EUropean Perspectives: Insights into International Student Mobility Trends Within the European Union and its Partners

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Neda Mohamed* Merve Kaftancıoğlu

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Abstract

This study investigates the trends governing student mobility within the countries of the European Union and its partners over the period between 2013 and 2022. In this study, countries were grouped into structures based on linguistic and cultural similarity in order to try and trace trends on the macro level related to these aspects. This paper aims to determine whether factors such as common language influence the decision of students to study in a certain country. The analysis involves grouping countries into cohorts by language family and regional division and comparing intra-cohort and inter-cohort student mobility. Despite initial hypotheses suggesting cultural and linguistic similarities as key determinants, the findings indicate inconsistent trends across different countries. Some nations strongly aligned with the hypothesis, while others did not, highlighting the complexity of factors driving international student mobility. The aim of this study is to try and understand the dynamics that are governing student mobility and the backstage of student decision-making processes.

Project Website

It is strongly recommended to use the project website to view the interactive visualizations: `https://nedamohamed.github.io/eu-perspectives-where-do-students-go/`

GitHub Repository

The source code and data for this project can be found on GitHub: `https://github.com/nedamohamed/eu-perspectives-where-do-students-go`

*Corresponding author: Neda Mohamed, neda.mohamed@sabanciuniv.edu

1 Introduction

The aim of this study was to understand the trends behind the mobility of international students by understanding the factors affecting the decision of which country they decide to go to. The topic of international students and the directionality of their flow has become especially relevant in the past few decades in discussions of globalization and exchange, equal or unequal. By analyzing the exchange patterns across the European Union (EU) and its partner countries, this study aims to identify any trends that shape the mobility of students.
Per the definition of the UNESCO Institute of Statistics (UNESCO Institute of Statistics, 2022), an international student is an individual who crosses a border or a territory and enrols in an educational institution. In this study, only the international students enrolling in tertiary-level education, for their Bachelor's degree, Master's degree or PhD qualification, were considered. The analysis focuses on the linguistic and cultural aspects, hypothesizing that students are more likely to go to a country if this country's official language is the same as, or at least relatively comprehensible to, the student's origin's official language. The proximity of two countries culturally is considered an incentive for intra-exchange of students among these countries even if they do not share the language but share a culture. For instance, according to the hypothesis, the intra-exchange of students among Nordic countries should be higher than the inter-exchange of students.
Through the analysis of the student mobility data within the EU over the ten years between 2013 and 2022, countries were grouped into cohorts based on their language, language family and regional division. The inter-exchange and intra-exchange were analyzed by comparing the number of students travelling within this cohort as compared to the number of students leaving the cohort.
For most countries, the results revealed no trends. It seemed that some countries, and not all, conformed to the hypothesis. The trend of one country in the network of student exchange had dynamics that were constant throughout the ten years. However, each cohort showed a consistent dynamic.

2 Literature Review

There is limited detailed research on the trends of international student mobility within Europe or other regions. Studies on this topic often lack comprehensive data and distinctions among student categories based on social, socioeconomic, and socio-demographic factors.
In the study by Judith Eder and Pitts (2010), through interviews and qualitative analysis, three pull and three push factors bringing international students to the United States were identified. The pulling factors included college-related aspects, physical geography, and U.S. culture. The push factors were seeking personal growth, language improvement, and career opportunities. Personal growth was perceived through the experience of independence abroad, while language improvement was often a key motivator for students wanting to en-

hance their English skills or those who considered English-speaking countries due to the global dominance of English. The study also highlighted constraints such as economic and visa issues, with visa issues being the most pressing. It should be noted that since the study participants were already international students, they had the means to study abroad, potentially explaining why visa issues were particularly salient to them.

The educational quality of the host universities or countries, especially compared to the country of origin, emerged as a major push factor in several studies. For instance, in a survey conducted in Western Australia cited by Mazzarol and Hosie (1996), where most respondents were from Asian countries, 53% of respondents cited proximity to home as a reason for choosing Australia, 36% mentioned climate and weather, and 34% chose Australia for better educational opportunities.

Social factors also play a significant role. According to Pimpa, 2003, peers significantly influence destination choice more than families or student recruitment agencies. However, while peers were influential in choosing the country, student recruitment agencies were more decisive in selecting the specific city and university.

It is important to note that findings from different studies do not always align neatly. According to Judith Eder and Pitts (2010), college-related factors, like the reputation of the college, are significant pull factors. However, this discrepancy can be attributed to the varying focuses and methodologies of each study. Some studies used qualitative interpretive methods like unstructured interviews, while others used surveys and structured interviews. The choice of methodology can significantly affect the results, as they depend entirely on participants' responses.

Regardless of whether the destination is in China, Australia, or the United States, there seems to be a consensus among different studies that there are almost always push factors in the country of origin driving students to seek education abroad. Moreover, there seems to be a cultural or physical geography aspect not heavily explored. In the study by Ke et al. (2022), it was observed that China was more attractive to Asian students compared to their non-Asian counterparts. This trend can be seen in other regions as well. As of 2017, 82% of EU students choose to study in other EU countries, and 60% of international students in Belgium, Poland, and Russia among other countries come from neighbouring countries (OECD, 2017). In the study by Ke et al. (2022), it was observed that while pull factors influenced students to go abroad, the push factors are more important. The pull factors can be institutional like school reputation, teaching environment and education quality; they can be social. Social factors include how stable Chinese society is and the current internationalization efforts. The influence of this pull factor varied with the country of origin. To elaborate, the results suggested that it was more likely for a student from Asia to be "pulled" to China when compared to a student from Europe or North America. A ranking showing how powerful the pull factors are in descending order:

1. Asia
2. Africa and South America
3. North America
4. Europe

Commonalities within cultures and proximity were cited as a reason for China being more pulling of Asian students, especially those in the Confucian sphere when compared to their non-Asian counterparts.
The study of the attractiveness of China for international students was based on the framework put forward by Ajzen (1991). Ajzen conceptualized the "Theory of Planned Behavior". This theory outlines that with major decisions, a social support network is often present. With decisions such as moving abroad, the influence of the social network is very prominent. It is very rare to encounter a student whose parents do not support their decision to go abroad, the unlikeliness of such a situation can be attributed to economic reasons of subsistence or simply psychological stability and mental health.
The macro factors, dubbed "Push-Pull" factors, are indeed crucial to shaping the trends of student mobility, but so are the individual and cultural factors. Unfortunately, they can not be studied at the same scale. Micro-focused studies can yield more conclusions related to the individual than macro-focused. However, grouped, we can become closer to the bigger picture. It is important to highlight that there is no single trend that can be consistently applied to all international students or all countries. Conclusions and results differ by region and methodology.

3 Methodology

3.1 Data Collection

The data used in this study was collected from the European Commission database (European Commission, Eurostat, 2024). For the years 2013-2022, the number of students by origin from partner EU countries or EU countries was recorded. Entries from non-EU partners were discarded to maintain the balance of the network as the figures for outbound EU students to these countries are not available in the European Commission dataset. To elaborate, as long as the country is an EU country or a partner, there was data for the pairwise exchange between the country and all other partners. The issue with non-partners is that the data for their incoming students was missing, for we only had access to how many students of that country were seeking education in the EU countries or their partners.
For the specific countries, for cohort division, information on the official language of the country as well as the family to which this language belongs was collected from encyclopedias, specifically the Encyclopaedia Britannica (Britannica, 2024).

3.2 Data Analysis

For each year, the weighted directed network for the mobility of females, males and the total mobility was generated. Analysis on the node level were run temporally, showing the makeup of the students by origin over the years in a certain country. The net flow of students per country was also accordingly calculated. Countries were grouped into cohorts based on either shared language, region or language family. Cohorts based on language were constructed given that the official languages of both countries is common in one case and that the languages belong to the same family in another. The proportion of the population that speaks this language if a country has more than one official language was not considered. The assumption was that a student from that country would be able to fluently speak in the official language(s) of the country. The only region constructed was the Nordic region consisting of the Nordic countries of Denmark, Finland, Iceland, Norway and Sweden.
Let n be the number of international outgoing students, and let n_intra be the number of outgoing students who travelled within the cohort and n_inter be the number of outgoing students who travelled outside the cohort. Then, the proportion for one cohort, let it be P_c can be defined as

$$P_c = \frac{\sum_{i=1}^{n_{\text{intra}}} n_{\text{intra}_i}}{\sum_{i=1}^{n_{\text{intra}}} n_{\text{intra}_i} + \sum_{j=1}^{n_{\text{inter}}} n_{\text{inter}_j}}$$

For every cohort, the exchange within the cohort was compared to the exchange outside the cohort.
Cohorts of the same size were created using comparable random networks and a similar analysis was run.
Methods used to analyse the network:

1. **Incoming students by origin:**
   For every node, the number of incoming students, divided by their origin, was visualized over the years. Should there be a trend depending on student origin or depending on how attractive a country is, this can be seen from this graph.

2. **Outgoing students by origin:**
   The same analysis applied to the "incoming students by origin" was applied to the outgoing students where for each country of origin, the destinations were mapped.

3. **Net flow of students:**
   Let S_{in} denote the number of students coming into a country and let S_{out} denote the number of students leaving said country. Then, the net flow of students can be defined as $S_{in} - S_{out}$. For every node and every year, the net flow was accordingly calculated.

4. **Proportion by cohort:**
   The intra-flow and inter-flow were calculated for every cohort as already

shown above. For different cohorts, the proportions were analyzed and compared to random network cohort exchange proportions. Comparability was ensured by making the cohorts of the random network being compared to the cohorts of the student network be of the same sizes This is explained in more detail in the next subsection.

Additionally, a network based on the language family and another network based on bordering countries were generated. The purpose of generating these networks was to understand if any trends can be attributed to geography or language if traced by the network topology.

3.3 Random Networks as Control Models

Random networks were generated to compare them to the networks generated by the mobility data. For each graph, 20 random graphs with the same number of nodes and edges were created. The edges for these graphs were chosen at random within the interval of $(0, 1)$. For each set of 20 graphs, the edges were averaged. By the end of the generation procedure, each graph had a comparable random graph that is the average of 20 other random graphs.
The cohorts for these graphs were generated by randomly choosing nodes and placing them in a single cohort of sizes comparable to the cohorts in the real networks. For instance, if a cohort in the real network is composed of 11 states, 11 nodes from the random network were chosen at random and made into a cohort. The same nodes were used for comparison across all networks, as in they were chosen once only for all instances and not chosen specifically for every instance.

4 Results

4.1 Network Overview: Descriptive Statistics

For every network, the number of nodes, at 37, was the same across the years between 2013-2022. As for the number of edges, it ranged between $(1130, 1180)$.

Year	Number of Edges
2013	1131
2014	1176
2015	1140
2016	1151
2017	1168
2018	1179
2019	1178
2020	1146
2021	1150
2022	1160

Table 1: Number of edges in the network from 2013 to 2022

4.1.1 Centrality

By closeness centrality measure, Austria had the highest score across all years in the Student Mobility Networks, at exactly 1.0. Austria maintained the same rank in the Border Network, at 0.33 centrality score. In the Language Network, Belgium had the highest centrality, which is expected given that it has four official languages, at 0.41.

Degree centrality analysis was also applied, and similar results were obtained. For the Student Mobility Networks, Austria had the highest degree of centrality at 1.00. However, for the Border Network, Germany had the highest centrality at 0.2. For the language network, Belgium maintained its rank with almost the same score, at 0.41.

These results suggest that Austria is a highly connected country in the context of student mobility, and this aligned, albeit superficially, with the closeness centrality of Austria in the Border Network. However, it is important to emphasize the great difference between the scores. Austria has the maximum possible score of 1 in the Student Mobility Networks whereas it is nowhere near the maximum possible, but is only at the relative maximum, in the Border Network, a static and unchanging network. In other words, it is not possible for any node to have a centrality higher than 1 which is the centrality of Austria in the Student Mobility Network. While it is also the most central node in the Border Network, other nodes that are more central can exist.

Spearman correlation analysis was conducted to compare the centrality in the student network with the centralities in the language and border networks. The Spearman correlation between the Student Network and the Language Network centrality was 0.1219 with a p-value of 0.466, and the Spearman correlation between the Student Network and the Border Network centrality was 0.2644 with a p-value of 0.109. These correlations are not statistically significant, indicating that there is no strong evidence of a meaningful relationship between the centralities in these networks.

4.1.2 Modularity

By applying Clauset-Newman-Moore greedy modularity maximization, the networks were divided into different communities (Clauset et al., 2004). In Table A2 (Appendix), the communities for the languages are shown. For most communities, the ancestor of the official language for each country is the same, except in the first community. The reason they might have been grouped is that many of these countries, like Cyprus and Macedonia, have more than one official language.

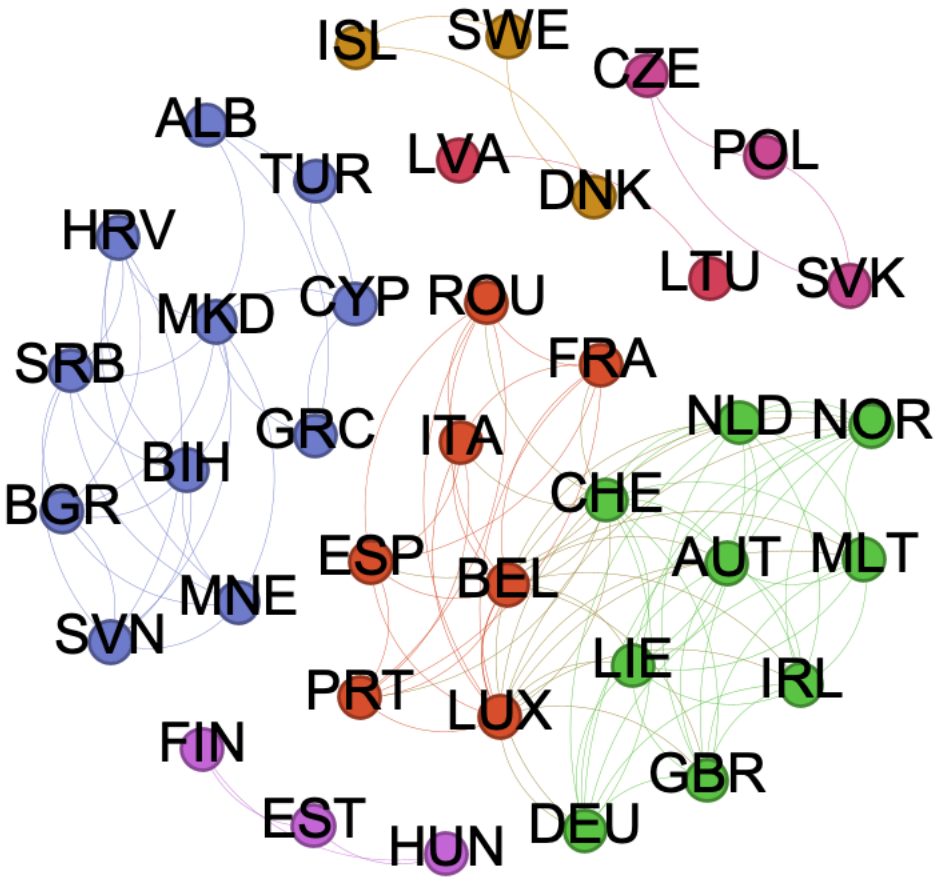


Figure 1: Language Network by Language Ancestor

The communities (Appendix) created as a result of geography were not that interesting. Islands were the sole nodes of their communities, quite naturally,

as they are isolated nodes in the networks. The other geographical modules are intuitive: Western Europe, the Balkans, Central and Eastern Europe, Scandinavian countries and the Iberian Peninsula.

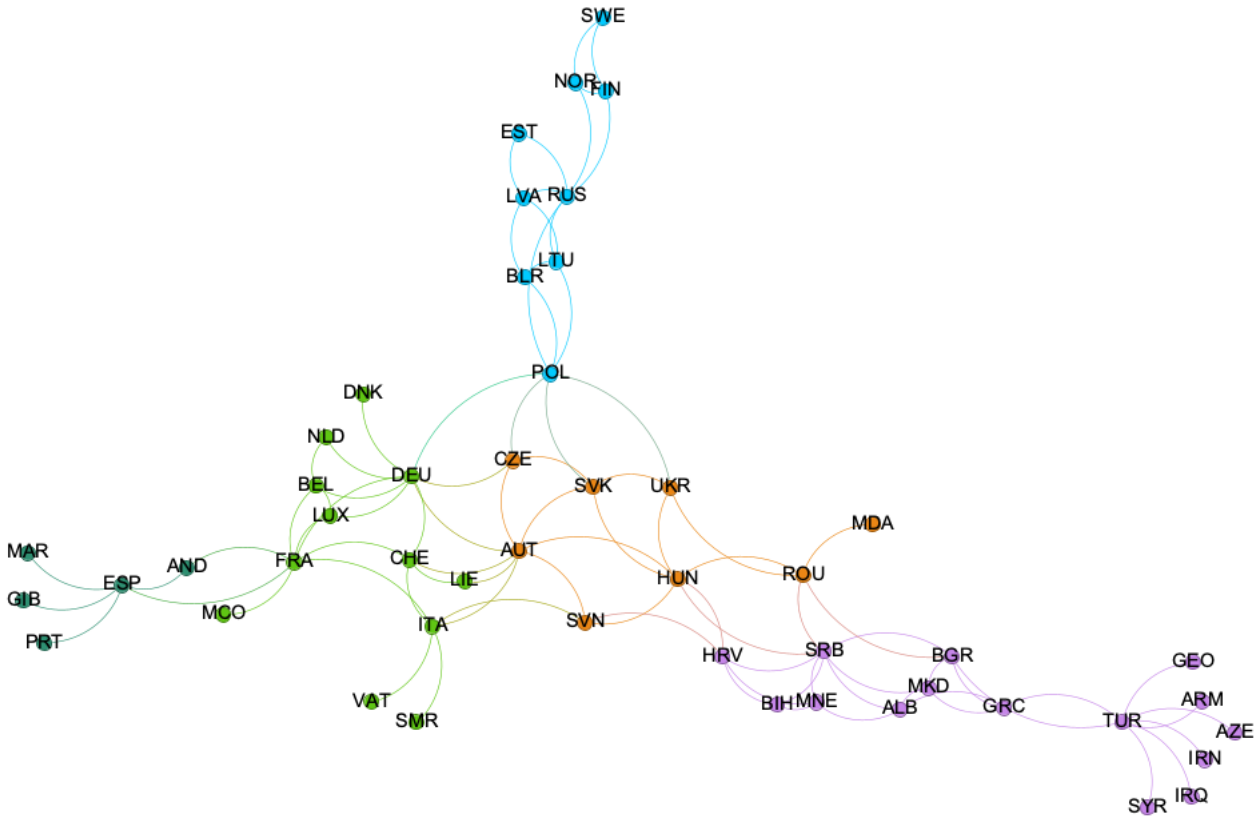


Figure 2: Border Network

For all Student Mobility Networks over the years between 2013 and 2022, the modularity division yielded the same results.

1. **Student Network Community 1:** Germany (DEU), Ireland (IRL), Greece (GRC), Finland (FIN), Malta (MLT), Hungary (HUN), Lithuania (LTU), Denmark (DNK), Portugal (PRT), Latvia (LVA), Norway (NOR), Liechtenstein (LIE), France (FRA), Switzerland (CHE), Turkey (TUR), United Kingdom (GBR), Iceland (ISL), Belgium (BEL), Czech Republic (CZE), Estonia (EST), Austria (AUT), Slovakia (SVK)

2. **Student Network Community 2:** Croatia (HRV), Cyprus (CYP), Luxembourg (LUX), Poland (POL), Serbia (SRB), Spain (ESP), Bosnia

and Herzegovina (BIH), Italy (ITA), Romania (ROU), Slovenia (SVN), Bulgaria (BGR), Albania (ALB), North Macedonia (MKD), Sweden (SWE), Montenegro (MNE), Netherlands (NLD)

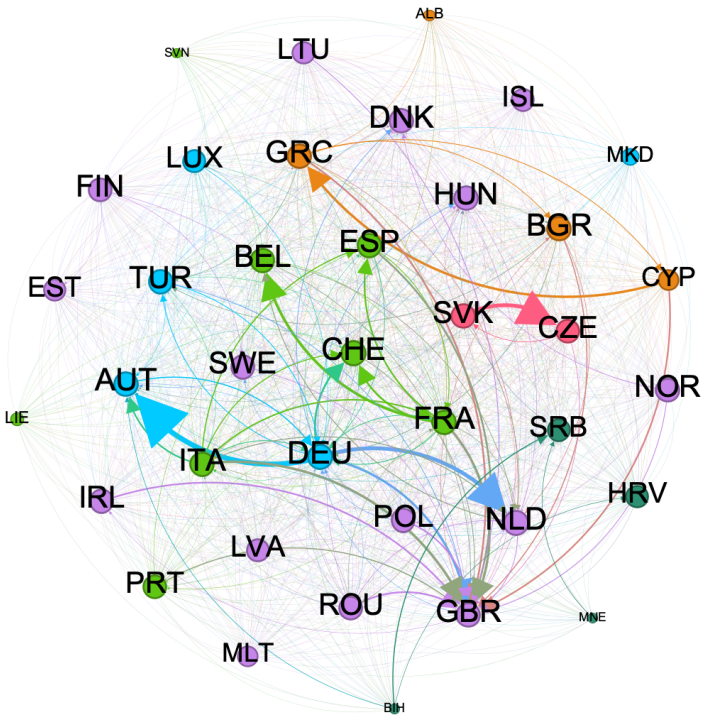


Figure 3: Network showing student mobility between EU countries and EU partners in 2019.

Similarities:

1. **Geographical proximity:** Similar to the Border Network Communities, the Student Network Communities seemed to exhibit clustering based on geographical proximity. For example, countries like Germany, France, and Switzerland were grouped in the first community, reflecting their close physical proximity in Western Europe.

2. **Cultural and historical ties:** Many countries within each Student Network Community share common cultural and historical ties. For instance, countries in Community 2, such as Croatia, Slovenia, and Italy, have historical connections through shared cultural heritage and past political affiliations.

3. **Regional dynamics:** Both sets of communities demonstrated clustering based on regional dynamics. Countries within each community often share common regional challenges, interests, and opportunities. For example, the Nordic countries in Community 1 have historically collaborated closely due to their shared socio-economic models and geopolitical interests.

Differences:

1. **Composition:** The composition of the Student Network Communities appears to differ from the Border Network Communities. While some countries may overlap, the arrangement of countries into communities does not neatly fit the border or the language modules.

2. **Focus areas:** The focus areas or criteria for grouping countries into communities may differ between the Student Network Communities and the Border Network Communities. It also does not take into account the weight. Other methods of analysis showed a more evenly distributed flow and did not distinguish exactly between the two modules.

Overall, while there are similarities in terms of geographical proximity and regional dynamics, the Student Mobility Network Communities likely have distinct characteristics compared to the Border Network Communities.

4.1.3 Inter- and Intra-Exchange

The exchange of students within countries in one cohort, intra-exchange, versus between countries of other cohorts, inter-exchange, was compared. The average exchange (Figure 4) was computed over the period between 2013-2022. In each graph, each country was plotted against the proportion of students who can be classified under "inter-exchange" and the proportion of students who can be classified under "intra-exchange". For 3 cohorts out of 9, the proportion of students who travelled within countries that speak the same language is higher than those who went to foreign language countries. The case of German-speaking countries is interesting. As mentioned before, countries are often consistent with their trends. This means that the make-up of students is usually constant temporally, with very minor changes. Austria, as a case, always received a higher proportion of students from German-speaking countries than non-German-speaking countries. The ratio is almost a $1:1$ ratio, unlike the case of Liechtenstein, a landlocked small state, which overwhelmingly receives students from German-speaking countries. In fact, 90% of students who go to Liechtenstein are from German-speaking countries.
Liechtenstein is approximately the size of Zurich but with only one-sixth of its population. Most of the workforce, around 60%, in Liechtenstein are citizens of other countries, with the majority being either Austrian or Swiss (von Kopp, 2015). This suggests that generally the majority of the people coming into the state are from other German-speaking countries, and student mobility may be governed by the same trends. However, there is not enough data to conclude

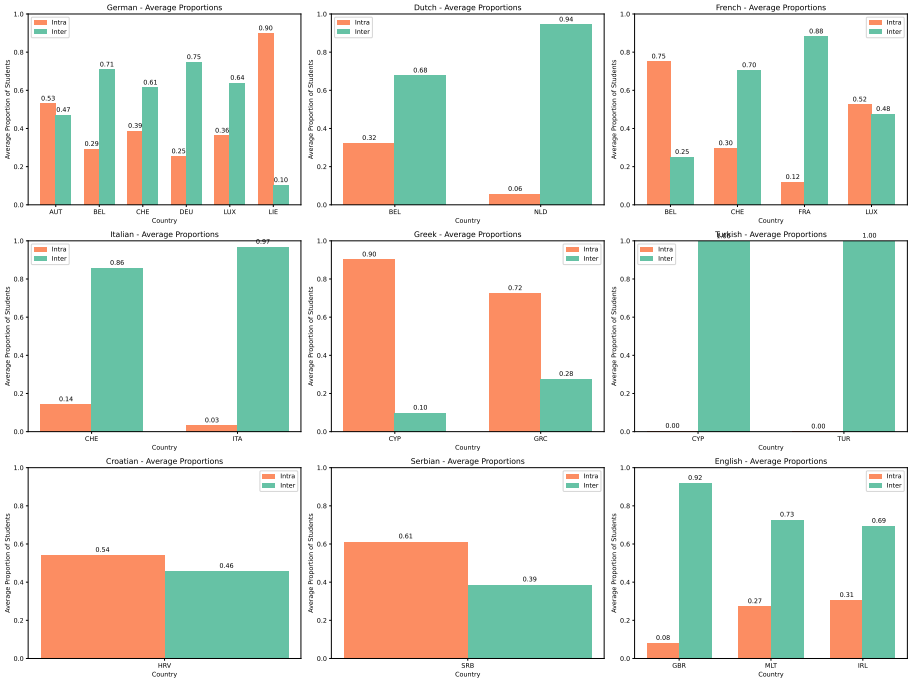


Figure 4: Inter- and intra- exchange by common language

this.
For all German-speaking countries, a significant proportion of the students were coming from the same cohort, with the minimum proportion being 25% in the case of Germany, a hub for students. It is apparent that when a country is an attractive hub for students, and thus attracts students from numerous origins, the proportions become more in favour of inter-exchange. Accordingly, if hubs like Germany and Great Britain are overlooked, a different picture will appear. These graphs primarily focus on the proportions by language. For countries like Swizterland, Belgium and Cyprus where there is more than one official language, the visualization is not accurate. According to the Federal Department of Foreign Affairs of the Swiss Confederation (Switzerland, 2023), Switzerland can be divided into four regions depending on the language spoken:

1. German is spoken as the main language by 62.3% of the population.
2. French is spoken as the main language by 22.8% of the population.
3. Italian is spoken as the main language by 8.0% of the population.
4. Romansh is spoken as the main language by 0.8% of the population.

Accordingly, in order to get an accurate proportion for the inter- and intra-exchange in multilingual countries, they have to be isolated. It is apparent,

as in Figure 5, that for the multilingual countries, the intra-exchange of students within EU countries and its partners is overwhelmingly higher than the inter-exchange of students. In the same figure, the intra-exchange proportion

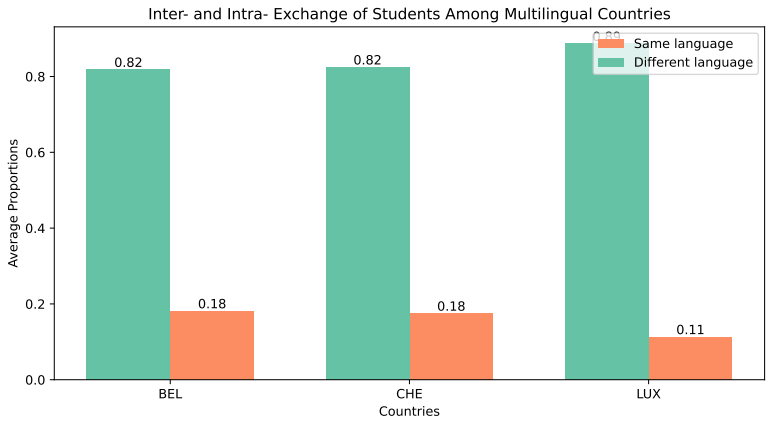


Figure 5: Inter- and intra-exchange proportions among multilingual countries

for Luxembourg is slightly higher than the corresponding metric for other countries. Given that Luxembourg is a landlocked country with a high population of foreigners, mostly European as well, at 47.2% of the population (STATEC Luxembourg, 2023). Whether or not there is a correlation between these statistics and the higher proportions for intra-exchange is an area that should be investigated if more data is available.

It is important to note that the figure can be misleading and does not necessarily diminish the international attraction of a certain country to students. The languages spoken across Europe are not that diverse, and the multi-lingual countries often have at least three official languages. Moreover, it is not necessary that every member of the population can speak all the official languages. For instance, around 20% of the Swiss population do not have one of the official languages as one of their main languages Switzerland (2023). A German student travelling to Switzerland can live in the French area but still be counted within the intra-exchange proportion.

The exchange between Cyprus and Turkey is zero. Infamously, the relationship between Turkey and Cyprus is not good, but whether this is what is affecting the student mobility between both states remains a question. The student mobility between the Turkish Republic of Northern Cyprus (TRNC) and Turkey is an ongoing stream. Half of the university students studying at Turkish Cyrpiot universities in 2015 came from Turkey (Turkish Republic of Northern Cyprus Ministry of Foreign Affairs, 2015). However, given that the TRNC is not an acknowledged state by the international body, their statistics may be excluded. However, when Cyprus is considered within the Greek cohort, it seems that most Cypriot students choose to study in Greece, and most Greek students choose

to study in Cyprus. However, the proportion of students who choose to study outside of this cohort is higher for Greece than for Cyprus. The reasons behind this preference can not be deciphered from the available data.
The Italian, Greek, Dutch, Serbian, Croatian and Turkish cohorts are of the same size. Should the Turkish cohort be discarded given the discrepancies due to the political situation, the Italian and Greek cohorts show very different trends. The Greek cohort displays mostly a behavior of intra-exchange while the Italian cohort displays a behaviour of inter-exchange.
For Serbian and Croatian cohorts, the second country for both cases is Bosnia and Herzegovina. On the basis that these countries are all partner EU countries, they were not removed from the dataset. However, it seems that if there indeed was an outgoing exchange of students from Bosnia and Herzegovina to either Croatia or Serbia, it was not recorded, and only its incoming students from these origins were reported. In the Croatian and Serbian cases, almost half of the outgoing students go to Bosnia and Herzegovina. The dynamics of these cohorts are very similar, even in the divisions of the proportions.
On a general note, the Dutch and the Italian cohorts behave similarly in the sense that the proportion of inter-exchange is higher than the intra-exchange. However, statistically, there is a remarkable difference. There's almost significantly less intra-exchange within the Italian cohort.
Focusing on the Italian cohort, as mentioned, a minority of the Swiss population uses Italian as their main language, so the comparison is not fair since Greeks and Cypriots mainly speak Greek. Drawing from this, it is almost as though Italy is the lone state in its cohort; thus, it makes perfect sense that all of the students leaving Italy would go to countries speaking different languages.
The reason we considered cohort sizes as a possible influential factor is that cohort sizes showed a trend with the random networks (Figure 6) which will be discussed later in this section. As it seems, no solid trend can be traced across the different cohorts. While the cohort size might have some influence, the geopolitical and economic factors that tend to affect mobility can not be governed to investigate the effect of the cohort sizes. It also seems that cohorts lie on either one end of the extreme if they are relatively small in size: the exchange will be overwhelmingly from within or overwhelmingly with the outside.
As for the English-speaking cohort, it is likely that the reason behind the consistently high inter-exchange rate is the position of the English language as a global language. Judith Eder and Pitts (2010) states in their study that English being the first language is a major factor in deciding the country of destination for students for the reasons discussed above.
Corresponding random networks were studied for the same trends. The number of cohorts present in the real Student Mobility networks was used to create random cohorts in the random networks. Nodes were chosen at random until a sufficient number of nodes for the cohort was reached. Using the same method used to calculate the inter- and intra-exchange proportions, the ratios were calculated.
In random networks, the probability of having an edge between any two nodes is the same for all nodes. Intuitively, as the size of the cohorts increases, the

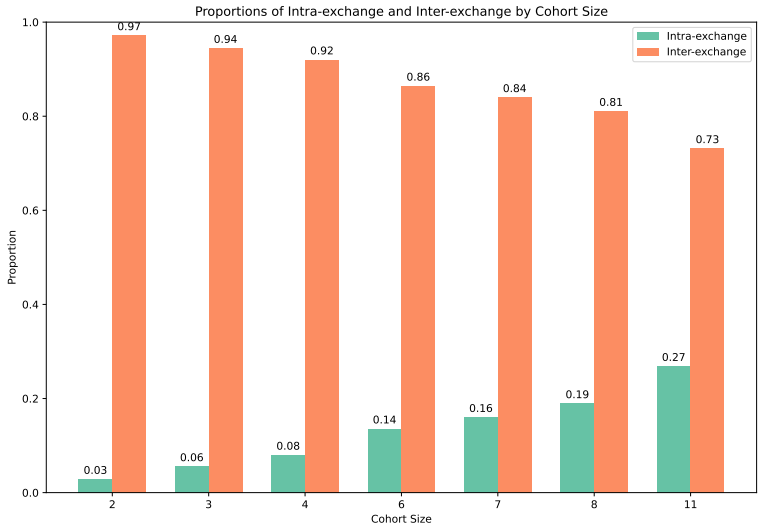


Figure 6: Exchange proportions in random networks.

proportion of intra-exchange also increases. For cohorts of size 2, if the student's choice of where to study is random, the inter-exchange proportion should be almost 97%, but that is indeed not the case. For the Student Mobility Networks, the numbers expected if the network was random were violated by every cohort. In fact, different cohorts, given the different circumstances, gave completely different results.

1. The identity of the elements within a cohort affects the dynamics of this cohort as the cohort size is not the only factor affecting the exchange of students. Factors related to geopolitics and economy can affect student mobility.

2. Some nodes tend to have a higher intra-exchange rate. These cohorts are usually not in Western Europe, with some exceptions being there. The nodes that usually have a high intra-exchange rate tend to be Slavic or from the Balkan region. The exceptions in Western Europe tend to be small countries. However, it is important to note that this conclusion can not be certain as the sample available is not that large.

If shared language families can be used to conclude commonalities within the culture, then the inter-exchange and the intra-exchange between countries that belong to the same language family can be used to consider the cultural aspect behind students' decisions. The basis for this assumption is that the populations were related at some point before branching off into different peoples (Baker

et al., 2017). Being related at some point would suggest that the cultures are related (Hettinger, 2008). The exchange comparison if cohort formed by

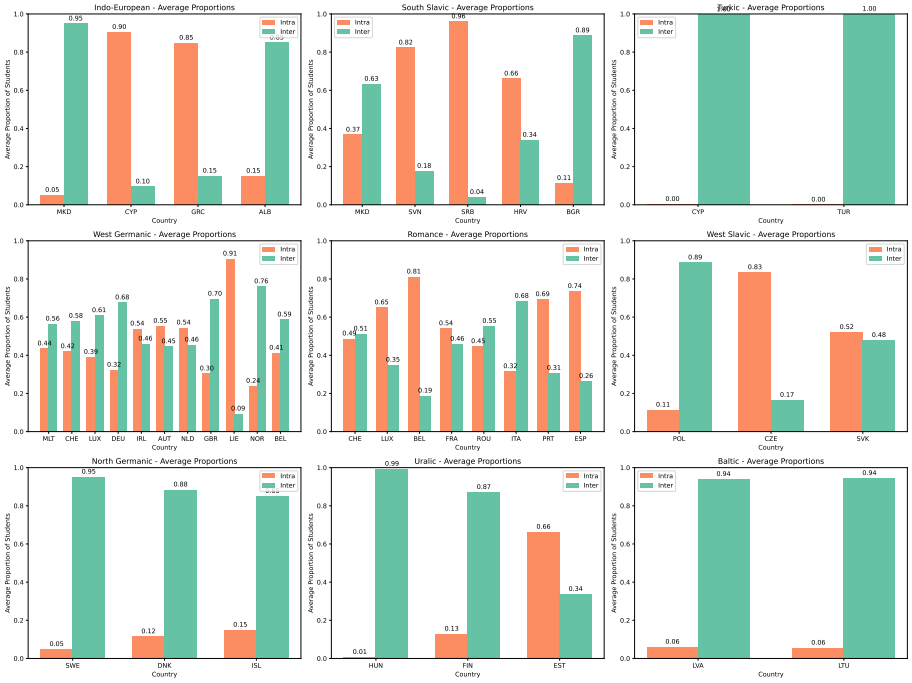


Figure 7: Inter- and intra-exchange between cohorts by language family.

language family does not offer new insights not discussed previously. The same trends prevail among the same countries. Four countries that were none of the cohorts discussed within the context of a shared official language, there are some tendencies:

1. For the most part, Slavic countries tend to exchange students among themselves more than any group.

2. The Romantic languages countries have an even exchange rate, but often lean towards intra-exchange. This might be due to the ease of transport between these countries or the similar cultures.

It seems that the students originating from some countries prefer to stay within the same region, as is the case with Estonia, Greece, Cyprus and many countries that consistently show high intra-exchange rates. Whether the cohorts were created based on language family or the official languages, there's a tendency for smaller countries and geopolitically less significant to follow this trend. This is merely an observation, and further investigation needs to be done in order to verify a relation if it exists.

4.1.4 Node-Level Analysis

Node-level can reveal trends in the popularity of a certain destination to students of other countries of origin. Node-level analysis shows the net flow, and it also suggests which countries are international hubs and which are regional hubs. For the node-specific graphs, it is strongly recommended that the interactive versions of the figures are used instead of their static counterparts. These figures can be accessed through the project website.
For the graph of incoming students, the key to the graph can be found in the appendix (Figure 16). The normalized number of students is mapped to the destination country, and country of origins are made distinct.

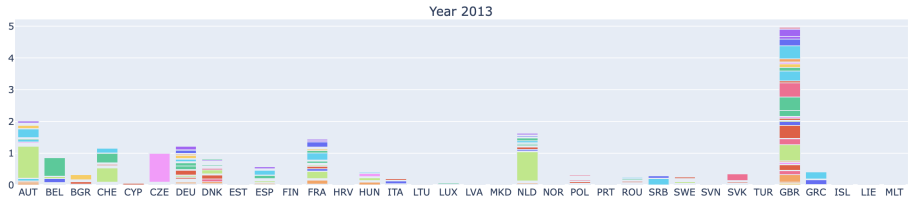


Figure 8: Incoming students by country of origin in 2013.

The trends seen in this figure change temporally. In 2013, Germany was not a diverse hub as much as it became in later years. The most common country of origin for international students in Germany was Austria, and almost half of the international students in Austria were coming from Germany. Consistently, until Brexit, Great Britain was the Hub, and it attracted diverse students across all the countries in the dataset. The proportions of these students are even comparable, with slight difference in most cases.
This also suggests that different students have different tendencies towards different choices. To explain, students from Germany mostly go to Great Britain, Austria, Switzerland, the Netherlands or Belgium. The other outgoing German students are divided over the other countries, and they make up very small fractions when compared to their fractions in the aforementioned countries. There's a similar trend observed with French students who tend to go to Italy, Spain and Belgium more than other states.
Brexit and the COVID-19 pandemic might have impacted the student mobility. This can be investigated by considering the number of incoming students for this period as in Figure 9.
There are striking differences. First, the maximum (normalized) number of students per country goes from around 5 in 2019 to around 3.8 in 2020. The maximum shifted from being stationed in Great Britain to being in Germany.
It is fair to say that that Germany took Great Britain's role as the diverse hub but with slightly smaller proportions per country of origin. It is still the case, as it is for all sets of data in our record, that Austria sends the highest number

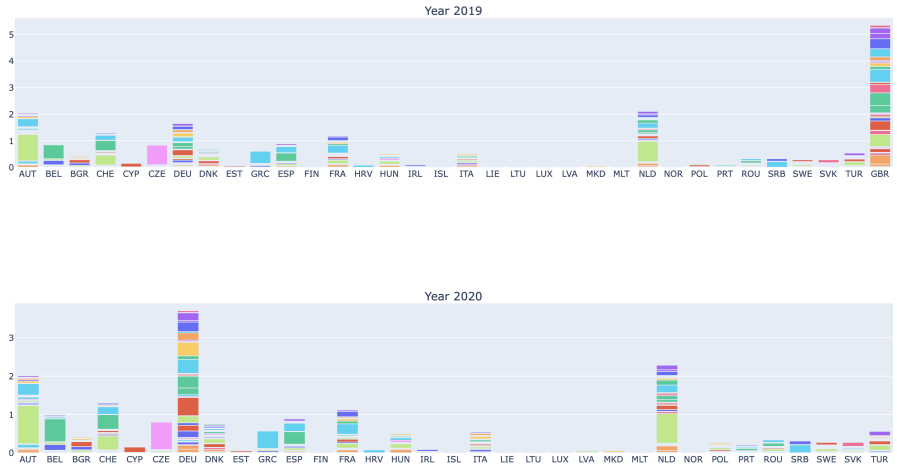


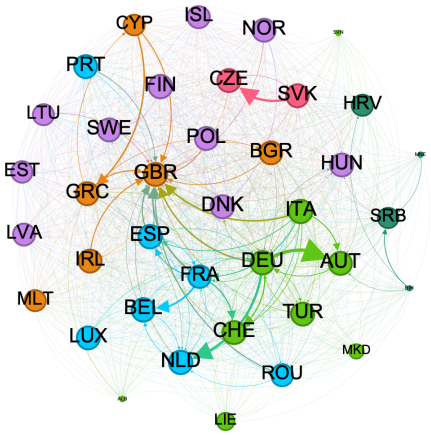
Figure 9: Incoming students mapped by destination made distinct by country of origin in 2019 and 2020.

of students, in proportionality, to Germany. However, this number more than doubled doubled after the pandemic, from around an average of 0.15 to 0.4. This can be due to Brexit. Great Britain was one of the top destination for EU students. After Brexit, EU students were forced to pay the full international-fees in order to be able to study in Great Britain, prompting a decline (ICEF Monitor, 2023). This neatly fits our observation of how the number of students visiting Germany from one country of origin, Austria in the discussed example, doubled. Perhaps this is as the Austrian students who would go to Great Britain went to Germany instead. The EU students who had planned to study abroad and could not due to Brexit might have chosen other destinations or stayed in their countries of origin. This can be investigated by considering the net flow of students. However, it is hard to decide whether the net flow changes are a result of the pandemic or Brexit.

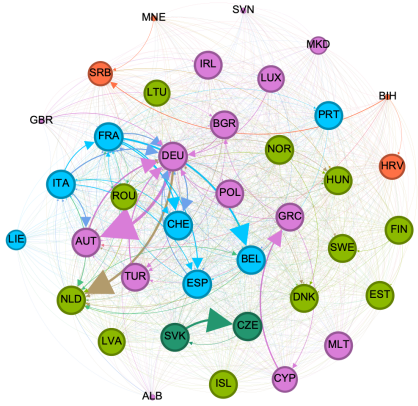
According to the study by Farnell et al. (2021), the short-term impacts of the pandemic entailed great uncertainty about student enrolment rates, with forecasts that they'll greatly decline, which they did by the start 2020/21 academic year. For example, the number of international student enrolment in Germany declined by 20% in that term. We do not observe this decrease in our dataset since it is not a global dataset, rather it is only focusing on the EU countries and their partners.

The values for other countries post-Brexit, pre-Brexit, post-pandemic, pre-pandemic remained relatively the same, with fluctuations being in the normal, expected range.

As observed in Figure 10, while Great Britain still exists in the network (as a destination), it does not have the same importance anymore. In this figure, we can see that countries that used to contribute to the student mobility pre-2020



(a) Student Mobility Network in 2019.



(b) Student Mobility Network in 2020.

Figure 10: Comparison of the Student Mobility Networks for 2019 and 2020.

do not contribute as much anymore. Examples include Bulgaria, Cyprus and Greece. This becomes more apparent when the outgoing students are plotted, with distinction made in accordance with the country of destination. This can be observed in Figure 11.

Per Figure 11, the removal of Great Britain as destination country is embodied by the removal of the Great Britain stacks from the 2019 graph when compared to the 2020 graph. By the key, students going to Great Britain are stacked in a purple colour. In the case of the country of origin being Germany (DEU), we observe that out of the three biggest stacks, two of which are purple, one of them disappears. The interactive graphs show that the stack that disappeared is the stack mapped to Great Britain as a destination. Moreover, we see that

Figure 11: Outgoing students mapped to country of origin, made distinct by their destinations in 2019 and 2020.

this made the number of outgoing students per country decrease and not shift from one country to another. The normalized number of outgoing students for Germany on average was almost 4, but it is barely above 3 in 2020. Again, this can be a result of the pandemic, Brexit or the interplay of the two events. Lastly, some shift happened between 2019 and 2020, causing the proportions of students studying in Germany to increase per country of origin.

It is important to note that starting 2020 onwards, Great Britain did not provide data about how many of its students are from EU or Eu partner countries to the European Commission. The position of the Great Britain node, thus, is not the most accurate presentation as it only became an origin and never a destination. This can be balanced out by aggregating data from the British records.

The effect of the pandemic is not exactly clean-cut. Students from Germany still went to Austria consistently (except in 2015)[1]. In fact, the maximum number of outgoing students from one country of origin to one destination country is consistently and Germany to Austria.

It is unclear what is the driver of each shift, but the two major events of that period that disrupted mobility were Brexit and the pandemic. More in-depth analysis is needed in order to conclude which shift is caused by which change and by what strength or intensity.

The argument for the pandemic is stronger. All countries, as will be discussed,

[1]The edge from Germany to Austria should have been the edge of the maximum weight. However, the data for 2015 has some kind of issue where all the students from Belgium are mapped to Belgium again, disrupting the "maximum" value of students going from one country to another. This issue is dealt with when statistical analysis is run, but it is not removed from the graphs.

were affected in similar ways post-2020. Such a global influence that reverses the mobility trends is most likely to be the pandemic. For countries that had a negative net flow, the flow either became less negative or became positive. This does not necessarily mean that the students stopped choosing said country as a study destination as it could also mean that the students whose country of origin is that country chose to stay there.
The net flow for each country, differentiated by gender, is on our website. In this paper, we will only discuss a few nodes since the trend is recurring.

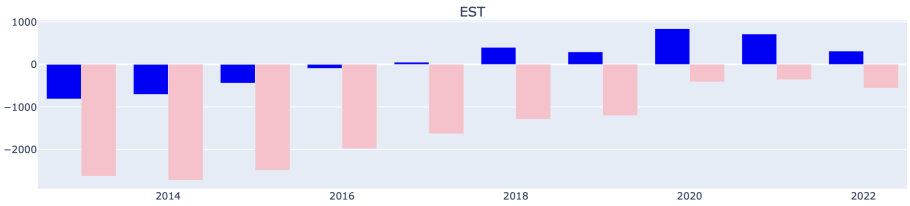


Figure 12: Net flow of students by gender to Estonia between 2013-2022. Blue for males, pink for females.

$$Net\ Flow_{gender} = Incoming_{gender} - Outgoing_{gender},\ \text{for gender in } \{\text{Male, Female}\}$$

The case of Estonia (Figure 12) supports this hypothesis a bit. Generally, the net flow of the students is negative. However, it seems that more females choose to leave the country than males. Even before 2020, the net flow was growing less negative. However, the change post-2020 is drastic and not as eventual as the change observed pre-2020. Moreover, in 2022, when the travel restrictions were lifted and the world was moving back to the normal way of life, the trend reversed again, and more students started leaving than staying, when compared to the previous year. This is not a unique case. Norway, Lithuania and Greece among other countries show a very similar dynamic.

As seen in Figure 13, 2020 is, again, a turning point. The trend is reversed,

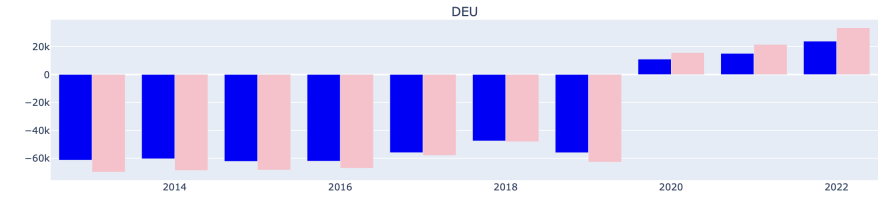


Figure 13: Net flow of students by gender to Germany between 2013-2022. Blue for males, pink for females.

with the net flow going from very negative to more positive. This either means

that more people are choosing to come to Germany or more Germans are staying in Germany, with the latter being more likely. Per the outgoing student graph, the international student traffic decreased significantly post 2020.
Since Germans' primary destination is Austria, it can be assumed that the reason for this change is most likely to be the pandemic and not Brexit. This is further supported by how the Austrian net flow changed post-2020, as in Figure 14.

There is a decrease, of around 20%, in the first year of the pandemic to the

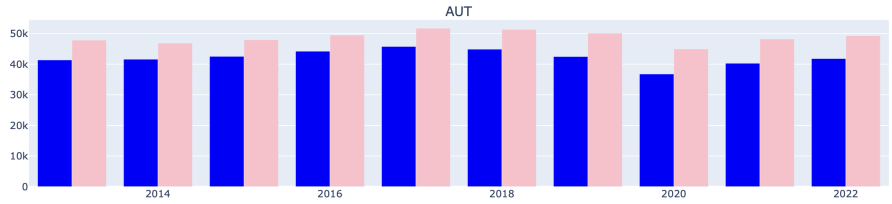


Figure 14: Net flow of students by gender to Austria between 2013-2022. Blue for males, pink for females.

net flow of students. A decrease of the net flow, in the context of travel bans, suggests that less people came to Austria as international students more so than Austrians choosing to stay as nationals staying instead of leaving should increase the net flow rather than decrease it.
For almost all nodes, there is a change post-2020:

1. If the net flow was consistently negative, it became less negative post-2020.
2. In some cases where the net flow was negtive, it became positive and continued to be positive.
3. In the cases where the net flow is positive, it became less positive.
4. In very rare cases, the net flow did not change.

It is fair to conclude that the accessibility of countries that are attractive to students decreased, decreasing their positive net flow. Likewise, the countries that tend to be less attractive had the incentive of the travel bans, forcing the local students, who would otherwise leave, to stay.
The reason for spikes in 2022 and the "reversing trends" could have been the eased travel bans, but it could have also been economic issues. In the case of Turkey, this is probably the case (Figure 15).

In the case of Turkey, the net flow was consistently negative, becoming less negative post-2020. However, as the restrictions around mobility eased in 2022, the net flow to EU countries and EU partners reached unprecedented levels, when compared to the data we have. Declining standards of living, inflation and an unstable economic situation are strong incentives for migration (Castelli, 2018).

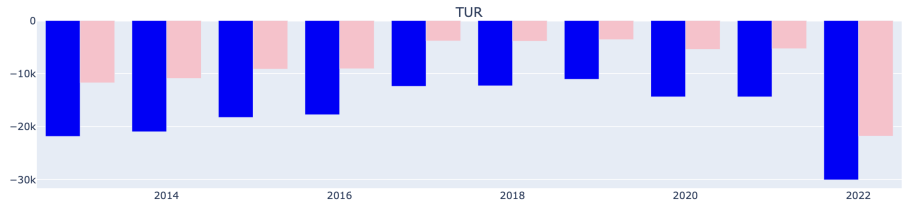


Figure 15: Net flow of students by gender to Turkey between 2013-2022. Blue for males, pink for females.

Polls in Turkey, as recent as October 2021, showed a lack of satisfaction with the economic situation and a declining standard of living (Loschky and Reinhart, 2022). Accordingly, more students are leaving in the search for better opportunities which is a common goal among international students.
For some nodes, the gender dynamics stood out. In the case of Turkey, the number of male students leaving the country to one of the other 36 countries in the study was consistently higher than the number of females leaving the country. This is not to say that the number of female Turkish students studying abroad in general is less than the number of male Turkish students. With the current set of data, this is an impossible conclusion to make.

5 Conclusion

Student mobility is driven by many factors: economic, cultural, linguistic and individual. In this study, student mobility was considered through a macro-lens to investigate what kind of conclusions can be drawn about the student mobility considering only data about their flow.
At first glance, geographical proximity, cultural and historical ties and regional dynamics seemed to be promising areas of research, given the similarities in networks composed on these bases and the Student Mobility Network. This approach heavily relied on the modularity of the network. It was found that depending on the group a node belonged to, it followed a certain dynamics of attracting people within that community or outside it. The rates of inter-exchange and intra-exchange within one cohort were almost constant. Smaller countries tended to exchange less with people outside its cohorts. It was observed that in some cultural groups, Slavic for instance, the intra-exchange was significantly higher than the inter-exchange. Cultural similarities between some countries prompted students to be more likely to travel to that country, as is the case for the student-exchange between France, Spain and Italy.
Brexit and the pandemic affected the dynamics of student mobility. The traffic of the students decreased, especially for countries who mainly sent their students to Great Britain. However, it is more likely, as discussed, that the pandemic

had a stronger effect as the trends were recovering in 2022. Due to the lack of data, the study could not consider the student mobility in a more global context. Future research should try to investigate whether the same dynamics apply on the global level. Moreover, studies centering the gender aspect to understand the discrepancy between the numbers of outgoing/incoming students by gender would be beneficial. Factors like equal pay, women's rights and the success of social movements, historically and contemporarily, can be considered in these studies.

There were attempts to map the GDP per capita and the GDP to the exchange rates, but they did not yield any successful results. This contradicts findings we are certain of. It is no secret that economic stability of the host country is an incentive to go as revealed in many studies and interviews with international students and migrants. Our suggestion is that for every edge, comparative economic stability index should be calculated.

The students going to Great Britain post-Brexit were not included in the dataset, but incorporating them would make the networks closer to reality. Such data is made available online by the British government.

Appendix

Croatia (HRV) Greece (GRC) Slovenia (SVN) Bulgaria (BGR) Montenegro (MNE) Turkey (TUR) Cyprus (CYP) Albania (ALB) North Macedonia (MKD) Bosnia and Herzegovina (BIH) Serbia (SRB)	Liechtenstein (LIE) Malta (MLT) Ireland (IRL) Germany (DEU) Austria (AUT) Norway (NOR) United Kingdom (GBR) Netherlands (NLD)	Italy (ITA) Romania (ROU) France (FRA) Switzerland (CHE) Belgium (BEL) Luxembourg (LUX) Portugal (PRT) Spain (ESP)
Estonia (EST) Hungary (HUN) Finland (FIN)	Iceland (ISL) Denmark (DNK) Sweden (SWE)	Poland (POL) Czech Republic (CZE) Slovakia (SVK)
Latvia (LVA) Lithuania (LTU)		

Table A2: Language Network Communities (Appendix)

Description of Border Network Communities

1. **Border Network Community 1:** Liechtenstein (LIE), Italy (ITA), Germany (DEU), France (FRA), Slovenia (SVN), Switzerland (CHE), Belgium (BEL), Luxembourg (LUX), Denmark (DNK), Austria (AUT), Netherlands (NLD)
2. **Border Network Community 2:** Croatia (HRV), Romania (ROU), Greece (GRC), Bulgaria (BGR), Montenegro (MNE), Turkey (TUR), Albania (ALB), Hungary (HUN), Serbia (SRB), North Macedonia (MKD), Bosnia and Herzegovina (BIH)
3. **Border Network Community 3:** Estonia (EST), Lithuania (LTU), Poland (POL), Slovakia (SVK), Latvia (LVA), Czech Republic (CZE)
4. **Border Network Community 4:** Sweden (SWE), Norway (NOR), Finland (FIN)
5. **Border Network Community 5:** Portugal (PRT), Spain (ESP)
6. **Border Network Community 6:** Ireland (IRL), United Kingdom (GBR)
7. **Border Network Community 7:** Cyprus (CYP)
8. **Border Network Community 8:** Iceland (ISL)
9. **Border Network Community 9:** Malta (MLT)

Figure 16: Key for the incoming and outgoing students graphs.

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