measured in 1998 and interacted with year dummies. Column 3 instead adds one-year lags of time-varying macro covariates (GDP growth, trade growth, FDI inflows as % of GDP, remittances as % of GDP, and the unemployment rate of 20–29 year olds), one-year-ahead consumer expectations of the unemployment rate, personal financial situation, overal economic conditions, and inflation, percent of tertiary students that are studying under the Bologna 3-tier higher education system, and one year lags of tertiary education spending as % of GDP. Column 4 shows triple difference estimates from Equation (4), where 50-54 year olds are used as the third difference. Column 5 limits the comparison group to EU15 countries that were not top destinations for immigrants before EU accession—Austria, Germany, France, Italy, Spain and the UK are excluded. Column 6 limits the comparison group to EU15 countries that did not have high unemployment rates for 20–29 year olds—Greece, Finalnd, Italy and Spain are excluded. Average NMS attainment between 1998-2001 is 16.5%. Wild bootstrap standard errors clustered at the country level are in parentheses. *,**,*** represent 10%, 5%, 1% significance levels.

complete a tertiary degree, I focus the discussion on the post-EU period. Column 1 shows the baseline results from Equation (1) without any additional controls, similar to Figure 5. The estimate is positive but not statistically significant. The results are similar when I include baseline macroeconomic conditions (column 2), and when I exclude comparison countries that could be susceptible to spillovers (columns 5 and 6).

Once I control for one-year lags of time-varying macro conditions, consumer expectations and tertiary edication characteristics, the DiD coefficient more than doubles and becomes statistically significant (column 3 of Table 6). These results suggest that lower migration costs after 2004 are associated with a 4.4 percentage point increase in the attainment rate among 25-29 year olds NMS nationals, or a 27% increase from a baseline NMS attainment of 16.4%. The same is true when I use a triple difference method with 50-54 year olds as the third difference in column 4. Since the triple difference specification controls for country-year fixed effects, I take the positive and statistically significant result as suggestive evidence that young NMS nationals not only enrolled in college at higher rates in response to better migration prospects, but also were more likely to persist in completing their degree. However, while the point estimates for the post-accession period are positive in all specifications, the standard errors are often large, which prevents one from drawing strong conclusions.

5.2 Did open borders affect the choice of college major?

So far, the results show that better migration opportunities associated with the 2004 EU enlargement increased NMS college enrollment rates among 20–24 year olds. Which college majors were students more likely to pick? Why would there be an incentive to choose certain majors over others? As discussed in Section 2, fears of mass immigrant influx from NMS to EU15 countries prompted EU15 countries—Austria and Germany specifically—to push to temporarily restrict access to their labor markets. The resulting transitional arrangements allowed new and old countries to restrict labor markets access for up to seven years following the 2004 enlargement. Of the EU15 countries, only Sweden, Ireland and the UK fully opened up their labor markets in 2004. While other EU15 countries restricted NMS workers access for at least two years, all countries made exceptions to these labor movement restrictions in line with domestic labor market shortages. As shown in Table 1, the sectors and occupations that were most often exempt from these restrictions were related to IT, engineering, health, and various services. These exemptions were announced in 2003, and it is possible that NMS students picked majors that would allow them to find employment in these exempt occupations.

I next explore whether these sector and occupation-specific exceptions are associated with changes in the choice of college major among NMS nationals. My prefered estimation strategy is the triple difference model presented in Equation (4), where I again use older cohorts as the third difference. This allows me to absorb any country-year specific changes that could have affected major choices. Table 7 presents estimates of Equation (4), where the outcome in each column is the percent of a birth cohort that ever enrolled in a specific major, measured at the country-year level. As before, the treated group comprises of NMS countries, and EU15 countries are the comparison countries. Cohorts making college enrollment decisions after 2002 are treated.[19]

The results presented in Table 7 show that NMS students chose college majors that closely match the occupational and sectoral labor shortages advertised by EU15 countries during the 2004 EU enlargement process.[20] NMS enrollment in IT, engineering and service degrees incresed both in anticipation of better migration opportunities, and once borders opened. NMS enrollment in IT and engineering (columns 5 and 6) increased by 45% and 30% in anticipation of open borders, and 85% and 52% once borders opened, respectively. NMS enrollment in services (column 9) increased by 30% in anticipation, and 75% after borders were removed. Enrollment in health-related degrees (column 8) increased by 65% in anticipation of open

[19] I drop the Czech Republic, Slovenia, Germany, Sweden and Portugal due to data availablity.

[20] To show that the parallel trends assumption is satisfied, Figure A2 plots estimates of ϕ_τ from Equation (2) for college majors of interest.

Table 7. Enrollment by college major

	(1) Teach	(2) Arts	(3) Soc. Sci.	(4) Natural Sci.	(5) IT	(6) Engin.	(7) Agri	(8) Med	(9) Services
2002-2004	-0.47	-0.43**	2.42***	0.41***	0.66***	1.34***	0.12	1.30***	0.48*
	(0.64)	(0.18)	(0.70)	(0.15)	(0.24)	(0.51)	(0.20)	(0.36)	(0.26)
2005-2013	-2.71***	-0.19	3.80*	0.53	1.23***	2.30**	0.23	0.45	1.25***
	(0.84)	(0.29)	(2.05)	(0.45)	(0.29)	(0.93)	(0.27)	(0.65)	(0.42)
Obs.	490	490	490	490	490	490	490	490	490
Mean outcome	3.68	1.20	11.98	1.35	1.45	4.43	1	1.99	1.65

Notes: This table presents estimates of γ_1 and γ_2 from Equation (4), where the outcome is the percent of a birth cohort that has ever enrolled in a college major, measured at the country-year level. NMS are treated countries, and EU15 are comparison countries. Cohorts after 2002 are treated. The third difference compares younger treated cohorts (20–24 year olds) to older untreated cohorts (50–54 year olds). The outcome is enrollment in teaching and education degrees in column 1, arts and humanities in column 2, social sciences, business and law in column 3, natural sciences in column 4, information technology in column 5, engineering, manufacturing and architecture in column 6, agriculture and veterinary in column 7, health-related degrees in column 8, and service-related fields (e.g., hospitality and management, transportation, environmental protection) in column 9. Due to data availability, I drop the Czech Republic and Slovenia from the treated countries, and drop Germany, Portugal and Sweden from the comparison countries. Wild bootstrap standard errors clustered at the country level are in parentheses. *,**,*** represent 10%, 5%, 1% significance levels.

borders, but I do not find a statistically significant increase once borders opened. While these estimates are large, they are less than half the enrollment effect found in Abarcar and Theoharides (2021), which finds that Philippino nursing enrollment increased by 156% in response to aggressive US nurse hiring.

NMS enrollment in fields that were less transferable and were not targeted by EU15 sectoral exemptions shows either no change or a decrease in response to open borders. For example, enrollment in teaching and education decreases after EU accession relative to the comparison group. This is unsurprising given that teaching degrees tend to be location and language-specific, and therefore less transferable across countries. Finally, I find sizeable increases in NMS enrollment in social sciences, business, and law both in anticipation of open borders and once borders opened up (column 3). While these degrees were not explicitely targeted by EU15 labor market exemptions, these degrees are versatile and offer a wide range of employment opportunities. It is possible that the increased enrollment in these majors reflected the desire of NMS students to signal their ability to potential employers in EU15 countries (Spence 1973).[21]

[21] I also estimate a triple difference specification, where I combine fields into EU15 targeted treated fields—IT, engineering, health and services—and untargeted and untreated fields—teaching, arts and humanities, social sciences, natural sciences, and agriculture and veterinary. Specifically, I estimate the following:

$$\begin{aligned} Y_{kct} = {} & \gamma_1 NMS_c * HighDemand_k * Anticipation_t + \gamma_2 NMS_c * HighDemand_k * PostEU_t + \\ & \alpha_1 NMS_c * Anticipation_t + \alpha_2 NMS_c * PostEU_t + \alpha_3 NMS_c * HighDemand_k + \\ & \alpha_4 HighDemand_k * Anticipation_t + \alpha_5 HighDemand_k * PostEU_t + \lambda_c + \delta_t + \zeta_k + \epsilon_{kct} \end{aligned} \quad (5)$$

Here, $HighDemand_k$ equals one for college majors with high EU15 demand, and zero for all other college majors. Estimates of γ_1 and γ_2 are positive and statistically significant, and show that NMS enrollment in targeted majors increased by 20% in anticipation of easier migration, and 35% in the long-run once migration barriers were removed.

Table 8. Attainment by college major

	(1) Teaching	(2) Humanities	(3) Soc. Sci.	(4) Natural Sci.	(5) IT	(6) Engineering	(7) Agri., Vet.	(8) Health	(9) Services
2002-2004	-1.13***	-0.38	1.29*	-0.20	0.28**	-0.05	0.01	0.04	0.02
	(0.34)	(0.25)	(0.67)	(0.19)	(0.13)	(0.40)	(0.20)	(0.29)	(0.14)
2005-2013	-2.55***	0.01	3.89***	0.43***	0.54***	0.63	0.03	-0.26	0.66**
	(0.81)	(0.34)	(0.94)	(0.15)	(0.17)	(0.77)	(0.26)	(0.40)	(0.33)
Obs.	512	512	512	512	512	512	512	512	512
Mean outcome	3.30	1.93	6.41	0.78	0.57	3.80	0.90	1.70	0.96

Notes: This table presents estimates of γ_1 and γ_2 from Equation (4), where the outcome is the percent of a birth cohort that has obtained a degree in a college major, measured at the country-year level. NMS are treated countries, and EU15 are comparison countries. Cohorts after 2002 are treated. The third difference compares younger treated cohorts (25–29 year olds) to older untreated cohorts (50–54 year olds). The outcome is attainment of teaching and education degrees in column 1, arts and humanities in column 2, social sciences, business and law in column 3, natural sciences in column 4, information technology in column 5, engineering, manufacturing and architecture in column 6, agriculture and veterinary in column 7, health-related degrees in column 8, and service-related fields (e.g., hospitality and management, transportation, environmental protection) in column 9. Due to data availability, I drop the Czech Republic and Slovenia from the treated countries, and drop Germany, Portugal and Sweden from the comparison countries. Wild bootstrap standard errors clustered at the country level are in parentheses. *,**,*** represent 10%, 5%, 1% significance levels.

Finally, I explore whether NMS college attainment increased in response to EU15 labor shortage incentives. Table 8 presents triple difference estimates from Equation (4), where the outcome is the percent of a cohort that has obtained a college degree in a given major. As before, younger cohorts (25–29 year olds) are considered treated, whereas older cohorts (50–54 year olds) are untreated. I find that NMS students were more likely to obtain a social science and IT degrees in response to easier migration, and are less likely to obtain a teaching degree.[22]

Summary of reduced-form results

To summarize, the results presented in this section show that better migration opportunities for NMS nationals increased NMS college enrollment and induced higher enrollment in college majors aligned with EU15 labor market shortages. The anticipation of migration barrier removal lead to a 15–25% increase in NMS college enrollment, and this increase persisted for many years after NMS countries enter the EU. The college major-specific results point to the importance of migration barriers and foreign labor demand in the choice of college major. IT, engineering health, and service-related degrees are easily transferable across countries and were in high demand in EU15 countries. On the other hand, fields like teaching and education might be more location-specific because of language and culture. The major-specific enrollment estimates support the idea that students in NMS were more likely to pick a major that gives

[22] Figure A3 plots estimates of ϕ_τ from Equation (2), where the left-hand-side variable is the percentage of 25-29 year olds that have a tertiary degree in a given field. The presence of pre-trends prevents me from drawing strong conclusions about the effect of migration incentives for many of these majors. However, there is strong evidence that students were more likely to persist in social sciences, business and law degrees, and to some extent in service-related fields.

easier access to labor markets abroad.

6 A model of college major choice with migration costs

In the lead-up to the 2004 EU enlargement, both new and old member states increasingly worried about the effects of mass migration on the domestic economy. As mentioned previously, EU15 countries feared a large influx of mostly low-skilled NMS immigrants would adversly affect labor market outcomes of natives. New member states instead expected a large outflow of highly educated workers, and worried about the detrimental effects of brain drain. While EU15 countries pushed to temporarily restrict access to their labor markets, new member states were thinking of ways to address potential skill shortages. Some of these policy proposals since EU accessions have included paying bonuses to young college graduates as an incentive to work in the home country; assisting workers and returning migrants with employment opportunities, housing, and healthcare; and restricting emigration for students who use state-funded college scholarships. The reduced-form results show that open borders in general and migration opportunities in particular had a positive effect on tertiary enrollment. However, the reduced-form analysis cannot tell us how these enrollment choices would change in the presence of alternative migration policies, changes in domestic wages, and if foreign wages of NMS emigrants are taxed by the sending country.

To evaluate the effects of alternative policies, I next develop a model that allows me to disentangle the effects of migration costs and wage differentials on college major choice. The model allows me to test various counterfactual policy experiments that capture some of the policies sending countries have considered in addressing skill shortages. In particular, in the first set of counterfactuals I compare sending country enrollment patterns under open borders and under fully restricted emigration that can vary by major. In another counterfactual exercise, I evaluate how enrollment patterns change when domestic wages for skilled workers increase, or when emigrants' foreign earnings are taxed by their country of origin. The results from these exercises improve our understanding on the types of policies that are effective in inducing youth in sending countries to enroll in tertiary education.

6.1 Model set up

The model begins with a high school graduate in a new member state. The high school graduate is deciding between five majors: enrolling in one of four college majors in the home country,

or entering the local labor force.[23] In the second period, the worker contiues working, and the college graduate enters the labor force. In this second period, migration is allowed and the individual chooses to work in the home country or in a foreign country. if the individual decides to emigrate, they have to pay a time and major-specific migration cost. The individual chooses the major that maximizes the present value of their lifetime utility.

Formally, the high school graduate's decision problem is:

$$k^{\star} = \underset{k \in \{L,S,NS,H,R\}}{\text{argmax}} \; u(k) + \epsilon_k + \beta \mathbb{E}_{\eta}\Big[\max_{j \in \{h,f\}} \Big\{ V^j(k) + \eta_k^j \Big\} \Big] \tag{6}$$

Here, k represents major, with L indicating the labor force, S college STEM fields, NS college non–STEM fields other than medical programs and service majors, H stands for health-related degrees, and R denotes service-related fields.[24] In the first period, the high school graduate receives flow utility $u(k)$ associated with major k, and a major preference shock ϵ_k the is i.i.d across majors and observed by the individual but not the econometrician. In the second stage, the college graduate or experienced worker chooses whether to work in the home country h, or work in the destination country f. They receive a continuation value that is location and major-specific. The location preference shock η_k^j is i.i.d across majors and locations, and observed by the individual in the second period.

Flow utility

The flow utility of a student choosing *college* major $k \in \{S, NS, H, R\}$:

$$u(k) + \epsilon_k = \alpha_{0,k} + \alpha_{1,k} MathScore + \alpha_{2,k} ReadScore + \alpha_{3,k} Female + \epsilon_k \tag{7}$$

where $MathScore$ and $ReadScore$ are the student's math and reading z-scores, and $Female$ is an indicator for sex. $\alpha_{0,k}$ captures a mean utility for college major k. $\alpha_{1,k}$ and $\alpha_{2,k}$ capture the boost to college major-specific utility from ability. I include a gender indicator as an attempt to proxy for college major-specific tastes. While there is no evidence that women are inherently better at a specific major, we observe gender differences in sorting into majors that could reflect various societal and cultural traits which can affect tastes. $\alpha_{3,k}$ thus captures the additional

[23] For brevity, I refer to the labor market as a major throughout the following sections. I use "college majors" when I refer to one of the four college majors.

[24] STEM degrees include the natural sciences, math and statistics, computing, engineering, manufacturing and construction. Non–STEM fields include teaching and education, arts and humanities, social sciences, business, law, agriculture and veterinary. Health degrees include medical degrees, nursing and social services. Service-related fields include personal services, transport services, environmental protection, and security services.

utility women might enjoy from certain majors relative to men. I assume that ϵ_k is distributed Type 1 Extreme Value, with location parameter 0 and scale parameter 1.

If the high school graduate chooses to enter the local labor force, their flow utility is

$$u(L) + \epsilon_L = \alpha_4 w^{hs}(math, read) + \epsilon_L \tag{8}$$

where $w^{hs}(math, read)$ is the expected domestic high school wage, which depends on the student's math and reading scores. α_4 captures preferences over earnings when the student is a high school graduate. I follow the migration literature and assume that utility is linear in wages (Kennan and Walker 2011, Grogger and Hanson 2011). This will also allow me to easily interpret the utility parameters in terms of monetary value.

Continuation value

In the second stage, the college graduate or experienced worker chooses whether to emigrate and receives a location-specific utility that is conditional on their major:

$$V^j(k) + \eta_k^j = \delta w_k^j(math, read) - MigCost_{k,t} \mathbb{1}_{(j=f)} + \eta_k^j \tag{9}$$

Here, $w_k^j(math, read)$ are expected wages for location-major $\{j, k\}$ that depend on the individual's math and reading ability. Should the individual choose to emigrate, they have to pay a migration cost $MigCost_{k,t}$ that depends on both major and time period. Specifically, the migration costs are different for those who migrate before the 2004 EU accession than those who migrate after the accession:

$$MigCost_{k,t} = \gamma_k + \gamma_{k*post} \mathbb{1}(Major = k, t \geq 2004) \tag{10}$$

where γ_k picks up the migration cost for major k before 2004, and γ_{k*post} captures the change in migration cost once borders open. The migration cost in my model represents costs related to obtaining visas and work permits, moving costs, as well as amenities and home attachment. Since amenities and home attachment likely do not change right around EU accession, γ_{k*post} isolates changes in migration costs associated with the opening of borders.

Model solution

Under the assumptions that η_k^j is distributed i.i.d. Type 1 extreme value, I can derive a closed-from solution for the expected continuation value over locations in the second period. Normalizing the preference shocks to have location 0 and scale parameter 1, the continuation

value becomes:

$$\mathbb{E}_{\eta}\Big[\max_{j\in\{h,f\}}\Big\{V^j(k)+\eta_k^j\Big\}\Big]=\overline{\gamma}+\log\Big(\sum_j \exp(V^j(k))\Big) \tag{11}$$

where $\overline{\gamma}$ is Euler's constant. The decision problem in the first period is then expressed as

$$k^\star = \underset{k\in\{L,S,NS,H,R\}}{\operatorname{argmax}} \; u(k)+\epsilon_k+\beta\left[\overline{\gamma}+\log\Big(\sum_j \exp(V^j(k))\Big)\right]$$

I will estimate the model parameters in two steps. In the first step, I estimate the migration parameters outside the model. I then use these migration costs estimates as fixed parameters in my model, and proceed to estimate the remaining parameters via Simulated Method of Moments (SMM). Before discussing the details of the estimation, I first describe the data necessary to estimate the model.

6.2 Data

Ideally, I would observe information on college major choice, demographics, cohort, ability, and post-graduation high school and college wages for each individual. Instead, I have three data sets that each provide subsets of the variables necessary for model estimation. First, the EU LFS provides data on college major choice and detailed migration flows. Second, OECD's Programme for International Student Assessment (PISA) provides data on ability and household income by occupation. Third, the EU Structure of Earnings Survey (EU SES) provides gross annual earnings information by country, year, gender, age, education level and occupation. All three data sets are representative of the population, and I next describe the assumptions I make in combining them for the purposes of model estimation. Going forward, I use data from Poland as the sending country and the UK as the destination country. I choose Poland as the representative sending country becase it was the largest new member state in terms of population, and had correspondingly large migration outflows. I choose the UK as the representative destination country because it was among the first to fully open its borders and it became the main destination country Polish migrants. Moreover, Poland and the UK had similar personal income tax rates before 2004, so I can easily compare gross annual earnings across the two countries.

Information on college major enrollment choice, gender, and cohort comes from EU LFS, which I have described in Section 3. I restrict the Polish LFS sample to the cohort of 20–24 year olds in 2000 as the untreated cohort, and the cohort of 20–24 year olds in 2006 as the

treated cohort. This follows the reduced-form analysis where I consider cohorts after 2002 as treated. The sample has 64,000 observations that are representative of the population.

Measures of college major–specific ability come from OECD's Programme for International Student Assessment (PISA) database. PISA is a representative survey of 15 year-old students measuring their knowledge using tests in mathematics, science and reading. The PISA test has been administered every three years since 2000 and covers OECD and some non–OECD countries. In addition, the survey collects background information on both students and their families, such as household income and parents' education and occupation, as well as information on the student's desired occupation at age 30. I calculate mean and variance of math and reading z-scores and the correlation between scores by gender and college major. I map a students' desired occupations to majors using major–to–occupation distributions from EU LFS. For example, if a 15 year old declares they want to be a computer programmer at age 30, I assign them to the major that is most represented in this occupation, which would be IT. If they declare an occupation in which workers mostly have a high school degree or less, I assign them to the "labor force" major. Then, for each individual in the EU LFS sample, I draw math and reading ability from a joint normal distribution that is gender and major-specific.

In combining the EU LFS and PISA data in this way, I assume that ability affects desired occupation—and thus desired major—in the same way that it affects realized occupation and majors. To check whether this assumption holds, Figure A4 shows the distribution of desired and realized occupations for the same cohort—15 year olds in 2000 and 30-34 year olds in 2015. While the distributions do not match perfectly, the figure shows similar patterns for many occupations. This implies that 15 year olds in Poland are on average quite capable of following through on their occupational goals. This might be a less surprising finding if one considers that students in Poland pick specialized courses in high school and take high school exit exams in subjects that are directly related to college majors. I use this finding as evidence that ability affects both desired and realized major and occupation in a similar fashion.

Next, to calculate expected earnings by major and location for each student, I use PISA information on student ability, household income bin, and parent's occupation. I translate the household income bin—expressed as percent of the median household income—into an individual income by taking the midpoint of the respective individual income bins calculated from the EU SES. I then estimate the following wage regression for each major and each location:

$$Inc_i = \alpha_0 + \alpha_1 MathScore_i + \alpha_2 ReadScore_i + \chi_i$$

where Inc_i is the midpoint of the individual income bin for student i's family, and math and

reading scores are the student's z-scores. I evaluate this wage regression separately by father's major and location. I then calculate expected earnings by major and location for each student in the EU LFS sample using the ability draws from PISA, the wage regression coefficients, and random earnings shock draws that follow the distribution of the residual error χ_i.[25][26]

6.3 Estimation

I estimate model parameters in two steps. In the first step, I estimate the migration parameters outside the model using data on migration flows. In the second part, I estimate the remaining model parameters via Simulated Method of Moments.

6.3.1 Step 1: Migration cost estimation

Under the distributional assumptions on the location preference shock η_k^j in Equation (11), I can calculate the probaility that an individual stays in their home country or emigrates. Specifically, the probability that an individual emigrates in the second period conditional on major can be expressed as

$$p(f|k,t) = \frac{\exp(\delta w_{k,t}^f - MigCost_{k,t})}{\exp(\delta w_{k,t}^h) + \exp(\delta w_{k,t}^f - MigCost_{k,t})}$$

Similarly, the probability that the individual stays in the home location is

$$p(h|k,t) = \frac{\exp(\delta w_{k,t}^h)}{\exp(\delta w_{k,t}^h) + \exp(\delta w_{k,t}^f - MigCost_{k,t})}$$

[25] Suppose a child's household income is between 50% and 75% of the median household income. I use the EU SES to calculate 62.5% of the median *individual* earnings. In doing so, I assume that parents' individual income and household income fall in the same position in their respective distributions. This assumption can be violated in households where only one parent works. For instance, it could be that only the mother works and earns a very high income, so her individual income is above the median, but the household income is below the median. I therefore focus on families where both parents work.

[26] There are several simplifying assumptions I impose in the wage calculations. First, I assume that children and parents have identical ability. While ability is of course not identical, this assumption is in line with many studies which use within-family comparisons since ability among family members is on average highly correlated. Second, I assume ability affects parents' and children's expected income in the same way. Third, I assume that parents' income does not affect children's ability. Fourth, I assume that the relationship between ability and wages among UK children holds for Polish children. Finally, the wage regression is not gender-specific, meaning that identical female and male students expect the same wage. While several papers have shown that females expect lower salaries (Reuben, Wiswall, and Zafar 2017, Kiessling et al. 2019), Roussille (2021) shows that the wage ask gap dissapears when women observe the median wage. I assume that 15-year old boys and girls observe average wages.

The log odds of migrating conditional on major and time period reduce to

$$\ln\Big(\frac{p(f|k,t)}{p(h|k,t)}\Big) = \delta(w^f_{k,t} - w^h_{k,t}) - MigCost_{k,t}$$

This equation can be estimated via logit using data on migration flows by major and time period (EU LFS) and earnings by major and location (EU SES). More precisely, I estimate the following

$$\begin{aligned}\ln\Big(\frac{Emigrants_{k,t}}{Stayers_{k,t}}\Big) = \delta(w^f_{k,t} - w^h_{k,t}) \\ + \gamma_0 + \gamma_1 \mathbb{1}_{\{k=S\}} + \gamma_2 \mathbb{1}_{\{k=NS\}} + \gamma_3 \mathbb{1}_{\{k=H\}} + \gamma_4 \mathbb{1}_{\{k=R\}} \\ + \gamma_5 \mathbb{1}_{t\geq 2004} + \gamma_6 \mathbb{1}_{\{k=S,t\geq 2004\}} + \gamma_7 \mathbb{1}_{\{k=NS,t\geq 2004\}} \\ + \gamma_8 \mathbb{1}_{\{k=H,t\geq 2004\}} + \gamma_9 \mathbb{1}_{\{k=R,t\geq 2004\}}\end{aligned} \tag{12}$$

Here, γ_0 picks up costs associated with migration before EU enlargement for those with no college experience. γ_1, γ_2, γ_3 and γ_4 reflect the additional costs paid by pre-accession emigrants who hold a STEM, non-STEM, health, or service-related degree, respectively. Next, γ_5 captures the change in migration cost for migrants with no college once borders open. γ_6, γ_7, γ_8 and γ_9 pick up college-major specific change in migration costs in the post-accession period.[27]

Table 9 presents the estimated coefficients from Equation (12). A negative migration coefficient implies larger migration costs. Qualitatively, the migration costs are as one would expect: college major-specific estimates in the pre-accession period are positive, which means that migration costs for college graduates before EU accession were smaller than for high school graduates. EU accession decreased migration costs for high school graduates by a third as shown by comparing γ_5 to γ_0. Migration costs for college graduates became even smaller after EU accession, with the exception of migration costs for non-STEM majors (γ_7). This might be because non-STEM majors include teaching, arts, humanities, and law programs, which are not as mobile as other degrees.

Finally, the parameter on the wage difference, δ, is practically 0 implying that wages did not play a role in the migration decision. The reason for this null result is because there is not much variation in the wage differences during the sample period I use. Moreover, δ in the migration cost regression does not have the same interpretation as δ in my model. In the model, δ captures the preferences over future income by major choice, whereas in the reduced-form regression college major is exogenous. I will therefore use the migration costs from Table 9, but will estimate δ within the model.

[27] In practice, I estimate migration costs using migration flows between Poland and the UK from 2002 to 2006.

Table 9. Migration Costs

	δ	γ_0	γ_1	γ_2	γ_3	γ_4
Coeff.	0.005	−31.685	0.512	1.888	2.558	12.213
SE	(0.031)	(1.121)	(0.283)	(0.558)	(0.824)	(0.096)
	γ_5	γ_6	γ_7	γ_8	γ_9	
Coeff.	11.963	0.589	−3.533	5.233	5.589	
SE	(3.732)	(0.135)	(0.109)	(0.123)	(0.114)	

Notes: This table presents migration cost estimates from Equation (12). Migration flows from Poland to the UK by year, gender, and major-occupation are calculated using EU LFS data (see Section 3). Average annual gross wages are calculated from the EU SES data on Poland and the UK. I restrict the sample to 2002–2006. Standard errors are in parentheses.

6.3.2 Step 2: Flow utility and wage parameter estimation

There are 18 model parameters that I estimate via SMM: base utility for each college major (4 parameters); math ability for each college major (4 parameters); reading ability for each college major (4 parameters); female mean utility by major (4 parameters); and preferences over wages (2 parameters).

Collecting all parameters in the vector θ, I minimize the following

$$\theta^{\star} = \underset{\theta}{\operatorname{argmin}} \Big[M_{data} - M(\theta) \Big]' W \Big[M_{data} - M(\theta) \Big]$$

where M_{data} are the data moments, $M(\theta)$ are the simulated moments, and W is the identity matrix.

I target 32 moments to estimate 18 parameters: the share of women and men enrolled in each major and time period (16 moments), and the share of students enrolled in each major and time period that have below median math scores (8 moments) and below median reading scores (8 moments).

6.3.3 Identification

The goal of the structural model is to separately identify the importance of migration costs, expected earnings, and abilities for major decisions. The main contribution of my structural model is to identify the effect of migration costs in the college major decision. I can achieve this using the 2004 EU accession, which provides variation in migration costs that I can estimate outside the model. I can then test the effect of different counterfactual policies that leverage migration costs to shape human capital accumulation decisions.

To separately identify the effect of tastes and pecuniary returns, previous studies have used information experiments (Wiswall and Zafar 2015) and exogenous price changes (Patnaik 2021). For example, Wiswall and Zafar (2015) run an experiment where they form a panel of

Table 10. Utility parameters

	Math	Reading	Female	Const.
STEM	7.92	4.38	-3.25	15.52
Non-STEM	11.96	2.64	8.52	9.92
Medicine	5.54	11.38	0.64	-0.20
Services	5.21	4.98	2.73	-0.02

Wages	
α_4	δ
5.13	0.66

Notes: This table presents model parameters estimated via Simulated Method of Moments. Wages are measured in thousands of euros. α_4 measures the increase in utility from a € 1,000 increase in expected domestic high school wages. δ measures the increase in utility from a € 1,000 increase in expected wages in the second stage. To express flow utility parameters in terms of euros, divide the parameter by α_4.

students' beliefs about major-specific ability and expected earnings, keeping tastes intact since the experiment surveys the same students minutes apart. To estimate my model, I use two different cohorts. My identification rests on the assumption that preferences for a particular college major did not change from one cohort to the next. Given that the cohorts in my sample are relatively close to one another and exposed to similar technologies, it is unlikely that tastes for majors changed across cohorts.

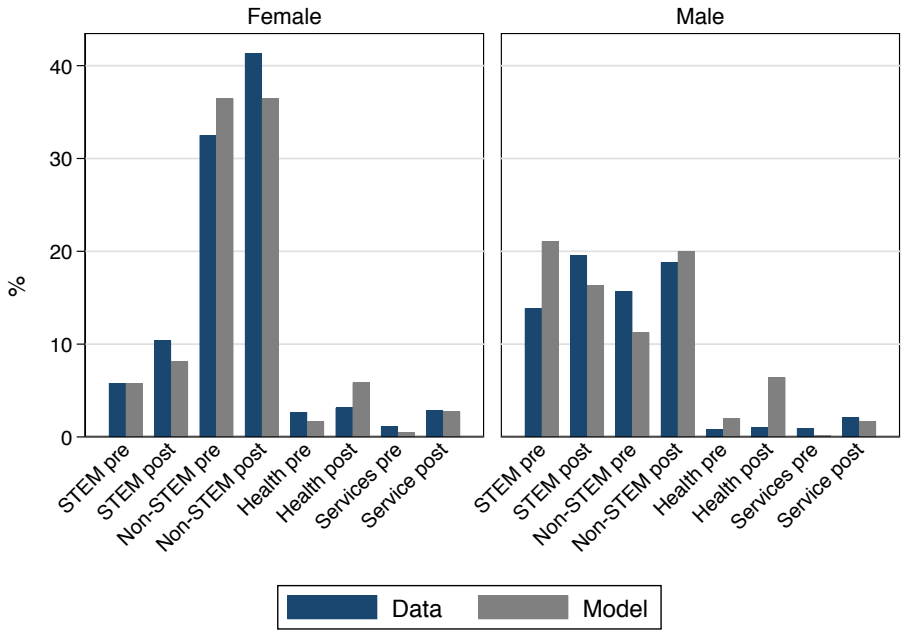
7 Model results and fit

Table 10 presents estimates of the 18 utility parameters. Since utility is linear in wages, and wages are expressed in thousands of euros, I can translate flow utility parameters in euros.[28] For instance, the mean utility of choosing a STEM major is 3,026 euros. Women's utility of choosing STEM is 633 euros lower than that of men. Math ability boosts utility more than reading ability in all college majors except in health-related fields. Interestingly, an increase of one standard deviation in math scores increases the utility of choosing STEM less than the utility of choosing non-STEM—1,544 euros and 2,331 euros, respectively. Women draw higher utility than men from all college majors except STEM.

The model matches the data relatively well. Figure 6 plots a subset of the targeted moments from the data agains the simulated moments. The left panel shows the percent of women enrolled in each college major for the treated (post) and untreated (pre) cohorts, and the right panel does the same for men. Overall, I match the pattern of enrollment across untreated and treated cohorts. For example, the share of women enrolled in IT increases between cohorts,

[28] In 2000, € 1 = \$0.90. In 2006, € 1=\$1.26.

Figure 6. Model fit



Notes: This figure shows targeted data moments in navy, and model-simulated moments in gray. The left panel shows the percent of females enrolled in each college major before and after EU accession, and the right panel shows the same probabilities for males.

and my model is able to capture that. This is true for most other moments, except for the share of men enrolled in IT, where my model predicts a drop in enrollment over time. My model also overestimates the share of men enrolled in health-related field, but still matches the increase across cohorts that I observe in the data.[29]

8 Counterfactual Policies

The goal of developing a college major choice model with migration costs is to evaluate how college major decisions are affected by changes in migration costs and wages separately, and to explore how these decisions would change under different migration and wage setting policies. In this section, I test several counterfactual policies that are in the spirit of policies that local governments in sending countries have proposed to address potential brain drain.

[29] Figure A5 further shows the model fit based on the share of enrollees that have below-median math and reading scores. The moments are well matched.

Table 11. Counterfactual exercises: Migration penalties

	Data		Model		(1) Counterfactuals	(2) Counterfactuals	(3) Counterfactuals
	Before	After	Before	After	Shut down all mig	Shut down skilled mig	Mig penalty avg. salary
% in College	36.6	49.4	39.4	48.8	33.9	28.7	41.8
% in STEM	9.9	15	13.5	12.2	13.1	10.8	11.1
% in Arts, Soc. Sci	24	29.9	23.7	28.2	20.7	17.7	24.9
% in Medicine	1.7	2.1	1.9	6.1	0.2	0.1	4.5
% in Services	1	2.5	0.3	2.2	0.04	0.02	1.3
Welfare			1.19	1.39	1.16	1.22	1.33

Notes: This table shows results from counterfactual policy model simulations. All counterfactual results should be compared to model simulated enrollment rates in the after-period. Column 1 shows Polish enrollment rates under autarky, where migration costs are set to infinity. Column 2 prohibits migration for college-educated people only. Column 3 imposes a migration penalty for college-educated individuals equal to average annual gross earnings of college graduates (€ 10,000).

8.1 Emigration restrictions

In the first set of exercises, I impose extreme restrictions on emigration from Poland to predict what would have happened to Polish enrollment rates. Column 1 of Table 11 shows the enrollment rates when all emigration from Poland is prohibited, and column 2 shows enrollment when only the college-educated are prohibited from migrating. These restrictions are unrealistic because they are both unconstitutional and against EU laws guaranteeing EU citizens free movement across borders. However, they reflect sentiments in sending countries that emigration leads to brain drain and has detrimental effects on long-run growth, and that preventing emigration would boost the local economy by increasing the stock of college-educated workers.

What would have happened to enrollment rates if emigration was entirely forbidden? Column 1 of Table 11 shows that compared to open borders, prohibiting emigration for everyone would decrease overall college enrollment from 49% to 34%, a 30% drop. More closely related to addressing brain drain fears, column 2 shows that when college-educated Polish citizens are prohibited from emigrating—but those with less than college can freely move,—college enrollment drops to 28%, a decrease of 40% relative to open borders.[30] These extreme policies show that if Poland's goal is to increase the stock of college-educated workers, draconian migration restrictions will not achieve that goal. Even when borders are open, most people do not migrate. Thus, large migration outflows of the college-educated would not even come close to offsetting the increase in college enrollment spurred by lower migration costs.

Turning to counterfactual policies that could be more easily implemented, I next explore moderate migration restrictions. Column 3 of Table 11 shows results when *college* migration costs are increased by an amount equivalent to average gross annual college earnings, or

[30] Anstreicher (2021) finds that if cross-state migration within the US was prohibited, college attendance would drop by 30%, which is similar to my finding.

Table 12. Counterfactual exercises: Wage subsidies and penalties

	Data		Model		(1) Counterfactuals	(2)
	Before	After	Before	After	Skilled wages X2	25% tax mig. wage
% in College	36.6	49.4	39.4	48.8	50.39	41.75
% in STEM	9.9	15	13.5	12.2	14.02	11
% in Arts, Soc. Sci	24	29.9	23.7	28.2	29.65	26.11
% in Medicine	1.7	2.1	1.9	6.1	5.05	2.68
% in Services	1	2.5	0.3	2.2	1.7	0.96
Welfare			1.19	1.39	1.4	1.25

Notes: This table shows results from counterfactual policy model simulations. All counterfactual results should be compared to model simulated enrollment rates in the after-period. Column 1 shows Polish enrollment rates when Polish college wages are doubled. Column 2 shows simulated moments when UK wages are decreased by 25%, or roughly € 10,000 on average.

10,000 euros in the case of Poland. This counterfactual exercise is in the spirit of proposals to tie migration penalties to state-funded college scholarships.[31] The results show that the overall enrollment rate falls to 42%, compared to 49% in open borders. While this drop is not as sharp as when migration is prohibited, it is still a 14% decrease in the enrollment rate for one cohort. Given a college emigration flow rate of at most 0.3% as shown in Figure 3, these migration penalties would have a much more detrimental effect on college enrollment compared to simply keeping the borders open.

8.2 Earnings subsidies and penalties

In the next set of counterfactuals, I explore how enrollment would respond if domestic or foreign wages changed. Column 1 of Table 12 shows enrollment rates when I double all college wages in Poland. The motivation behind this counterfactual is similar to policy proposals in sending countries to provide wage subsidies for skilled workers. Overall enrollment increases only by one percentage point in response to doubling Polish college wages. This counterfactual is closely related to that in column 3 of Table 11, where I increased college migration costs by the average college wage in Poland. Increasing college migration costs decreases enrollment rates by more than a comparable increase in domestic college wages increases enrollment.[32]

Finally, column 2 of Table 12 predicts enrollment when all UK wages are cut by 25%. This exercises is related to proposals to tax the earnings of emigrants as a way to compensate the

[31] For example, in 2012 Hungary required state-funded college students to sign a contract promising to stay in Hungary for several years post-graduation as a way to pay back the state funds these students received.

[32] I also test a policy where I increase UK wages by the Polish wage, or by an average € 10,000 for college graduates and around € 6,000 for high school graduates. The enrollment rate increases to 56%, implying that an increase in UK college wages increases enrollment by more than an equivalent level increase in Polish college wages.

sending country for resources invested in these emigrants. Here, I test the effect of a one-shot 25% tax rate on foreign earnings of Polish nationals. The results show that overall enrollment in Poland decreases to 41%, which is similar to the decrease in enrollment when college migration costs are increased by 10,000 euros (column 3 of Table 11). The takeaway from these exercises is that pull factors—migration costs and foreign wages—have a larger effect on enrollment in Poland than increases in domestic wages.

9 Conclusion

This paper estimates the effect of removing barriers to migration on college enrollment and major choice in migrant-sending countries. My identification strategy exploits exogenous variation in migration costs that occurred during the 2004 European Union enlargement. Migration incentives increased drastically for nationals of new member states (NMS), but did not change substantially for old member states. Using EU Labor Force Survey data and an event study and difference-in-differences frameworks, I find that NMS college enrollment rates increased by 15-25% just in anticipation of better migration prospects, and over 30% once borders opened. I further exploit occupational exemptions to temporary labor movement restrictions imposed by EU15 countries towards NMS citizens to investigate if NMS students chose majors in line with EU15 labor shortages. I find that NMS students were more likely to enroll in fields associated with occupations with labor shortages in EU15 countries, such as IT, engineering, health, and service-related fields. These findings point to a pattern of sorting into fields related to occupations in high demand abroad, while sorting out of fields that are more likely to be location-specific such as teaching. My results show that brain gain is the likely outcome even within an open borders context, and lend support to recent studies which find positive effects of migration opportunities on higher education investments under closed borders (Chand and Clemens 2019, Abarcar and Theoharides 2021, Khanna and Morales 2021).

Policy-makers in sending countries have long worried about brain drain and shortage of skilled workers, and have proposed measures to address potential labor shortages and skill mismatch, such as tuition subsidies, migration penalties, and skill-specific wage guarantees. To test the effectiveness of some of these policy proposals, I develop a simple model of individual college major choice with a migration option. Counterfactual policy results show that college enrollment in Poland—used as a representative new member state—is more sensitive to changes in migration costs and foreign earnings, than it is to changes in domestic earnings. These results are informative for workforce development policies in lower income countries and less prosperous regions in developed countries that face high emigration rates.

Finally, it is important to note that my reduced-form results show that even in the presence of open borders, the increase in college enrollment is large compared to the emigration rate of highly educated individuals. Prior research has estimated large efficiency gains from merely allowing people to freely cross borders (Klein and Ventura 2007, Kennan 2013). My results that global gains could be even higher if one accounts for the fact that educational investments respond to future possibilities to migrate.

References

Abarcar, Paolo, and Caroline Theoharides. 2021. "Medical Worker Migration and Origin-Country Human Capital: Evidence from U.S. Visa Policy." *Review of Economics and Statistics (forthcoming)* .

Adda, Jerome, Paolo Pinotti, and Giulia Tura. 2021. "There is more to Marriage than Love: The Effect of Legal Status and Cultural Distance on Intermarriages and Separations."

Altonji, Joseph G. 1993. "The Demand for and Return to Education When Education Outcomes are Uncertain." *Journal of Labor Economics* 11(1): 48–83.

Altonji, Joseph G., Peter Arcidiacono, and Arnaud Maurel. 2016. "The Analysis of Field Choice in College and Graduate School: Determinants and Wage Effects." *Handbook of the Economics of Education* 5: 305–396.

Amuedo-Dorantes, Catalina, Delia Furtado, and Huanan Xu. 2019. "OPT policy changes and foreign born STEM talent in the U.S." *Labour Economics* 61.

Anstreicher, Garret. 2021. "Spatial Influences in Upward Mobility."

Arcidiacono, Peter. 2004. "Ability sorting and the returns to college major." *Journal of Econometrics* 121: 343–375.

Batista, Catia, Aitor Lacuesta, and Pedro C. Vicente. 2012. "Testing the 'Brain Gain' Hypothesis: Micro Evidence from Cape Verde." *Journal of Development Economics* 97: 32–45.

Beffy, Magali, Denis Fougere, and Arnaud Maurel. 2012. "Choosing the Field of Study in Postsecondary Education: Do Expected Earnings Matter?" *Review of Economics and Statistics* 94(1): 334–347.

Beine, Michel, Frédéric Docquier, and Cecily Defoort. 2011. "A Panel Data Analysis of the Brain Gain." *World Development* 39(4): 523–532.

Beine, Michel, Frédéric Docquier, and Hillel Rapoport. 2008. "Brain Drain and Human Capital Formation in Developing Countries: Winners and Losers." *The Economic Journal* 118: 631–652.

Bell, David N., and David G. Blanchflower. 2011. "Young people and the Great Recession." *Oxford Review of Economic Policy* 27(2): 241–267.

Berger, Mark C. 1988. "Predicted Future Earnings and Choice of College Major." *ILR Review* 41(3): 418–429.

Bhagwati, Jagdish, and Koichi Hamada. 1974. "The Brain Drain, International Integration of Markets for Professionals and Unemployment: A Theoretical Analysis." *Journal of Development Economics* 1: 19–42.

Bhagwati, Jagdish, and Carlos Rodriguez. 1975. "Welfare-Theoretical Analyses of the Brain Drain." *Journal of Development Economics* 2(3): 195–221.

Blom, Erica, Brian C. Cadena, and Benjamin J. Keys. 2021. "Investment Over the Business Cycle: Insights from College Major Choice." *Journal of Labor Economics* 39(4): 1,043–1,082.

Bordon, Paola, and Chao Fu. 2015. "College-Major to College-Then-Major Choice." *The Review of Economic Studies* 82(4): 1,247–1,288.

Chand, Satish, and Michael A. Clemens. 2019. "Human Capital Investment under Exit Options: Evidence from a Natural Quasi-Experiment." *IZA Discussion paper No. 12173* .

Clemens, Michael A. 2011. "Economics and Emigration: Trillion-Dollar Bills on the Sidewalk?" *Journal of Economic Perspectives* 25(3): 83–106.

de Brauw, Alan, and John Giles. 2017. "Migrant Opportunity and the Educational Attainment of Youth in Rural China." *Journal of Human Resources* 52(1): 272–311.

Dellas, Harris, and Plutarchos Sakellaris. 2003. "On the cyclicality of schooling: theory and evidence." *Oxford Economic Papers* 55(1): 148–172.

di Maria, Corrado, and Emiliya A. Lazarova. 2012. "Migration, Human Capital Formation, and Growth: An Empirical Investigation." *World Development* 40(5): 938–955.

Dinkelman, Taryn, and Martine Mariotti. 2016. "The Long–Run Effects of Labor Migration on Human Capital Formation in Communities of Origin." *American Economic Journal: Applied Economics* 8(4): 1–35.

Djajic, Slobodan, Frederic Docquier, and Michael S. Michael. 2019. "Optimal Education Policy and Human Capital Accumulation in the Context of Brain Drain." *Journal of Demographic Economics* 85(4): 271–303.

Docquier, Frederic, Ousmane Faye, and Pierre Pestieau. 2008. "Is Migration a Good Substitute for Education Subsidies?" *Journal of Development Economics* 86(2): 263–276.

Docquier, Frederic, and Hillel Rapoport. 2012. "Globalization, Brain Drain, and Development." *Journal of Economic Literature* 50(3): 681–730.

Dustmann, Christian, and Ian P. Preston. 2019. "Free Movement, Open Borders, and the Global Gains from Labor Mobility." *Annual Review of Economics* 11: 783–808.

Fihel, Agnieszka, Anna Janicka, Pawel Kaczmarczyk, and Joanna Nestorowicz. 2015. "Free movement of workers and transitional arrangements: lessons from the 2004 and 2007 enlargements."

Gibson, John, David McKenzie, and Steven Stillman. 2011. "The impacts of international migration on remaining household members: Omnibus results from a migration lottery program." *Review of Economicsand Statistics* 93(4): 1297–1318.

Girsberger, Esther Mirjam. 2017. "Migration, Education and Work Opportunities." *IZA Discussion Paper No. 11028* .

Grogger, Jeffrey, and Gordon H. Hanson. 2011. "Income Maximization and the Selection and Sorting of International Migrants." *Journal of Development Economics* 95: 42–57.

Hamilton, Bob, and John Whalley. 1984. "Efficiency and Distibutional Implications of Global Restrictions on Labour Mobility." *Journal of Development Economics* 14(1): 61–75.

Han, Luyi, and John V. Winters. 2020. "Industry Fluctuations and College Major Choices: Evidence from an Energy Boom and Bust." *Economics of Education Review* 77.

Hoxby, Caroline, and Jeffrey Brown, editors. 2015. *How the Financial Crisis and Great Recession Affected Higher Education*. Chicago: University of Chicago Press.

Iregui, Ana Maria. 2005. "Efficiency Gains from the Elimination of Global Restrictions on Labour Mobility." In *Poverty, International Migration and Asylum*, edited by George J. Borjas and Jeff Crisp. New York: Palgrave Macmillan, 211–238.

Jackson, Osborne. 2018. "Does Immigration Crowd Natives Into or Out of Higher Education?" *Working paper* .

Kennan, John. 2013. "Open Borders." *Review of Economic Dynamics* 16: L1–L13.

———. 2017. "Open Borders in the European Union and Beyond: Migration Flows and Labor Market Implications."

Kennan, John, and James Walker. 2011. "The Effect of Expected Income on Individual Migration Decisions." *Econometrica* 79(1): 211–251.

Khanna, Gaurav, and Nicholas Morales. 2021. "The IT Boom and Other Unintended Consequences of Chasing the American Dream."

Kiessling, Lukas, Pia Pinger, Philipp K. Seegers, and Jan Bergerhoff. 2019. "Gender Differences in Wage Expectations: Sorting, Children, and Negotiation Styles." *IZA Discussion Paper No. 12522* .

Klein, Paul, and Gustavo Ventura. 2007. "TFP Differences and the Aggregate Effects of Labor Mobility in the Long Run." *The B.E. Journal of Macroeconomics* 7(1).

Lang, Iris Goldner. 2008. "Transitional Arrangements in the Enlarged European Union: How Free is the Free Movement of Workers?" *Croatian Yearbook of European Law and Policy* 3(3).

Long, Bridget T. 2004. "How Have College Decisions Changed Over Time? An Application of the Conditional Logistic Choice Model." *Journal of Econometrics* 121(1-2): 271–296.

McKenzie, David, and Hillel Rapoport. 2011. "Can Migration Reduce Educational Attainment? Evidence from Mexico." *Journal of Population Economics* 24: 1331–1358.

Moses, Jonathon W., and Bjorn Letnes. 2004. "The Economic Costs to International Labor Restrictions: Revisiting the Empirical Dsicussion." *World Development* 32(10): 1,609–1,626.

Mountford, Andrew. 1997. "Can a Brain Drain be Good for Growth in the Source Economy?" *Journal of Development Economics* 53(2): 287–303.

Navarro, Salvador, and Jin Zhou. 2018. "Human Capital and Migration: a Cautionary Tale."

Pan, Yao. 2017. "The Impact of Removing Selective Migration Restrictions on Education: Evidence from China." *Journal of Human Resources* 52(3): 859–885.

Patnaik, Arpita. 2021. "Pricing, Income and College Major Choice."

Patnaik, Arpita, Joanna Venator, Matthew Wiswall, and Basit Zafar. 2020. "The Role of Heterogeneous Risk Preferences, Discount Rates, and Earnings Expectations in College Major Choice."

Patnaik, Arpita, Matthew Wiswall, and Basit Zafar. 2020. "College Majors." *NBER WOrking Paper No. 27645* .

Ransom, Tyler. 2016. "Selective Migration, Occupational Choice, and the Wage Returns to College Majors."

Reuben, Ernesto, Matthew Wiswall, and Basit Zafar. 2017. "Preferences and Biases in Educational CHoices and Labour Market Expectations: Shrinking the Black Box of Gender." *The Economic Journal* 127: 2,153–2,186.

Roussille, Nina. 2021. "The Central Role of the Ask Gap in Gender Pay Inequality." *Working paper* .

Shrestha, Slesh A. 2017. "No Man Left Behind: Effects of Emigration Prospects on Educational and Labour Outcomes of Non–Migrants." *The Economic Journal* 127(600): 495–521.

Spence, Michael. 1973. "Job Market Signaling." *The Quarterly Journal of Economics* 87(3): 355–374.

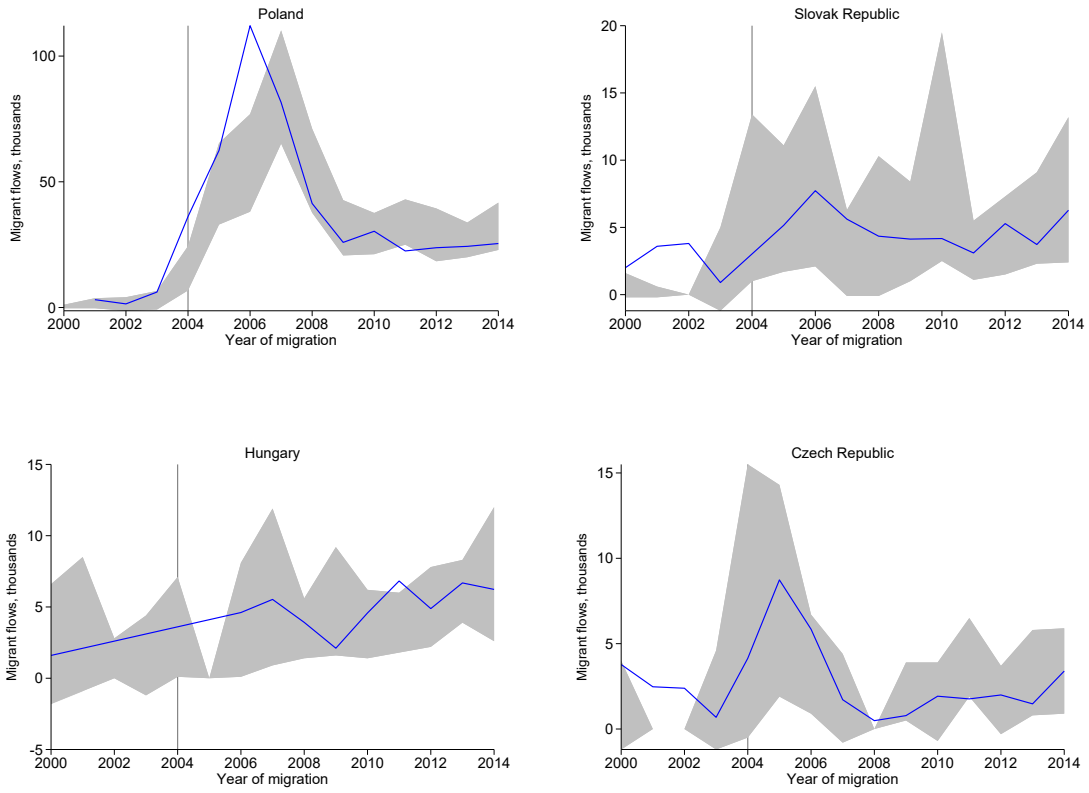
Theoharides, Caroline. 2017. "Manila to Malaysia, Quezon to Qatar: International Migration and its Effects on Origin–Country Human Capital." *Journal of Human Resources* .

Winters, John V. 2017. "Do earnings by college major affect graduate migration?" *The Annals of Regional Science* 59: 629–649.

Wiswall, Matthew, and Basit Zafar. 2015. "Determinants of College Major Choices: Identification from an Information Experiment." *Review of Economic Studies* 82(2): 791–824.

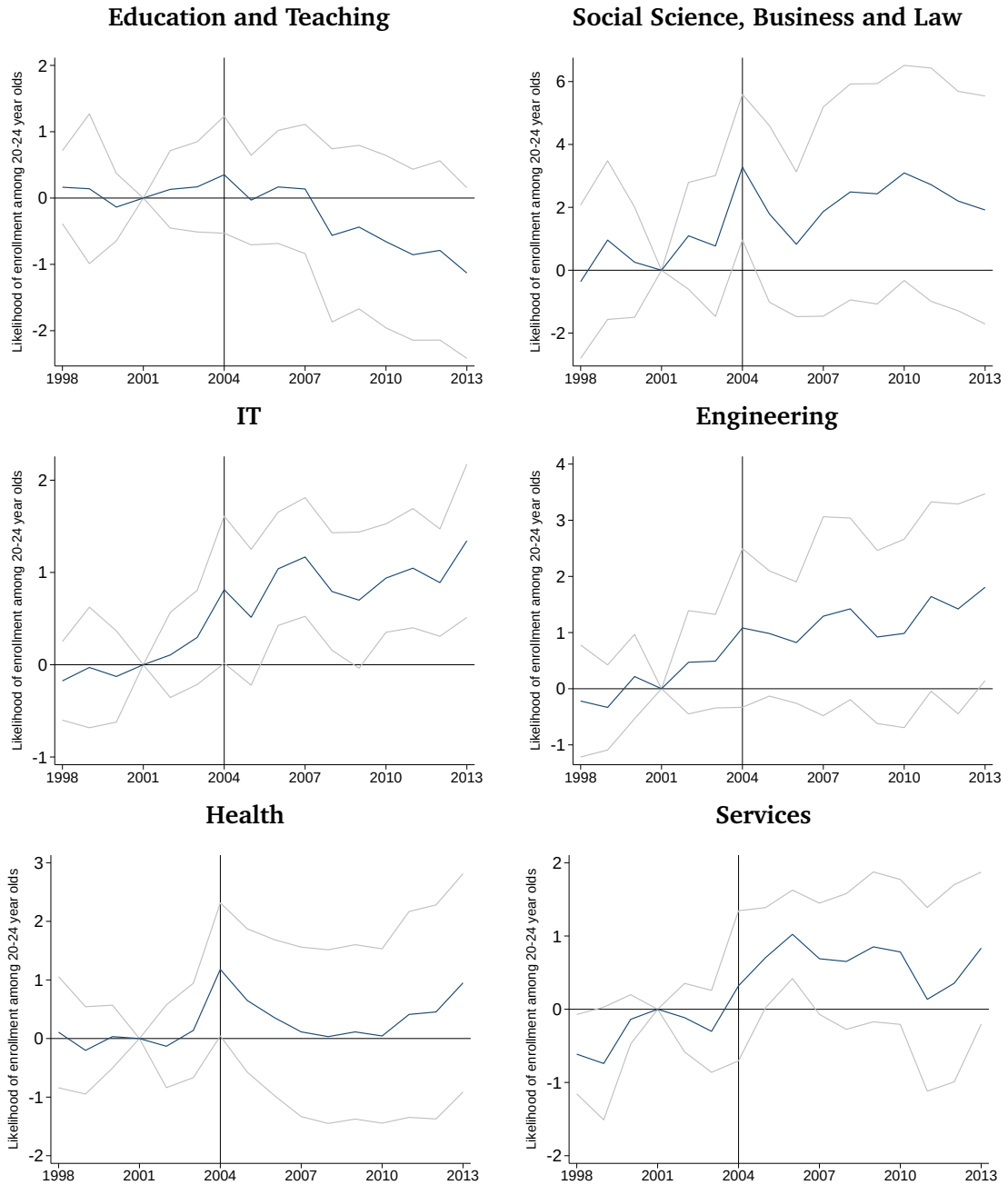
Yang, Dean. 2011. "Migrant remittances." *Journal of Economic Perspectives* 25(3): 129–151.

Figure A1. Data checks: Migration flows to UK from EU LFS and UK IPS data



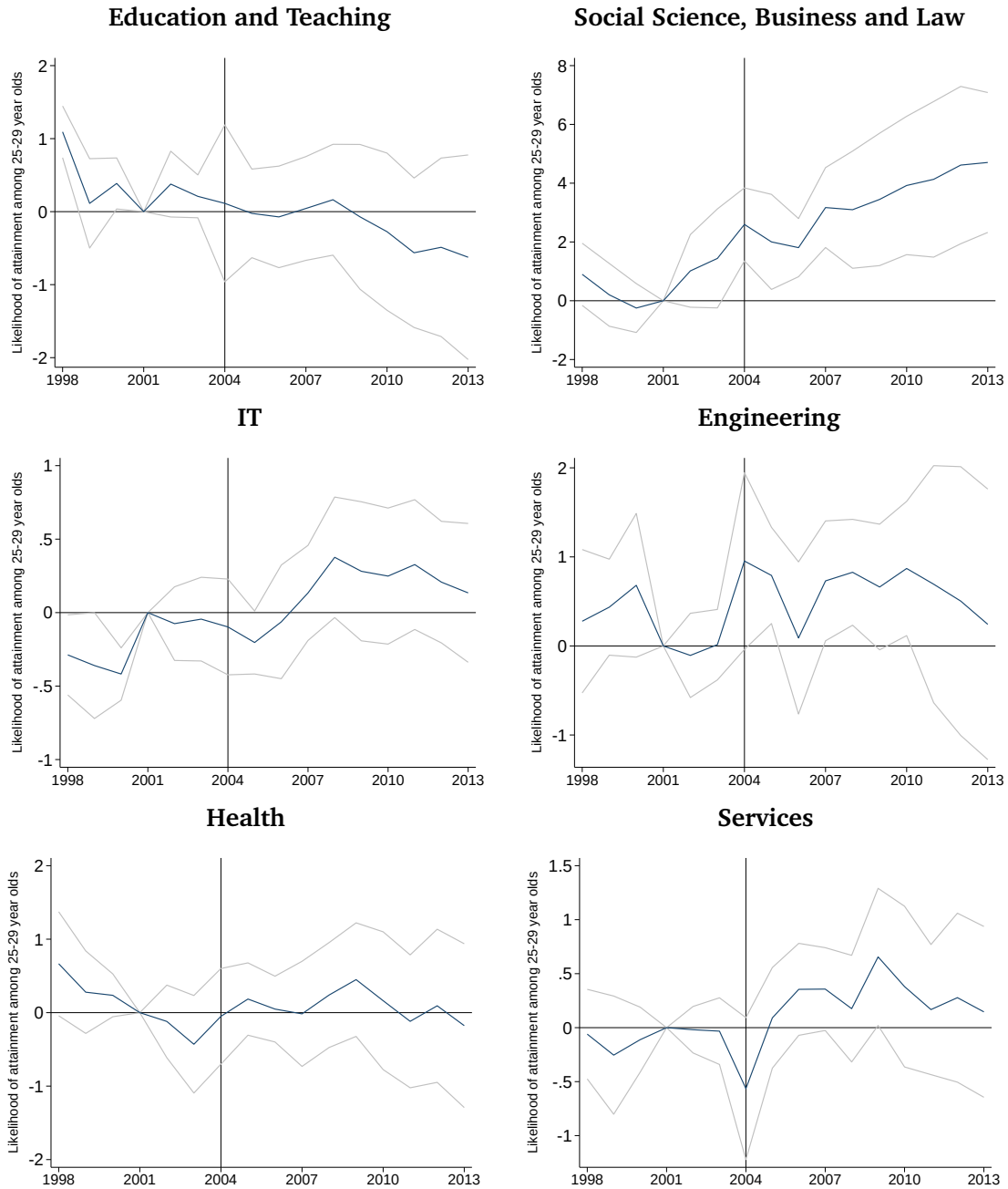
Notes: This figure plots migration flows of NMS citizens from selected countries to the UK using two different sources. The blue line shows migration flows of NMS citizens to the UK I have calculated using EU LFS data. The gray area represents 95% confidence bands of the estimated migration flows provided by the UK International Passenger Survey. The overall correlation between the UK IPS estimates and my migration flow calculations is 0.94.

Figure A2. Open borders and enrollment by major



Notes: This figure plots estimates of ϕ_τ from equation Equation (2) with no additional controls, separately by college major. The outcome variable is the percent of 20–24 year old birth cohorts that were ever enrolled in college. The blue line plots point estimates of ϕ_τ. The gray lines present 90% confidence intervals based on wild bootstrap standard errors. The coefficient in 2001 is normalized to 0. The y-axis value shows the percentage point increase in a given year relative to 2001. NMS are treated countries, and EU15 are comparison countries. The vertical line at 2004 marks EU accession.

Figure A3. Open borders and attainment by major



Notes: This figure plots estimates of ϕ_τ from equation Equation (2) with no additional controls, separately by college major. The outcome variable is the percent of 25–29 year old birth cohorts that had obtained a college degree. The blue line plots point estimates of ϕ_τ. The gray lines present 90% confidence intervals based on wild bootstrapped standard errors. The coefficient in 2001 is normalized to 0. The y-axis value shows the percentage point increase in a given year relative to 2001. NMS are treated countries, and EU15 are comparison countries. The vertical line at 2004 marks EU accession.

Figure A4. Desired versus realized occupation

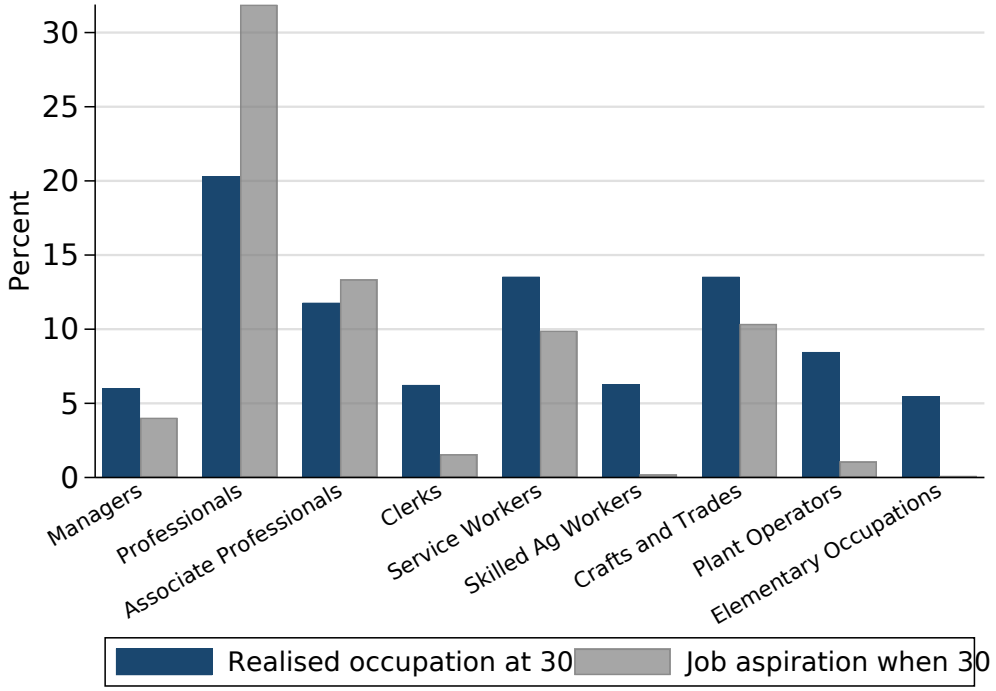


Figure A5. Model fit