論　　文

Migration, Human Capital, Brain Drain and Gain*
—A Perspective in Light of the EU's Experience—

Robert F. OWEN**

Abstract

The interdependence between migration, human capital formation and countries' economic welfare *via*, notably, brain drain and gain effects, is examined, while highlighting certain key features from the experience of the European Union. First, a broad empirical overview of trends in international migration since 1980 is offered for EU countries, in comparison with patterns in certain other major developed countries, including Japan and the United States. In addition to the hypothetical structural changes arising from enhanced intra-EU labor mobility under the Schengen Agreement, another distinctive feature of the European experience has been a marked build-up in the importance of Erasmus student mobility. Associated trends and imbalances across countries are identified. A more summary presentation of empirical findings and methodological insights, based on an empirical investigation relating to the inter-regional labor mobility of recently graduated French workers, is also provided. This micro-econometric analysis uses Probit models, corrected for selection bias, when examining both micro and macro-economic determinants of the mobility of recent graduates across French regions. Findings suggest that educational attainment influences job offers directly, as well as, indirectly, through heightened geographical mobility. In this regard, a strong, but non-linear, link between education and spatial mobility is identified. A welfare analysis emphasizes how human capital "quality" can impact the evaluation of migration effects, while proposing an approach for calculating imputed welfare effects of interregional mobility.

* An earlier version of this paper was presented at an ESRI conference in Tokyo in March 2017. The proposed analysis has been influenced, in part, by joint research undertaken with Bernard Franck and Jean-Pascal Guironnet, including cited published and unpublished papers. The particularly assiduous empirical research assistance of Matthieu Poullin is also greatfully acknowledged, as well as the contributions of Valentin Burban and Pedro Javier Soria.

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A subsequent conceptual framework is proposed for understanding how heterogeneous abilities and initial national levels of educational attainment, along with differences in the quality of higher educational systems and associated access conditions, critically co-determine individuals' international educational choices and their related, subsequent professional options. Associated implications for national economic welfare are outlined. An array of factors in shown to potentially determine students' decisions whether to be trained and/or work at home, or abroad. These include the quality and pricing of educational offerings, the openness, specificity and selectivity of university systems, international salary differentials and foreign job market access conditions. Self-selection on the part of heterogeneous individuals is a key element determining the balance between brain drain and brain gain effects, along with the relative efficacy of countries' optimal educational policies, aimed at attracting international talent.

JEL Classification Codes: F22, D82, I25, I28, J24
Keywords: human capital, brain gain, brain drain, international migration, labor markets, European Union, international educational choices and policies, heterogeneous agents, self-selection

人口移動、人的資本、頭脳流出と頭脳流入
——EUの経験を踏まえた展望——

Robert F. OWEN

〈要 旨〉

本論文では、EUの経験を踏まえ、頭脳流出・頭脳流入の効果を通じた人口移動、人的資本形成、そして一国の経済厚生の相互関係を検証し、鍵となる特徴を示している。初めに、日本や米国を含む他の主要先進国におけるパターンとの比較を通じ、EU諸国について、1980年以降の国際的人口移動の傾向を実証的に概観した。シェンゲン（Schengen）協定のもとで促進されたEU域内における労働移動を背景とした構造的な変化に加え、エラスムス（Erasmus）プログラムによる学生の移動の重要性が示された。

次に、最近の大卒のフランス人労働者による地域間の労働移動に関する調査に基づく実証結果と方法論的な視点についても報告している。この分析には、プロビットモデルを用い、選択バイアスを修正した上で、フランス国内の最近の大卒による地域間の移動の決定要因を検証している。分析結果によれば、教育水準は、直接的に、また地域間移動の高まりを通じて間接的に就職に影響を及ぼすことが示唆されるとともに、教育と労働移動の間の強固で、非線形な関係が確認された。経済厚生分析をもとに、人的資本の質が、どのように人口移動の評価に影響を与えるかを示すとともに、地域間労働移動に係る厚生効果を計算するためのアプローチを提案している。

最後に、個々に異なる能力、教育水準に関する初期レベル、また、高等教育システムの質やアクセス環境の違いが、どのように個人の国際的な教育選択やその後の職業選択を決定するかについての理論的な枠組みを提示し、国レベルの経済厚生へのインプリケーションを導いている。国内または海外で訓練を受ける、あるいは働くといった学生の決定に潜在的に影響を与える要因には、教育の質や価格、大学システムの開放性、特殊性、選択性、国際的な給与差、そして海外の労働市場へのアクセス環境などが含まれる。また、異質な個人における自己選択(self-selection)は、国の教育政策の相対的な効果とともに、頭脳流出・頭脳流入の間のバランスを決定する重要な要素となっていることが示される。

JEL Classification Codes：F22, D82, I25, I28, J24
Keywords：人的資本、頭脳流出、頭脳流入、国際的人口移動、労働市場、EU、国際的な教育選択と政策、異質な個人、自己選択

I. Introduction

International human capital mobility has been at the heart of the brain drain literature, initiated in large part by Bhagwati and Hamada (1974), and subsequently elaborated to consider the counterbalancing effects of brain gain effects on economic welfare in source and recipient countries. In what Schiff (2006) has termed the "new brain drain literature," Mountford (1997) and Stark *et al.* (1997), have identified a potentially important source of brain gain, which is independent from return migration. Specifically, although migration can generate a loss of domestic talent, it can also prompt an upsurge in the overall educational level of a home country, as a result of higher propensities to invest in human capital. Attractive foreign labour market conditions offer heightened incentives for domestic workers to strive to attain higher qualification levels, whether or not they ultimately find jobs abroad, thereby fostering, ceteris paribus, increases in average productivity levels at home. More generally, and as will be subsequently elaborated, it is increasingly apparent that there is a critical nexus between individuals' decisions to be educated, at home, or abroad, and their subsequent professional mobility internationally.

A central objective of the present research is to examine how the international competition for talent is potentially impacted by the interrelation between students' choices regarding where to be educated internationally and the prospects for subsequent professional mobility across borders. More specifically, a central hypothesis to be scrutinized is that the determinants of the international mobility of highly skilled professionals, along with the associated stakes for a country's economic welfare, are quite different from those for less skilled workers. An associated issue is the identification of ways in which educational and labor market policies can shape the international distribution of brain drain and brain gain effects.

The experience of European Union countries with migration can be regarded as being of particular interest for identifying generic features of the interrelation between human capital formation, international labor mobility, along with associated economic and policy stakes. Notably, heightened integration in the EU has provided a natural experiment for examining the simultaneous implications of liberalized immigration policies and cooperative international educational policies; in an overall setting where there have been marked differences in educational performance across European countries, as well as in wages and other aspects of the historical functioning of national labor markets. As such, it will be suggested that there are potential lessons from the EU for other countries, outside Europe, including in Asia. In this respect, the Japanese scenario, where an aging population poses apparent economic challenges, points to

the question of the extent to which a selective easing of existing constraints on international migration, combined with internationally-oriented educational policies, can eventually enhance the sustainability of the country's international competitiveness.

Of particular interest in the European case is the extent to which there are observed simultaneous changes in the international mobility of students and redefined patterns of international migration within the EU. The European experiment has been largely defined by the fall of the Berlin Wall in 1989, the formation of the Single Market in 1992, and the Schengen Agreement, implemented in 1995, consisting now of all but two EU nations. This combined product and labor market liberalization experience provides, at least in theory, a unique setting for examining determinants of international labor mobility across an expanded and large set of countries.[1] Paralleling the associated product and labor market integration has been the development of European Erasmus Student and Faculty Exchange Programs. First initiated 30 years ago, these programs are aimed at fostering international educational opportunities and the educational exchange of talent across not just EU, but also certain other participating countries.[2] Hence, by drawing on the European experience, it is possible to highlight the scope for national and international policy initiatives to impact the mobility of skilled persons across countries in Asian, and elsewhere. Yet, the subsequent analysis of educational and labor mobility across EU countries will also identify substantial imbalances in brain drain and brain gain flows, while pointing to certain factors, including, notably, wage differentials, which can account for such trends.

The conceptual analysis subsequently proposed in this paper will also emphasize distinctive features and determinants of the international competition for talent, while underscoring linkages between students' international educational choices and labor market conditions across countries. A proposed heterogeneous-agent framework builds on an extensive international migration literature. While certain existing approaches to modelling brain drain and brain gain effects entail macroeconomic frameworks with representative agents, as in Vidal (1998), many also consider microeconomic decisions at the level of individual agents, including choices regarding optimal investment levels in education.[3] Stark *et al.* (1997) have proposed a frame-

[1] Of course, current negotiations regarding Brexit may well redefine the current state of educational ties and the international labor market mobility between Great Britain and the rest of the EU.

[2] The transformation of European labour markets has fostered a prolifera of studies, treating a wide range of related issues, these include those by Barslund, Busse and Schwarzälder (2015), Bertelsmann Stiftung (2014), Bonin *et al.* (2008), Boswell (2005), CEPS (2014), Eurofound (2014), European Commission (2010, 2014), Favell (2008), Pascouau (2013), Vandenbrande *et al.* (2006), Zimmerman (2008), Zimmerman and Bauer (1999), and Zimmerman and Straubhaar (1993).

[3] The literature overview here follows the presentations in Franck and Owen (2015, 2016).

work, which demonstrates how, when indivuals are given the opportunity to migrate, choices regarding educational attainment will determine that individual's wage on the foreign labour market. In other modelling frameworks, as proposed by Stark *et al.* (1998), the potential migrant takes into account a probability of finding a job abroad, which is identical for all individuals, or, as in Stark (2004), constrained by a minimum threshold level of qualification. Mountford (1997) and Beine *et al.* (2001, 2008) propose models where an individual's decision is of a binary form—whether to undertake education or not, while the probability of finding foreign employment is exogenous. This does not allow a role for differences in individuals' characteristics, so that migrants are randomly selected. In contrast, Chiswick (1999) provides for self-selection by migrants, since, assuming two categories of individuals, the rate of return to migration is greater for those with high-ability, relative to lower-ability persons. Nonetheless, this literature has principally focused on the links between incentives to invest in human capital at home and subsequent migration flows.

The evaluation of brain drain/brain gain effects is made in the literature by assessing the impact of migration on a variety of specific economic objectives, which, however, do not include an explicit social welfare per se. Notably, migration is shown to influence the growth rate of the home economy, as in Beine *et al.* (2001), the average educational level, as highlighted by Stark *et al.* (1997, 1998) and Lien and Wang (2005), average productivity in Mountford (1997), as well as the wages of non-migrants in Stark (2004).

There are now a quite large number of empirical and analytical studies, assessing different dimensions of the general determinants and consequences of migration, including the potential size and impact of brain drain, gain, and waste effects. Notably, a rather comprehensive and global overview is provided in a recent studies, undertaken by the OECD (2016a, b, c) and the International Organization for Migration (2015), as well as in an earlier report of the ILO (2006). Beine *et al.* (2008) and Borjas (1999a) provide insightful surveys of certain key issues and contributions to the literature on international migration.[4]

Yet, there often remains a lack of consensus regarding the size of conjectured positive effects of migration upon levels of education, welfare and/or growth. Furthermore, much of both the theoretical and empirical literature has been focused on the impact on source, rather than home,

[4] Certain more specific dimensions of the determinants and effects of migration are also investigated by, among many others, Beine, Docquier and Rapoport (2007), Borjas (1999b), de Haas (2011), Hatton and Williamson (2002), Czaika and de Haas (2014), Katz and Stark (1987), Mayda (2010), Özden and Schiff (2006), Özden *et al.* (2009), Schiff (2006), Sjaastas (1962), and Solimano (2008). Specific work on international mobility in Asia and other areas, such as, Latin American and the Caribbean, include, respectively, the papers by Xing *et al.* (2014) and Niimi and Özden (2007).

countries. Notably, Beine *et al.* (2001, 2008) find that the proportion of migrants must be low for such effects to be apparent. According to Schiff (2006), preliminary studies by the World Bank show no positive impact, while Groizard and Llull (2006) indicate a similar finding.

A critique by Rosenzweig (2008), which faults existing approaches to the analysis of brain drain and gain in two crucial respects, is particularly germane for motivating the modelling framework, subsequently proposed in this paper. First, he contends that the potential impact of the "'risk' of emigrating" for "domestically-educated tertiary educated person(s)" is de facto quite minimal. Second, Rosenzweig suggests that "the literature ignores the endogeneity of the emigration probability," while arguing that, in fact, "the choice of the location of tertiary education significantly affects the probability that the person can emigrate."[5] (pp. 2−3) Critically, existing analytical research has paid relatively little attention to the question of whether distinctive brain drain and gain effects may arise, depending on the extent to which educational investments take place either in home and/or host countries. Nonetheless, the policy stakes of the international mobility of high-skilled workers are increasingly recognized as a source of substantial policy concern.[6]

The overall organization of this paper is as follows. Initially, the empirical analysis proposed in the next section focuses on salient features of migration involving the EU. A global perspective is offered, which includes comparisons with certain other non-EU developed countries—notably, Japan and the United States. The discussion starts by identifying salient characteristics of inflow and outflow migration stocks and their trends for major EU economies, as well as certain other OECD economies. This global overview of patterns and trends in international migration also covers a rather large time horizon, starting in 1980. The discussion includes relatively detailed characterizations of the composition of migrant inflows and outflows across EU countries by countries of origin and destination. The subsequent empirical analysis, in the first part of Section II, investigates certain dimensions of educational mobility in Europe, as reflected by Erasmus educational flows. A number of bilareral and multilateral imbalances in student flows across participating countries are identified. In the absence any comprehensive survey, which documents the international professional mobility of Erasmus students following their international educational mobility, it is, nonetheless, useful to com-

[5] While the analytical framework proposed by Rosenzweig does not allow for differences in individual abilities, his empirical findings are consistent with a number of the modeling assumptions, which are subsequently invoked here. Notably, he reports evidence that students are motivated by foreign studies in order to obtain employment in a host country and that quality differences in university systems also appear to trigger the decision to study abroad.

[6] See, for example, Leipziger (2008) and Solimano (2008).

pare student mobility imbalances with overall patterns of international migration within the EU. The identification of significant asymmetries between host and origin countries of migrants suggests that there may well be common factors explaining imbalances in both international flows of students and the overall international mobility of individuals, corresponding then to an asymmetric distribution of brain drain and gain effects across EU countries. Such issues appear to be particularly acute for Eastern European countries, as source countries of both outwardly mobile students and permanent migration flows, which, undoubtedly, include significant numbers of rather, well-educated workers.

The second part of Section II reports findings and methodological insights for empirical investigations relating to the inter-regional labor mobility of recently graduated French workers, based to the research of Franck and Owen (2015, 2016). The micro-econometric analysis used in these studies relies on Probit models, corrected for selection bias, to examine the role of both micro and macro-economic determinants of mobility across French regions. The analysis, thereby, explains the probability that individuals will move, either temporarily, or permanently. The relative significance of a range of both individual and regional characteristics, including wage differentials and the tightness of regional labor markets, are assessed, while also evaluating associated implications of inter-regional mobility for eventual wage premiums or penalties and highlighting, again, the potential role of self-selection. While confirming a number of predictions of human capital theory, the empirical findings suggest that educational attainment influences job offers directly, as well as, indirectly, through heightened mobility. Consequently, a strong, but non-linear, link between education and spatial mobility points to potential biases in estimated returns to mobility and human capital formation. Finally, a welfare analysis emphasizes that it is not just numbers of migrants, but their human capital "quality," which needs to be considered when assessing implications of migraton. An approach for calculating imputed welfare effects of interregional mobility is proposed, based on imputed monetary inflows, which correspond to earnings differentials resulting from migration.

In Section III an enlarged framework for analyzing the nexus between human capital formation and international migration for both students and workers is provided. A central message is that while the determinants of international educational and subsequent professional mobility are complex, it is readily apparent that educational and labor market policies involving skilled indivduals are quite distinctive, relative to those for less skilled workers. The analysis relies on the existing research of Franck and Owen (2011, 2015, 2016) to consider distinct categories of brain drain and brain gain effects, arising from the eventual decision to undertake further human capital formation, either at home, or abroad. Associated international implica-

tions are explored in a two-country setting, which could be extended to envisage game-theoretic issues involving competition between university systems internationally. Individuals, who are heterogeneous in terms of their abilities, face the option of eventually pursuing further studies, while choosing between the alternative university systems. These educational investment decisions are based, among other considerations, on the interrelation between differences in students' innate abilities, quality and access costs of the educational systems, as well as subsequent employment prospects and anticipated wage earnings in both countries. Nonetheless, under certain conditions, certain individuals may opt to remain relatively less trained and, consequently, only be able to work in their country of origin at a lower wage rate. Thus, the analysis highlights the critical linkages between human capital formation, international educational and professional mobility.

A concluding section highlights the overall contribution of this research, briefly summarizes key findings and insights, and also suggests certain directions for more in-depth research.

II. An Empirical Perspective Regarding Migration, Student Mobility and Human Capital Formation in the European Union

II. A. EU Migration Flows in a Global Perspective

This section starts by characterizing salient empirical features of migration for the EU in a global perspective. In the latter regard, certain comparisons with other major developing countries, including, notably, Japan and the United States are offered. The discussion starts by identifying salient characteristics of inflow and outflow migration stocks and their trends for the EU, while covering a rather large time horizon−beginning in 1980. Subsequently, the composition of migrant inflows and outflows across EU countries by countries of origin and destination are characterized, in detail.

In addition to the hypothetical structural changes arising from enhanced intra-EU mobility of workers and other individuals under the Schengen Agreement, another distinctive feature of the formation of the European Union has been the increased educational exchanges across borders. Notably, the development, over the last 30 years, of the Erasmus programs for promoting the international mobility of students and educators have transformed many aspects of the academic environment across not only EU, but also other, participant countries. Associated trends are identified, based on the calculation of Grubel-Lloyd indices, which reflect the state of the imbalances in student flows across Erasmus participating countries. While European surveys,

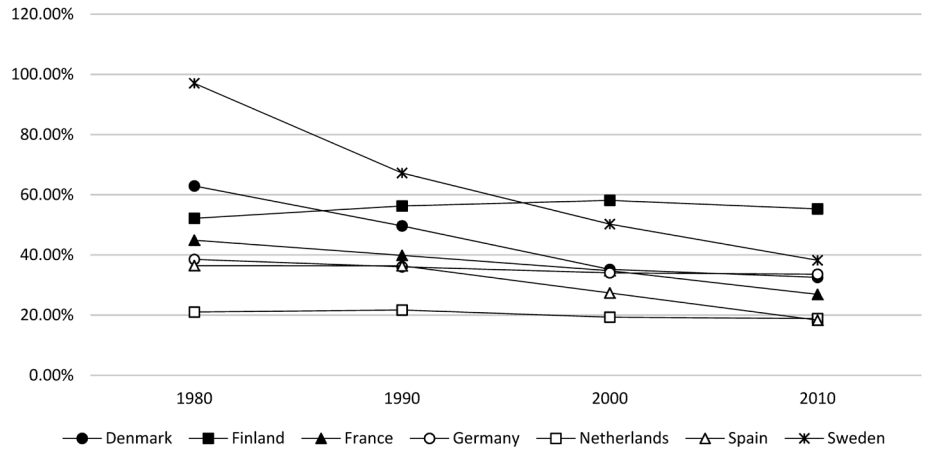
documenting students' subsequent international professional mobility, are not readily available, significant asymmetries of students between host and origin countries are readily identifiable. These are highly suggestive of likely subsequent imbalances in the international flows of professionals, trained outside their home countries in the EU, thereby pointing to associated brain drain and gain effects.

II. A. 1 Migration Stocks in the EU and Elsewhere—A Global Perspective

A. 1. a. The Configuration of Inward Migration Stocks across EU Countries

Figures 1a,b,c, present the evolution of EU migrant stocks for a number of major European countries over the period from 1980 to 2010.[7] The series are broken down into a distinction between intra-Schengen Area and extra-Schengen Area stocks. Contrary to what might be expected, a priori, the intra-European shares have either remained constant or, actually, decreased since the formation of the mobility pact in 1985. However, extra-EU migration stocks within European countries have increased rather sharply for a number of countries since the formation of the Schengen Area. Indeed, this effect is captured by a sharp break for a number of countries as of 2000. This structural break pattern is notably the case for Spain, Germany and France, but Finland is the only country without such a sharp increase.

Figure 1a. Percentages of Intra-European Migration over Time—1980–2010



[7] References for data sources are provided in Technical Appendix I.

Figure 1b. Evolution of the Number of Intra-European Migrants over Time

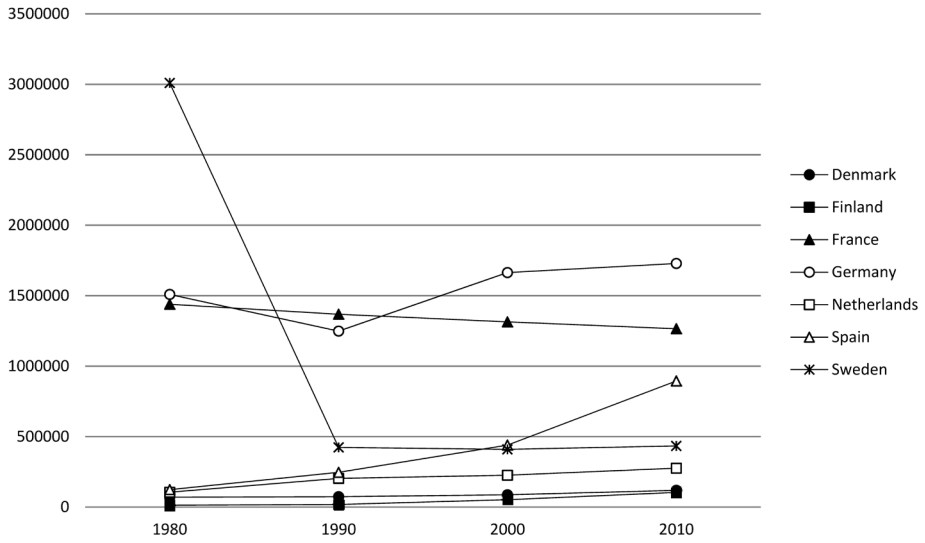
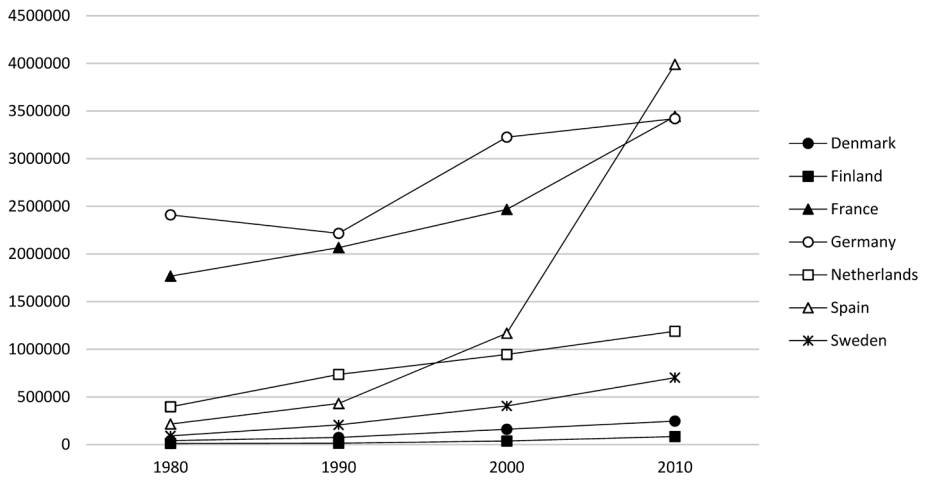


Figure 1c. Evolution of the Number of Extra-European Migrants over Time



A. 1. b. The Configuration of Migration Abroad: EU Outward Migration in a Global Perspective

The following figure identifies, for an initial period spanning 1960 through to 2000, the leading sending countries in terms of the stock figures on their migrants abroad. During that period, the Russian Federation was generally the largest source of migrants.[8] However, it is also apparent that whereas certain European countries, including Poland, the United Kingdom

[8] In part, the scenario for the Russian Federation is linked to the break up of the former Soviet Union.

Figure 2. Top 10 Sending Countries in the World—1960–2000

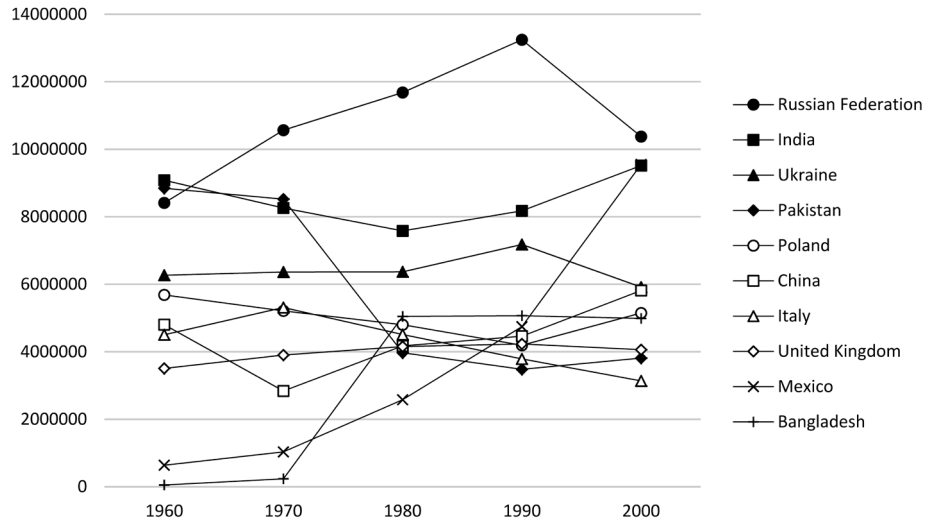
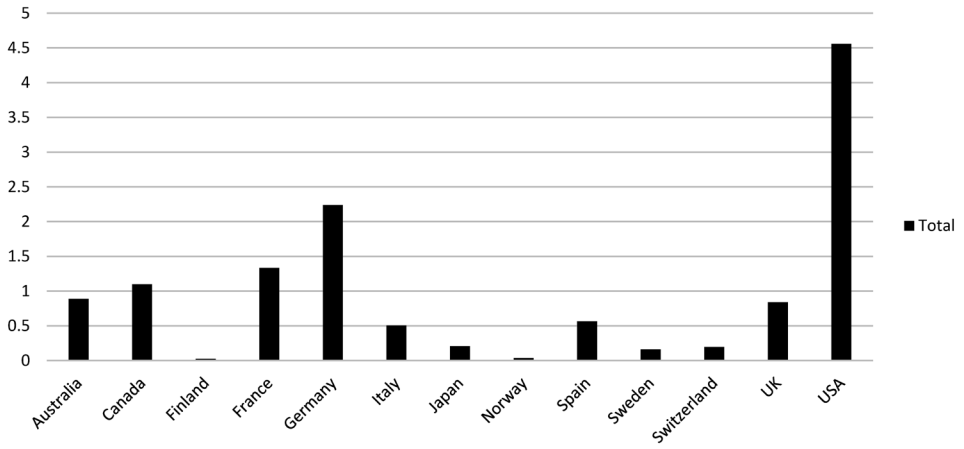


Figure 3a. Standardization of the percentage of migrants hosted by the percentage of GDP per capita of the host country (2000)



and Italy, are relatively prominent source countries of international migrants, European migration during that period is just one part of a much larger story about international mobility, which has often involved non-EU countries, which subsequently became emerging markets.

As shown in Figures 3a,b,c a consideration of relative migrant inflow propensities suggests a quite different ranking of host countries, depending on whether the standardization is based on standard of living (GDP/capita), or on overall size, as measured in terms of either GDP, or population. When standard of living is used, as shown in Figure 3a, the United States is by far the largest host country, followed by France and Germany. Yet, in Figure 3b, which offers a

Figure 3b. Standardization of the percentage of migrants hosted by the percentage of GDP of the host country (2000)

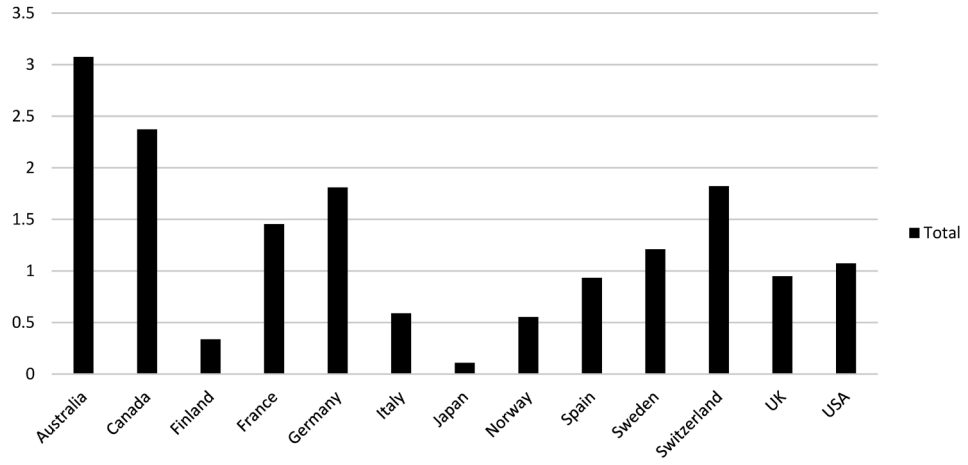
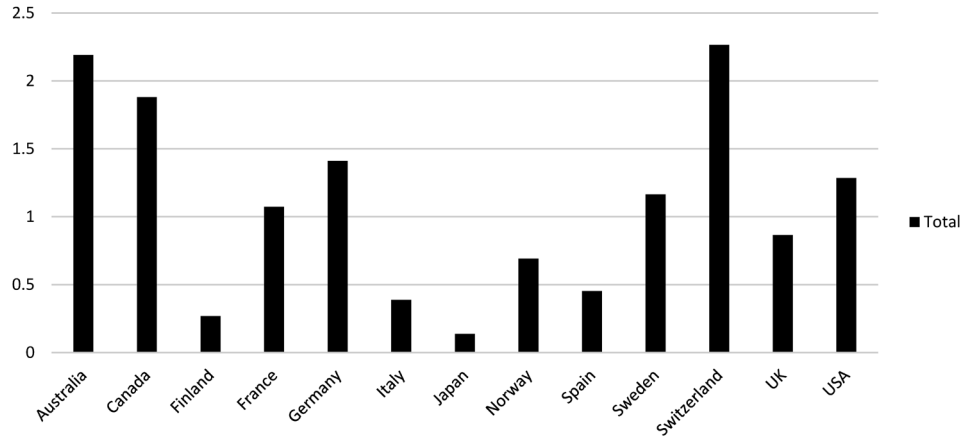


Figure 3c. Standardization of the percentage of migrants hosted by the percentage of population of the host country (2000)



comparison in terms of the size of the host countries, based on their percentage shares of GDP, Australia and Canada stand out in terms of their relative shares of migrants. Furthermore, the relative positions of Germany, Switzerland and France are then more prominent than that of the United States. Yet, as previously, Japan's share of inward migrants is consistently low. The strikingly low position of Japan, when compared with other OECD countries, is also demonstrated in Figure 3c. This time the comparison standardizes the different countries' positions, based on their relative shares in terms of their share of overall population, relative to those of the other host countries under consideration. Taking into account the size of countries, on the basis of their populations, rather than GDP, does not substantially alter the comparative rank-

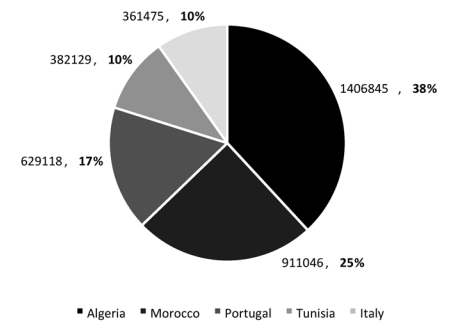
ings across countries, in relation to those involving size in terms of GDP, with one notable exception. When the comparison involves population, Switzerland becomes the leading country in terms of its relative propensity to host migrants—followed by Australia and Canada.

II. A. 2. The Composition of EU Migrant Inflow and Outflow Stocks by, Respectively, Countries of Origin and Destination

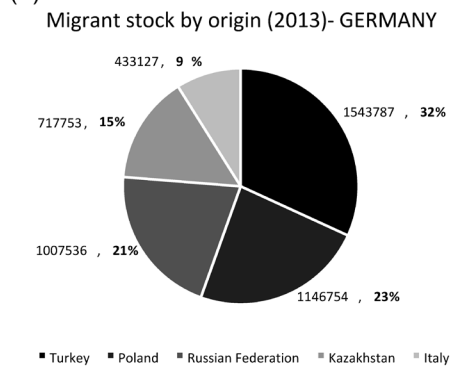
An initial overview of the nature of migrant stocks in the largest and/or most prosperous EU countries (as well as in Switzerland) is provided for 2013 in Figures 4 and 5. The first set of these pie-diagrams (Figures 4) reports the numbers of migrants and their shares of the overall inward migrant stocks for the four largest EU countries, while identifying, in each case, five of the principal source countries. An immediate insight is that when it comes to the size of migration stocks, history often matters a lot. Notably, a major source of hysteresis is the historical colonial ties of certain countries, including, notably, for France, the United Kingdom and Spain. In the case of France, the largest stocks of migrants come from North Africa. The principal source countries include Algeria, Morocco, and Tunisia, which account for almost three-fourths of all migrants, coming from the top five countries of origin. Similarly, in the case of the United Kingdom, three countries–India, Pakistan and Ireland–account for roughly two-thirds of the five largest migrant source inflows. Nonetheless, the share of migrants from Poland in the UK is also prominent. For Spain historical ties with Ecuador, Columbia and other Latin and Central American countries are apparent in the migrant inflow stocks, broken down again by countries of origin. Geography also matters, as reflected by the role of migrants from Morocco, which is a proximate neighbor with close historical links. Nonetheless, there is, again, an importance of migrant stocks involving Eastern European countries, as shown by the observation that roughly one third of the overall share of migrant stocks, involving the top five source countries in Spain, come from Romania. In the case of Germany, the historical importance of migrants from Turkey is also apparent. Nonetheless, the German economy is the one most influenced by migration from Eastern Europe. These inward migrant stocks include that of neighbouring Poland, as well as those from parts of the former Soviet Union. Finally, the role of migration from Eastern Europe is also apparent in the case of Italy, which has substantial shares of migrants from neighboring Albania, but also from Romania, which has the largest single share of the top-five migrant countries, amounting to fully 44 percent. An apparent hypothesis to be tested is that the much lower wages in Eastern European countries, relative to western European host countries, have constituted a key push factor, incluencing migrants destination decisions.

Figures 4a–e. Distribution of Migrant Stocks for Selected Large EU Countries in 2013, Broken Down by Principal Countries of Origin

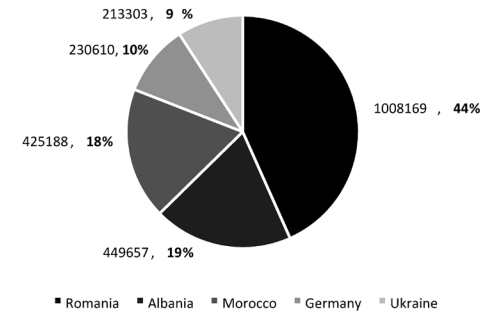
(a)



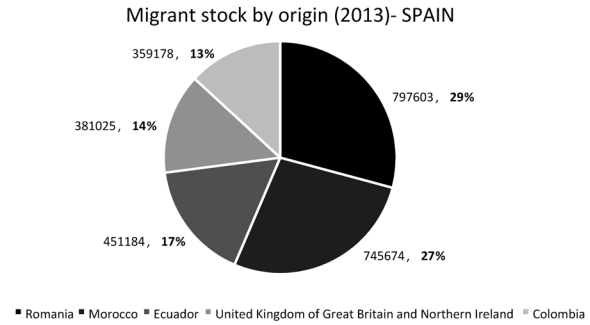
(b)



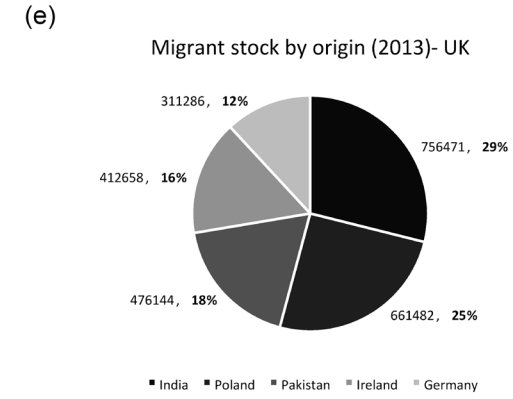
(C)



(d)

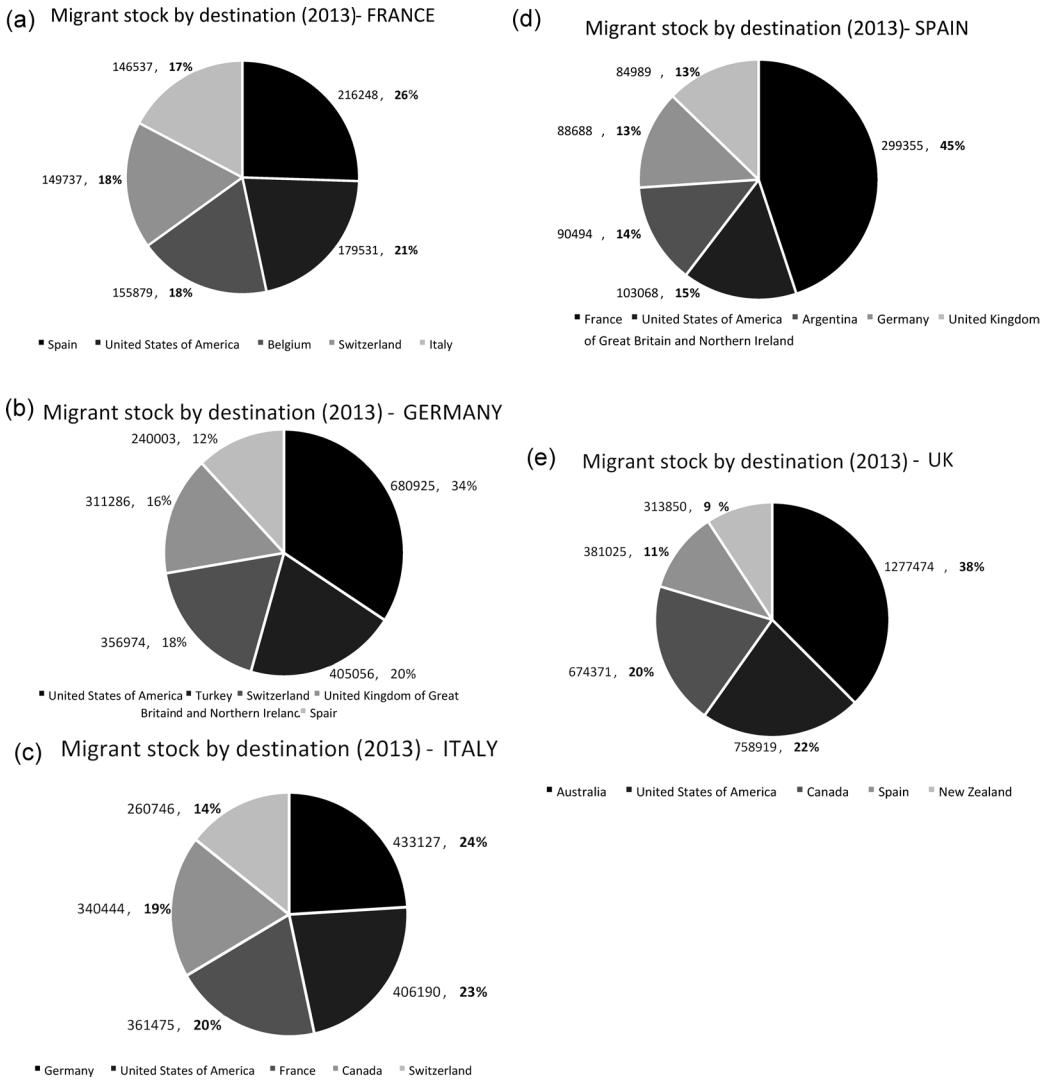


(e)



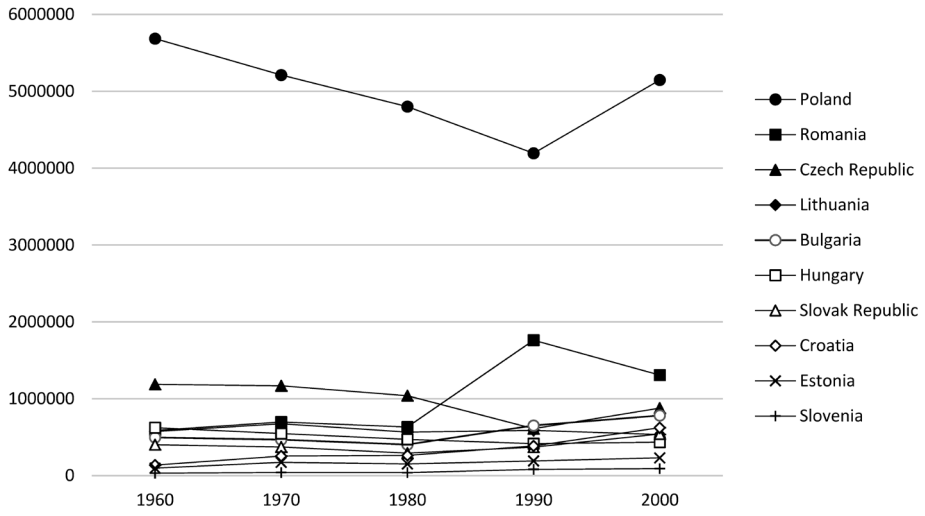
When it comes to the principal destination countries, shown in Figures 5, historical ties appear to play a more nuanced role. On the one hand, in the case of the United Kingdom, almost 90% of emigrant stocks, among the top five host countries, are in former colonies. These include, in order of importance, Australia, the United States and Canada. Here historical ties ap-

Figures 5a–e. Distribution of Migrant Stocks for Selected Large EU Countries in Terms of Principal Countries of Destination



pear to be coupled with the relative prosperty of those host countries, in terms of the attractive employment and living conditions they appear to offer, along with their relatively open immigration policies. Presumably, a common language also plays a key role. Yet, in contrast, in the case of France, most outward migration entails neighbouring European countries. A striking exception is the case of the United States, which, as a relatively large host country, accounts for roughly a fifth of the top-five destination countries for outward French immigration. EU ties also play a key role for Spain and Italy. In the former case, only the United States and Ar-

Figure 6. Top 10 Sending Countries–Eastern European Countries



gentina figure among the top destinations. Moreover, these host countries explain less than a third of the outward migration stocks among the top destination countries. Other EU countries, including Germany, France and Switzerland, also play a major role in accounting for outflows of Italian migrants−constituting roughly 60 percent. Again, other significant components involve North America. In this regard, the host country shares of the United States and Canada are roughly equally balanced. In the case of Germany, the largest single share of outward migration is also to the United States, which along with Great Britain, accounts for approximately half of the German migrant stocks abroad−again among the top five host countries.

Figure 6 depicts, in detail, the outward migration scenarios for Eastern European countries over the period 1960 through 2000, thereby capturing key effects of the collapse of the Berlin-Wall in 1989. A first key remark is that Poland is by far the largest source country in terms of absolute numbers of migrants abroad. Furthermore, this historical dominance of Poland, relative to the outward migrant stocks of other Eastern European countries, as a source of international migrants, has continued through to the most recent reported year, 2000. It is also striking that whereas there are increases in the migrant stocks abroad for several countries, it is Romania that experienced, by far the largest relative increase in the initial upswing of its stock of outward migrants in 1990, even though there is a subsequent decline by 2000.

II. A. 3. A Perspective on Student Mobility in Europe

International educational initiatives constitute key pillars of a European strategy to create, over time, more unified labor markets across the EU. Specific initiatives include the so-called

Bologna Process, which seeks to harmonize university diplomas and standards, and Erasmus Exchange Programs, aimed at promoting the international mobility of students and teachers across the participant countries. Together, these and other policy initiatives, which are seeking to create a European Higher Educational Area, represent a unique natural experiment, fostering the international coordination and reinforcement of national educational policies. More specifically, the Erasmus student exchange programs, which have benefited from substantial financing at the EU level, can be regarded as attracting, in general, a set of particularly high-quality students. In this respect, there are both formal selection and self-selection mechanisms, which determine the pool of talented student participants. The Erasmus mobility program is available not just to the 28 EU member states, but also to countries with associate membership, or potential membership, status. Specifically, Croatia, Iceland, Montenegro, Norway, Serbia, Switzerland and Turkey also participate in these European exchange programs.

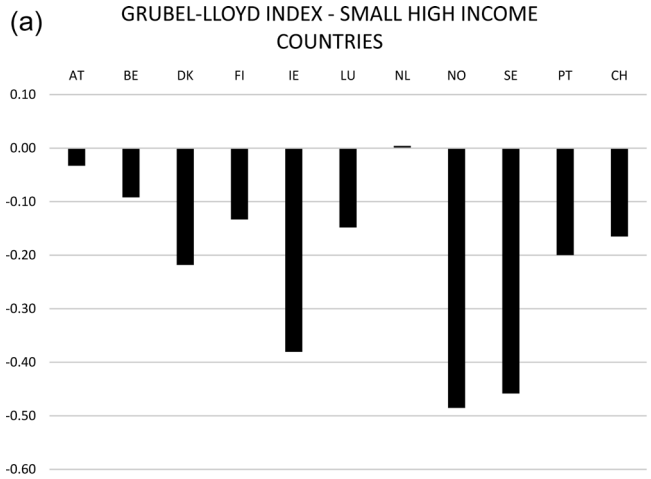
Figures 7a,b,c along with Table 1, offer summary statistical analysis relating to the mobility of Erasmus students, who have participated in the European student exchange programs in 2013.[9] In the proposed analysis, the well-known Grubel-Lloyd index, which was initially conceived to measure intra-industry trade, has been adapted to assess the potential extent of imbalances in student mobility between different categories of countries. Specifically, the formula for this index, GL_{ij}, involves a calculation, for a reference country i, in relation to other Erasmus mobility participating countries, j. The index is specified, then, by: $GL_{ij}=(X_{ij}-M_{ij})/(X_{ij}+M_{ij})$, where X_{ij} corresponds to the number of Erasmus students, who are outwardly mobile from the country i and are studying in any of the other j countries. The number of students who are inwardly mobile to the reference country i, from other EU source countries j, is designated by the variable M_{ij}. Hence, GL_{ij} represents a standardized measure, across countries, of the balance between student outflows and inflows. Specifically, this GL_{ij} index has the apparent interpretation that a country of reference, i, with a calculated positive (negative) index value is a country, which can be regarding as having a deficit (surplus), in terms of Erasmus student flows, since it is sending more students abroad, than it is receiving in exchange.

The three figures summarize the findings from the Grubel-Lloyd index calculations for an inital set of EU countries, which can be regarded as either (i.) small high-income countries, (ii.) large high-income countries or (iii.) medium-income countries. With regard to the first set of small high-income countries−with the one exception of the Netherlands (NL), for which the index is close to zero−all of these other countries countries are receiving more students from

[9] A list of codes for statistical analysis relating to participant Erasmus Program countries is provided in Technical Appendix II.

Figures 7a–c.

(a)



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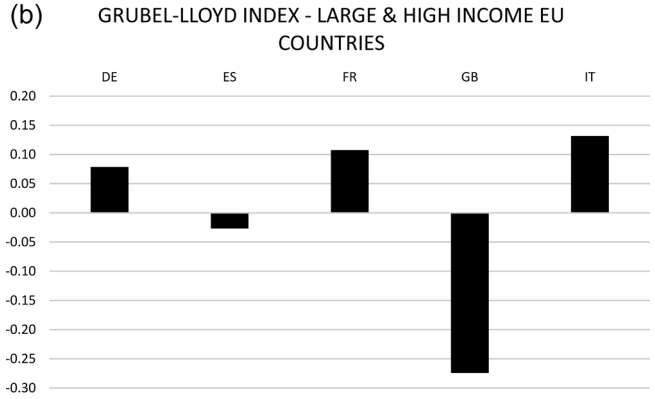


(c)

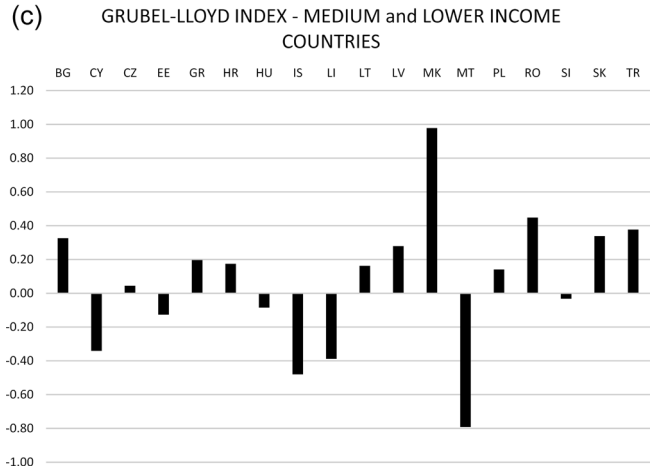


Table 1. Alternative Measures of Flows of Erasmus Students in 2013, Broken Down by Participant Countries, in Terms of Numbers Sent and Received

Country	Codes	Sending	Receiving	Sending minus Receiving	Grubel-Lloyd index	Standardizatio by GDP (X)	Standarization by GDP (M)
AUSTRIA	AT	5793	6188	-395	-0.03	1.00	1.07
BELGIUM	BE	7754	9321	-1567	-0.09	1.10	1.32
BULGARIA	BG	1757	894	863	0.33	2.33	1.18
SWITZERLAND	CH	3036	4235	-1199	-0.16	3.88	5.41
CYPRUS	CY	395	803	-408	-0.34	1.21	2.46
CZECH REPUBLIC	CZ	7510	6868	642	0.04	2.65	2.42
GERMANY	DE	36257	30964	5293	0.08	7.89	6.74
DENMARK	DK	3710	5779	-2069	-0.22	10.92	17.00
ESTONIA	EE	1010	1302	-292	-0.13	0.28	0.36
SPAIN	ES	37235	39277	-2042	-0.03	0.98	1.03
FINLAND	FI	5569	7279	-1710	-0.13	0.11	0.14
FRANCE	FR	36759	29621	7138	0.11	11.31	9.11
UNITED KINGDOM	GB	15610	27401	-11791	-0.27	8.55	15.01
GREECE	GR	4470	3004	1466	0.2	21.45	14.42
CROATIA	HR	1403	987	416	0.17	0.43	0.30
HUNGARY	HU	4025	4764	-739	-0.08	0.14	0.17
IRELAND	IE	2972	6622	-3650	-0.38	7.25	16.15
ICELAND	IS	237	674	-437	-0.48	2.74	7.78
ITALY	IT	26331	20204	6127	0.13	41.86	32.12
LIECHTENSTEIN	LI	30	68	-38	-0.39	0.04	0.08
LITHUANIA	LT	3423	2467	956	0.16	24.80	17.87
LUXEMBOURG	LU	434	585	-151	-0.15	7.17	9.67
LATVIA	LV	2185	1231	954	0.28	0.19	0.10
MONTENEGRO	ME	89	1	88	0.98	0.01	0.00
MALTA	MT	230	1978	-1748	-0.79	0.03	0.28
NETHERLANDS	NL	10638	10551	87	0	3.47	3.44
NORWAY	NO	1666	4806	-3140	-0.49	0.64	1.85
POLAND	PL	15521	11693	3828	0.14	25.16	18.96
PORTUGAL	PT	6957	10430	-3473	-0.2	5.21	7.82
ROMANIA	RO	5742	2189	3553	0.45	8.89	3.39
SWEDEN	SE	3720	10012	-6292	-0.46	0.20	0.54
SLOVENIA	SI	1792	1911	-119	-0.03	0.23	0.24
SLOVAKIA	SK	3177	1570	1607	0.34	0.34	0.17
TURKEY	TR	15060	6818	8242	0.38	1.35	0.61

abroad that they are sending. This imbalance is particularly striking for most of the Nordic countires, including particularly Norway (NO) and Sweden (SE), while also being rather acute for Ireland (IE).

In contrast, for the second set of large and relatively high-income EU countries, there is a much more varied set of mobility imbalances. Notably, Germany (DE), France (FR) and Italy (IT) are countries, which experience net outflows of students, whereas Great Britain is clearly the country with greatest new inflow of students. Presumably, one apparent explanation for this pronounced imbalance in the case of Britain is the question of the language of instruction. Indeed, many EU students perceive the opportunity to study in English as a critically important qualification; in light of the subsequent international mobility opportunities such a qualification offers for further, more advanced, studies and/or post-graduation professional employment prospects.

Figure 7c relates to eighteen countries, which are, generally, medium and lower-income Erasmus participating countries. Many of these countries are from Eastern Europe, or parts of the former Soviet Union. There also are a certain number of relatively small EU countries in terms of their population, including Cyprus (CY), Malta (MT), Liechtenstein (LI), or another higher-income small country with a special EU status−Iceland (IS). The graphical presentation of the Grubel-Lloyd indices appears to show, ostensibly, that the scenario for student mobility imbalances is much more varied for this third set of countries. However, it will actually be argued that there is a fairly clear pattern underlying these results. More specifically, the largest number of these countries have relatively high positive Grubel-Lloyd indexes, and, hence, net outflows of students. This initial set of countries comprises a large number of Eastern European countries, as well as countries which were formerly part of the Soviet Union. Notably, the net ouflow countries include such relatively recent EU member states, as Bulgaria (BK), Latvia (LV), Lithuania (LT), Poland (PL), Romania (RO) and Slovakia (SK). Other countries with significant positive Grubel-Lloyd indexes, so that, once again, they are sending more students than they are receiving, consist of Croatia (HR), Greece (GR) and Turkey (TR). Although four countries have relatively large negative Grubel-Lloyd index values, they constitute, arguably, special cases. These countries, consisting of Cyprus (CY), Iceland (IS), Liechtenstein (LI), and Malta (MT), are all relatively small in terms of both their population and university sytems. Indeed, an overall interpretation of the results reported in this final figure, along with those in Table 1, which provides more detailed statistical information, suggests that the Erasmus exchange program have created remarkable historical educational opportunities. As a result of these Erasmus programs, a large numbers of participants have come from countries, which prior to the fall of the Berlin Wall, were largely isolated from the rest of the world. These students have been offered unique educational opportunities across a wide set of historically more prosperous, northern and western European nations. Of course, based on the available information, it remains an open question as to what portion of these students have ultimately decided to stay on to work either in the host countries of their studies, or in other higher-wage economies, including not just those in Western Europe. Thus, the overall evaluation of the impact of the Erasmus programs, in terms of more permanent brain drain and gain effects, represents a major educational and employment policy question for further investigation.

$$\text{Standardization(X)}: \frac{Sending(i)/\sum All\ Sending}{GDP(i)/\sum GDP}$$

$$\text{Standardization (M)}: \frac{Receiving(i)/\sum All\ Receiving}{GDP(i)/\sum GDP}$$

II. B. Human Capital Formation and the Professional Mobility of Graduates: A Perspective from the French Experience

The analysis in this sub-section offers a complementary and more detailed perspective on the interrelation between human capital formation and subsequent professional mobility, based on the experience of France. The discussion, which offers an overview of findings from papers by Franck, Guironnet and Owen (2015, 2017), examines the determinants of inter-regional domestic mobility of recently graduated French workers, along with associated implications for individuals' earnings and impact effects on regional economic welfare. More specifically, the discussion summarizes research methodology and certain key findings, based on French micro-survey data, which are not currently available in a comparable form for the EU, as a whole.[10] Consequently, relative to the previously proposed, broader empirical investigation for the EU, offered in the first part of this empirical section, this additional analysis provides a more detailed and explicit consideration of the links between educational attainment and professional mobility. The reported research was based on a unique survey of young graduates in France, covering a five-year period following their graduation in 2004. The investigation considers not just determinants of initial inter-regional mobility, to other regions, following graduation, but also then examines the determinants of decisions involving return migration to the region where the students concluded their studies. The overall analysis thereby distinguishes between more temporary interregional labor mobility from the regions were individuals were educated, relative to more longer-term mobility.

The forementioned micro-econometric studies use Probit models, corrected for selection bias, to examine the role of both micro and macro-economic factors, as determinants of graduates' mobility across French regions. The analysis is focused on a binary decision relating to whether a recent graduate is mobile, or not; thereby, explaining across a survey sample, the probability that individuals will move, either temporarily, or permanently. A novelty of the research is the combined emphasis on both micro-macro factors, as potential determinants of the interregional professional mobility of recent graduates. The relative significance of a range of both individual and regional characteristics, including wage differentials and the tightness of regional labor markets, are assessed. Associated implications of inter-regional mobility for

[10] Indeed, such micro-survey data relating to the professional mobility of recent graduates is rather unique, since comparable statistics are available for only a rather limited number of countries.

eventual wage premiums, or penalties, are also evaluated, while highlighting, the potential role of self-selection, along with the associated biases such processes entail.

The econometric findings, reported by Franck, Guironnet and Owen (2015, 2017), have demonstrated significant explanatory roles for both individual characteristics and regional macroeconomic variables, when accounting for both permanent and temporary mobility. In particular, the proposed estimation techniques and specifications respond to a central problem of selection bias. Notably, more capable individuals face larger numbers of job offers across any given geographical space, while also having greater incentives to search across larger spatial areas of potential employment. Consequently, it is argued that it is not mobility, per se, which is being explained by educational attainment. Indeed, more advanced educational attainment, along with certain non-observable characteristics, also impact the wage earnings of more ambitious and talented individuals indirectly through an expanded set of overall job offerings, independent of spatial search costs. A key related insight is that self-selection mechanisms can critically contribute to explaining high initial mobility propensities by more educated and capable individuals. Hence, the influence of education on mobility decisions is overestimated if selection bias from unemployed workforce is not addressed. Yet, the findings demonstrate that self-selection plays quite a different when explaining return, hence temporary, mobility to an initial region of studies. Relative to the sub-cohort of highly educated individuals, who are initially mobile, it is precisely the least educated individuals who are more likely to return to the regions where they received their most advanced training, therein reflecting a "lemons" effect.

Together, the empirical findings of Guironnet, Franck and Owen confirm non-linear relations between levels of educational attainment, mobility and wage earnings. Yet, in contrast to certain findings of other studies, such non-linear effects appear weakened when samples consist of educated young workers, since such individuals undoubtedly correspond to a somewhat more homogeneous group, as compared with the working population, as a whole.

An analysis of the associated earnings equation reveals that permanent mobility generates a wage premium, whereas temporary migration, reflecting a return decision, appears to entail a financial penalty. Hence, to the extent that the potential interaction between earnings and mobility is not explicitly taken into account, the returns to mobility are underestimated. A novelty of the proposed research approach is the calculation of imputed regional welfare effects, arising from interregional mobility. These are based on imputed monetary inflows, which correspond to earnings differentials resulting from migration. In particular, a proposed multi-level, econometric framework underscores that while there are consistently financial gains generated by permanent and temporary mobility, the magnitude of those returns can depend on whether the

regions, where individuals are trained, are either poor, or rich. In this regard, labor movements away from a large metropolitcan capital city, namely Paris, generally have a negative effect on individuals' earnings, although there is a probable exception in the case of highly educated individuals. The latter finding of exceptions may well be attributable to a regional demand outside of Paris for specific skills, in such fields as the exact sciences. Such findings underscore the subtilities underlying the nexus between optimal educational and employment policies at regional levels, as well as, more indirectly, those at national and international levels.

A final novelty of this reported research for France is the suggestion that the consequences of migration for explaining heightened disparities in regional economic welfare are accentuated, when calculations are based on an incomes approach, rather than on quantity statistics, corresponding to flows of individuals. Hence, there is a crucial quality issue, applicable to the welfare implications of brain drain and gain effects. Namely, regions, which suffer from a deficit in physical numbers of net migrants, are also those, which experience acute imbalances involving the net flows of the most skilled and capable individuals.

In sum, while the research of Guironnet, Franck and Owen has confirmed a number of predictions of human capital theory, the empirical findings suggest that educational attainment influences job offers directly, as well as, indirectly, through heightened mobility. Consequently, a strong, but non-linear, link between education and spatial mobility points to potential biases in estimated returns to mobility and human capital formation. Finally, a welfare analysis emphasizes that it is not just numbers of migrants, but their human capital "quality," which needs to be considered when assessing implications of migraton.

Yet, certain limitations of the survey data analyzed in these studies for France warrant consideration. Notably, the French Generation Survey, used in the research, does not include individuals who are internationally mobile following their graduation. Furthermore, the time horizon, tracking the professional mobility of recent graduates, is somewhat limited. In this regard, the empirical framework does not permit an evaluation of potential role of macroeconomic cycles and crises in triggering mobility decisions, along with the associated stakes for regional economic performance. A related remark is that to the extent that micro educational-employment surveys can follow the career and mobility paths of individuals over longer periods of time, it should be possible to assess the relative role of generic and specific human capital for explaining the spatial mobility of individuals across their educational and professional life cycles.

Thus, a simultaneous exploration of the determinants of inter-regional and international mobility appears as a promising direction for extended research, provided that detailed micro-survey data can address such questions. Indeed, existing research has not adequately examined

the interrelation between somewhat disparate sets of literature relating to regional migration and international brain drain-gain. At a European level, as well as in other areas worldwide, key questions remain regarding what specific factors determine the extent of border effects, impeding mobility. The latter, undoubtedly, vary not just across countries, but also across regions within and between countries. Furthermore, the nature of the potential role of selection bias in accounting for the potentially non-linear relations between national and international returns to educational investments may differ, depending on the magnitude of regional differences in push-pull factors. An international comparative perspective could reveal the relative efficacy of a larger array of educational and other public policies aimed at creating virtuous training and employment cycles through, for example, the promotion of poles of research and industrial excellence in specific fields, at national and international levels.

III. A General Conceptual Framework for Examining the Interrelation between International Educational Choices and Employment

The analysis in this section proposes an enlarged conceptual framework for analyzing the nexus between human capital formation and international migration. A crucial insight is that the international competition for talent is appropriately modelled in a heterogeneous agent framework, in which asymmetric information potentially plays a critical role in defining the efficacy of a given country's ability to attract the best students and/or researchers. Key features of the existing research of Franck and Owen (2011, 2015, 2016) are elaborated to consider distinct categories of brain drain and brain gain effects, arising from the eventual decision to undertake further human capital formation, either at home, or abroad. The phenomenon of brain waste can also be characterized within the proposed heterogeneous agent framework.

The analysis outlines, in somewhat general terms, how a two-country model framework could be extended to explore international welfare implications in a two country, game-theoretic setting, where heterogeneous individuals face the option of eventually pursuing further studies, while choosing between the alternative university systems—at home, or abroad. These educational investment decisions are based, among other considerations, on the interrelation between differences in students' innate abilities, the quality and access costs of the educational systems, as well as subsequent employment prospects and anticipated wage earnings in both countries.[11]

[11] The analysis, however, does not consider the additional complication of international migration by unskilled workers.

The organization of this section is as follows. The basic modelling analysis, proposed in section III.A., starts with a general formulation of the heterogeneous individuals' ex ante choices, regarding whether to undertake additional human capital formation, at home or abroad, or remain less skilled. An individual's underlying ability determines known productivity gains from studying in either university system, along with expected probabilities of subsequently obtaining foreign market employment at higher wages. These anticipated gains depend on the hypothetically realizable gains in productivity. These are, in turn, a function of individuals' abilities across the heterogeneous population, as well as the quality of the chosen national university system. A determination of the alternative evaluations of the net returns to additional educational investments also depends on the specific costs borne by students in each university system. However, the net returns from undertaking further university studies also need to be compared with the lower wage for lower skilled workers in the home country. In particular, individuals can opt not to upgrade their skills, and then remain at a lower and uniform level of productivity. Unlike more educated workers, workers with less-developed skills are understood to only have the option of working at home.

Section III.B. then characterizes how alternative configurations of educational decisions are critically dependent on certain modelling parameters. These include the heterogeneity of innate abilities, quality of university systems, educational costs, as well as employment prospects and anticipated wage earnings. Distinctive brain drain and brain gain effects depend, respectively, on the size of the sub-populations of individuals who migrate permanently, as compared with those who return home with enhanced productivity, or upgrade their human capital by pursuing further studies at home. While extensive comparative static results are not reported here, the analysis does explain how changes in certain key model parameters potentially impact international educational decisions, associated migration flows, and economic welfare, as well as the dependency of these effects on educational and employment policy initiatives in the two countries.

III. A. Basic Modeling Framework

III. A. 1. General Overview

A two-country setting provides a basic framework for examining the interrelation between international educational choices, migration flows and economic welfare at home and abroad.[12] A central concern is on the international educational choices of a heterogeneous population of

[12] The modeling framework developed here follows the more detailed analysis elaborated by Franck and Owen (2016).

individuals, who differ in terms of their abilities. These individuals, who are understood to come from a representative source country, formulate their decisions regarding whether and where to invest in human capital, based on their anticipations regarding their subsequent professional work prospects at home and abroad. The mobility of students is impacted, potentially, by quality and cost differences between university systems internationally. International educational choices also depend on subsequent employment prospects, as well as individual-specific factors, relating to language, cultural and other factors in the countries.

A distinctive feature of the proposed analysis is the demonstration of how the option to invest in further human capital formation, either at home, or abroad, can generate distinctive sets of brain drain and brain gain effects, as well as brain waste. As a result, economic welfare in the two countries depends critically on the quality of, and cost differences between, university systems, along with employment prospects and wage earnings in the domestic and foreign labor markets. More specifically, a representative individual, coming from a heterogeneous population of individuals in the domestic country, faces an ex ante educational choice as to whether to remain unskilled, or to upgrade his/her human capital by either undertaking further domestic studies or in the foreign university system, which is assumed to be of higher quality. Of course, these educational decisions are also influenced by the portion of cost differentials between the educational systems in the two countries, which are borne by students. These, in turn, depend on countries' educational pricing strategies, as well as eventual domestic and foreign grant programs. The latter are aimed at promoting either, or both, countries' economic welfare. Hence, the international search for talent can be viewed in terms of non-cooperative, or cooperative strategic behavior, on the part of the two different nations.

III. B. The Initial Modeling Framework

The point of departure for the more formal modeling is a characterization of the interrelation between the abilities of the heterogeneous individuals in the domestic country and attainable productivity levels, where the latter depend on potential differences in the quality of educational offerings at home and abroad, and, hence, locational educational decisions. The domestic, or source, country, in this proposed modeling framework is home to a set of individuals, who are envisaging potential migations for educational and/or professional reasons. More specifically, in the source country there is a set of individuals with a range of abilities, where the capability of the representative *k*th agent, is designated as a_k. These abilities are distributed across the population, such that $a_k \in [a_1, a_2]$, where a_1 and a_2 indicate, respectively, the most, and least, capable persons in this heterogeneous set. An educational production function is un-

derstood to characterize how abilities, along with differences in the quality of national educational systems, co-determine an attainable productivity level, e_k, for skilled individuals. However, individuals, who do not pursue further studies, remain relatively unskilled, and are assumed to remain at a lower productivity, e_0, which, as a simplification, is understood to be the same regardless of innate abilities.

More formally, the educational production function, specified by $e_k=f(a_k, Z)$, is an increasing function of its arguments and the cross-derivative, f_{12}, is positive. Here, Z represents the quality of a particular country's educational system, such that $Z\in\{z, z^*\}$. The latter symbols distinguishing the educational quality of, respectively, the domestic and foreign countries, where it will be assumed, in general, here that the foreign educational system is of higher quality, such that $z^*\geq z$. Consequently, a distinction can be made between the higher level of productivity realized by the *k*th individual, e_k^*, when studying abroad $e_k^*=f(a_k, z^*)=e_k^*(a_k)$, relative to the level attainable through studies at home, $e_k=f(a_k, z)=e_k(a_k)$. Furthermore, it is assumed that there is increased productivity gain for more capable individuals, when they are educated in a higher quality system.

In light of the assumed superior quality of the foreign university system, the hypothetical educational options of pursuing further studies, either at home, or abroad, translate for the representative *k*th individual into a unique combination of productivity values (e_k, e_k^*). The overall set of attainable combinations of productivity levels can be represented for the heterogeneous population, as a whole, by a line segment in a graphical framework, where conceivable levels of domestic and foreign productivity are represented, respectively, on the horizontal and vertical axes. Such a line segment, which is referred to, here, as the talent-educational quality locus, represents the nexus of attainable productivity gains, determined by the interrelation between the distribution of individuals' talents and the performance-enhancement generated by the quality of the two countries' educational systems.

There are at least three major determinants of the characteristics of the talent-educational quality locus, and hence the position and shape of the associated line segment, which warrant further elaboration. First, the degree to which the foreign university system offers a superior opportunity to enhance certain individuals' productivity levels is captured by the extent to which any part of the locus diverges away from a bisecting straight line, emanating from the origin, in the space of hypothetical realizable productivity values (e_k, e_k^*), demarcated by the horizontal and vertical axes. Second, a related remark is that higher degrees of convexity of the upper part of the locus corresponds to scenarios where a higher quality of the foreign educational system offers a potential higher enhancement of the most talented individuals; since

they would experience greater relative productivity gains, as compared to those which could be realized through foreign studies by less able persons. Such an issue of heightened quality differentiation, according to students' abilities, will be termed here as the relative degree of "elitism" of the foreign educational system. Third, for any given productivity scale, the initial point of departure of the talent-educational quality locus, relative to the origin, reflects the relative quality of the domestic country's pre-university educational system.

An essential focus of any comparative analysis of the interrelation between human capital investment, international educational mobility and subsequent employment decisions is to establish specific propositions on the basis of changes in variables, which impact the relative positions of the talent-educational quality locus and curves demarcating three hypothetical educational regimes. More specifically, a particular concern is how the balance between brain drain, grain and waste effects can depend on the hypothetical combinations of source and recipient countries.

The initial position of the talent-educational quality locus is determined, in part, by the quality of pre-university educational system in the source country, where the latter can be regarded as a separate variable entering the educational production function. Thus, its endpoints are determined by the extreme values for individuals' initial stocks of talents, a_1 and a_2, and the quality of the domestic primary educational systems. The length of this locus is defined by the degree of elitism in different educational systems, while its slope will be steeper than a 45 degree line, to the extent the foreign university educational system is superior to that of the domestic country.

In this proposed modeling framework, whereas skilled workers have the possibility of migrating abroad, it is postulated, again as a means for simplification, that unskilled individuals only can work at home at a fixed wage rate, w_0. In each labor market, the wages of skilled workers are understood to be an increasing function of workers' realized productivity levels, which, as noted, depend on both their abilities and educational choices. A necessary condition for the possibility of *permanent* international migration, driven by more favorable employment prospects abroad, is that, for a given level e of individual productivity, the foreign salary is greater than that in the home country.[13] Accordingly, for any given level of productivity, it is assumed that the corresponding salary in the foreign country, $w^*=w^*(e)$, is greater than that at home, $w=w(e)$, for all productivity levels and individuals. Furthermore, it will be postulated that the difference between these levels widens as productivity levels increase. In view of a

[13] However, *temporary* migration can occur in order to undertake studies abroad, even when there is no prospect of foreign employment. A necessary condition is that the expected additional gain in salary at homemore than offsets any greater educational costs. This results from enhanced productivity because of more favorable university conditions abroad,

lower productivity level, e_0, the wages attainable by unskilled persons, denoted as $w_0=w(e_0)$, are always inferior to those for skilled workers.

In order to facilitate the subsequent analysis of the critical interrelation between wages, productivity and educational choices, it is useful to introduce additional notation for the representative *k*th individual. More specifically, the wages earned on the home or foreign labor markets will differ depending on whether the individual is trained at home or abroad. The higher quality, foreign university system yields a greater productivity gain, which, in turn, yields relatively higher wages in the domestic and foreign job markets, denoted, respectively, as $w(e_k^*)=w[e^*(a_k)]$ and $w^*(e_k^*)=w^*[e^*(a_k)]$. Accordingly, the following inequalities summarize, then, the interrelation between wage earnings and the location of human capital formation: $w(e_k)<w(e_k^*)$ and $w^*(e_k)<w^*(e_k^*)$.

III. C. The Ex Ante Model of Human Capital Formation with Heterogeneous Individuals

The analysis now characterizes the interrelation between educational choices and both temporary and permanent migration flows by focusing on the individuals' decisions of whether, or not, to invest in further human capital, either at home, or abroad. While this choice will be formulated for a representative *k*th person, it is essential to recognize that the specific choices can vary across the heterogeneous population as a function of differences in abilities. A variety of other factors can also critically impact the decision whether or/not to pursue further studies in one of the two countries' university systems. These include the range of probabilities of gaining access to the foreign labor market, which as previously noted depend on the choice of university systems. Other relevant considerations include the interrelation between salary differentials and productivity levels for skilled workers in the two labor markets, as compared to the fixed domestic wage for unskilled workers. Furthermore, both increases in productivity and associated gains in salaries differ across the population of heterogeneous individuals, according to abilities. Finally, the *ex ante* human capital decisions are also potentially impacted by the tradeoff between expected higher financial returns from further education and the corresponding relative costs, either at home or abroad.

More specifically, a representative individual faces three conceivable choice options, designated as outcomes [0], [1] and [2]. These correspond, respectively, to decisions to: i. not undertake any further studies, ii. pursue further studies at home, or iii. undertake studies abroad. Those individuals, opting not to continue their studies, remain relatively unskilled. For simplicity, it is assumed that these individuals are unable to work abroad and face an exogenously given domestic wage equal to w_0. However, by undertaking further studies, a representative in-

dividual, *k*, can upgrade his/her level of productivity. This permits access to the foreign labor market with variable probabilities, depending on where the individual invest in human capital, potentially at different educational stages, and, of course, his/her ability. More specifically, if the individual were to study at home, or abroad, the corresponding probabilities of being hired in the foreign country are designated, respectively, as $p(e_k)$ and $p^*(e_k^*)$, where $p(e_k) \leq p^*(e_k^*)$. There are two distinct rationales for assuming that a foreign education can lead to enhanced prospects of being employed abroad. First, this may be due to the assumption that the foreign university system is of a higher quality. Second, there may be informational, network and host country labor market policies, which generate more favorable labor market access for host country trained students, even when they are equally qualified relative to those trained abroad.

The decision to pursue further studies potentially depends on a weighing of the expected salary gains in relation to the additional costs of further studies at home or abroad, where the latter are denoted, respectively, as I and I^*. Note that such costs may include not just tuition costs, but also living and other expenses, but also the costs of cultural adaptation and acquiring, for example, a new language.[14] The net cost differential for undertaking further studies in the two systems, is designated as i, such that, $i=I^*-I$. In light of the foregoing discussion, the expected salary earnings from studying in either country can be represented by the following two general functional forms:

$$g(e)=p(e)w^*(e)+(1-p(e))w(e), \text{ and}$$
$$g^*(e^*)=p^*(e^*)w^*(e^*)+(1-p^*(e^*))w\,(e^*). \quad (1)$$

The proposed formulation here of the decision, determining individuals' eventual investments in human capital, is more general than in most existing models of the brain drain, since it allows for both heterogeneous individuals and agent-specific, human capital arbitrage decisions between two educational systems. The critical choice of each individual is whether to pursue further studies and, if so, in which country. The latter decision depends on the quality of the different educational systems and the relative prospects of access to the higher wage foreign labor market. Accordingly, three conditions characterize this educational decision for the representative *k*th individual. First, there is an incentive to continue his/her education at home, rather than remain unskilled, if the following condition, labeled (C1):

[14] The analysis here abstracts from the potential heterogeneity of such agent-specific costs across the population. Such differences could arise because of locational, and other, individual specific incentives, including tuition feeds and government educational grants. As analyzed by Franck and Owen (2011, 2015, 2016), such policies can be tailored to promote social welfare in a given country.

$$p(e_k)w^*(e_k)+(1-p(e_k))w(e_k)- I>w_0\,, \tag{2a}$$

If this condition holds, option [1] will be chosen in preference to [0], and it can be equivalently expressed as condition (C2):

$$g(e_k)>I+w_0. \tag{2b}$$

Second, studies abroad will be preferred to remaining unskilled, i.e. option [2] dominates [1], if condition (C12) holds:

$$p^*(e_k^*)w^*(e_k^*)+(1-p^*(e_k^*))w(e_k^*)-I^*>w_0\,, \tag{3a}$$

Or, alternatively,

$$g^*(e_k^*)>I^*+w_0\,. \tag{3b}$$

Conditions (2) and (3) are necessary for an individual to choose to undertake further studies, either at home, or abroad. Nonetheless, to determine a student's final educational choice, it is also essential to consider an additional arbitrage condition, which compares the relative net returns from studying in the two university systems. The additional sufficiency condition for option [2] to prevail over [1] is:

$$\begin{aligned} &p^*(e_k^*)w^*(e_k^*)+(1-p^*(e_k^*))w(e_k^*)-i> \\ &p(e_k)w^*(e_k)+(1-p(e_k))w(e_k) \end{aligned} \tag{4a}$$

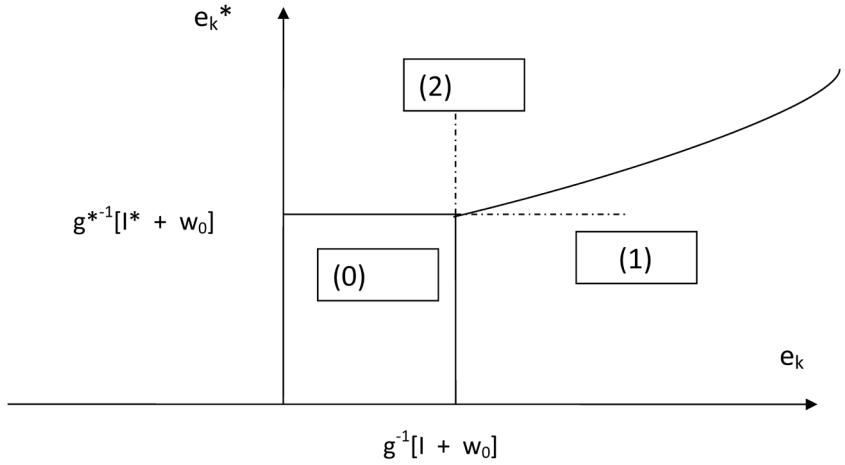
More simply, the latter can be expressed as:

$$g^*(e_k^*)-g(e_k)>i\,. \tag{4b}$$

Together, inequalities (3) and (4) constitute sufficient conditions for an individual to decide to study abroad. However, when the opposite inequality to (4) holds, along with condition (2), an individual will instead elect to study at home, rather than either studying abroad, or remaining unskilled. Hence, option [1] then prevails.

Corresponding to each of the foregoing inequalities, (C1), (C2) and (C12), are equations consisting of equalities, which identify limiting values in a plane of productivity levels (e, e^*), thereby demarcating zones, such that each of these conditions is met. More specifically, in the case of (C1) that equality can be expressed as $e=g^{-1}[I+w_0]$, which represents a vertical line, as depicted in Figure 8. Analogously, the frontier, determining the set of productivity values such that condition (C2) is satisfied consists of a horizontal line, defined by $e^*=g^{*-1}[I^*+w_0]$.

Figure 8. The Interrelation between Productivity Levels, Financial Opportunity Costs of Further Studies and the Configuration of Human Capital Regimes



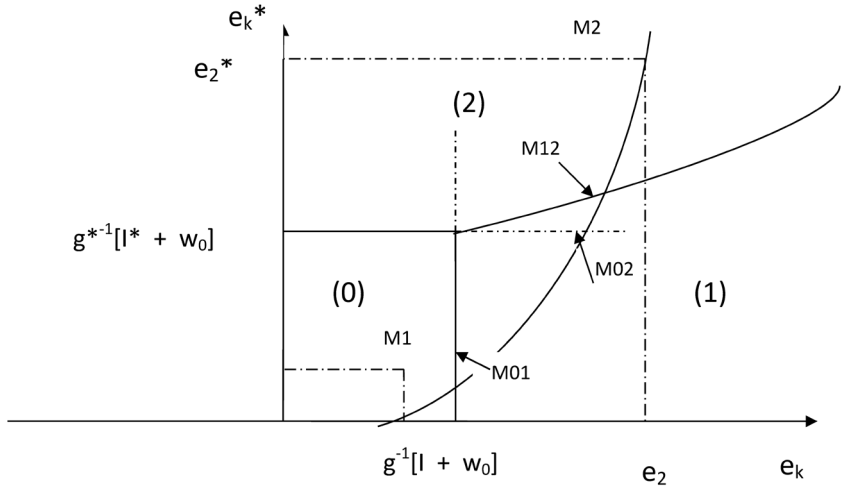
Ceteris paribus, an increase in the opportunity cost of studying in the domestic (foreign) university system leads to a rightward (upward) shift in the corresponding boundary line and, consequently, increases the threshold productivity level, e(e^*), necessary to undertake such further studies.[15]

As depicted in Figure 8, a combination of two out of the three boundary lines, along with the associated inequality conditions, permits an identification of the three alternative, and mutually exclusive, choice regimes. Whereas in zone (0) there is no further investment in human capital, zones (1) and (2) correspond to a pursuit of further studies in, respectively, the home or foreign university systems.

The actual educational choices over a hypothetical population of heterogeneous individuals requires an examination of the interrelation between, on the one hand, the previously identified factors determining the positions of the boundary conditions for the three regimes; and, on the other hand, the specific distributions of students' abilities, such that $a_k \in [a_1, a_2]$, as well as the quality differences in the two countries' educational systems–both prior to and during university studies. The combined effects of these factors translate into the determination of the position, length and slope of a line segment in (e_k, e_k^*) space, which may, or may not, straddle more than one of the zones, [0], [1] or [2]. As previously mentioned, this curve is referred to, here, as the talent-educational quality locus. It represents the nexus of attainable productivity gains, determined by the interrelation between the distribution of individuals' talents and the

[15] The determination of nature of the other boundary curves is further elaborated in a separate technical appendix.

Figure 9. Scenario Where All Three Human Capital Regimes Are Chosen by Certain Subsets of Individuals Across Heterogeneous Population[16]



performance-enhancement generated by the quality of the two countries' educational systems. While the determinants of the relative position of the talent-educational quality locus, in relation to the human capital choice regimes, will not be examined in more detail here, they are critical for assessing the extent of potential brain drain, brain gain and brain waste effects. One representative outcome, depicted in Figure 9, is the case where different subsets of the overall population of heterogeneous individuals from the source country, will decide either not to undertake further studies, domestically, or abroad.

A more extended analysis of the foregoing conceptual framework can be used, for example, to formulate a number of key propositions, regarding the implications of changing home or host countries' educational policies. These include, for example, the impact of tuition rates, on brain gain and brain drain effects, as assessed in terms of flows of students. The associated determinants and implications of economic welfare in the two countries can also be characterized, in a general setting where each country competes for international talent in a game-theoretic setting. A key modelling issue relates to how a diverse set of modelling parameters impact educational decisions and subsequent employment prospects.

Alternative regimes, determined by threshold effects and associated non-linearities, correspond to distinctive brain drain and brain gain flows across the population of heterogeneous individuals, thereby defining the welfare calculations. The welfare implications of non-cooper-

[16] To facilitate the illustration of certain choice outcomes in this illustration, the scales for the productivity levels are assumed to differ between the e_k and e_{k^*} axes. Consequently, the talent-education locus does not necessarily lie above a bisecting 45-degree line; as would otherwise be the case without such a distortion.

ative and cooperative national policies can be investigated in either a shorter-term scenario, where the quality of the university systems in the two countries is taken as given, or in a longer-term one where countries can upgrade their educational offerings in order to attract the best students. Governments not only impact individuals' decisions to undertake further studies, along with the flows of students between countries, through educational policies; but also, in the case of the foreign country, the extent of labour market access. In the case of a non-cooperative solution, the domestic (foreign) country seeks to maximize the gain in productivity resulting, for example, from a lowering of tuition fees in order to foster more human capital formation. Countries face potential policy tradeoffs, which are defined not only by the extent that brain drain dominates brain gain effects, but also arise from the cost of public sector funding for education, when tuition fees fall short of the actual educational costs incurred by the universities. A particular advantage of a heterogeneous-agent framework is that it brings clearly to light the role of informational failures for defining optimal educational and labor-market policies, along with the dependency of such policy initiatives on self-selection processes.[17]

IV. Conclusion

Following a review of relevant literature, a broad empirical overview of trends in international migration and student mobility has been offered from a European perspective. In contrast to the EU and other developed countries, the low levels of migration stocks in Japan—both in absolute and in relative terms—are quiet striking. In addition to the hypothetical structural changes arising from enhanced intra-EU mobility under the Schengen Agreement, a distinctive feature of international mobility in Europe has been a marked build-up in the importance of Erasmus student mobility. Associated trends and imbalances across countries have been identified, while highlighting the role of Eastern European countries, as source economies of migrants to western European countries. As emphasized, the nature of the European "experiment" with heightened inter-country student and labor mobility is unique, in many respects. Accordingly, a worthwhile direction for further research would be to extend the empirical investigation to more rigorously evaluate the relative significance of key determinants of observed migration imbalances across the European Union, on the basis of econometric estimations and/or calibrated modeling simulations.

[17] Certain of the potential implications of alternative assumptions, regarding the extent of a public authority's knowledge of students' underlying abilities, have been explored in the earlier work of Franck and Owen (2011, 2015, 2016).

A second empirically-oriented, sub-section of this paper has summarized key findings and methodological insights, obtained from an empirical investigation of the inter-regional labor mobility of recently graduated French workers. The micro-econometric analysis, which used Probit models, while correcting for selection bias, examined the role of both micro and macro-economic determinants of mobility across French regions. The analysis, thereby, explained the probability that individuals will move, either temporarily, or permanently. This empirical analysis offers an assessment of the relative significance of a range of both individual and regional characteristics, including wage differentials and the tightness of regional labor markets, while also evaluating associated implications of inter-regional mobility for eventual wage premiums or penalties and highlighting, again, the potential role of self-selection. In addition to confirming a number of predictions of human capital theory, the empirical findings suggest that educational attainment influences job offers directly, as well as, indirectly, through heightened mobility. Consequently, a strong, but non-linear, link between education and spatial mobility points to potential biases in estimated returns to mobility and human capital formation. Finally, a welfare analysis emphasizes that it is not just numbers of migrants, but their human capital "quality," which needs to be considered when assessing implications of migraton. A proposed approach for calculating imputed welfare effects of interregional mobility used imputed monetary inflows, corresponding to earnings differentials resulting from migration.

The subsequent conceptual analysis started by offering a general framework for understanding how heterogeneous abilities and levels of educational attainment, along with differences in the quality of educational systems and access conditions, critically co-determine individuals' international educational choices and subsequent professional options; thereby impacting national economic welfare. Whether students will ultimately choose to be trained and/or work at home, or abroad, depends on an array of factors, including the quality and pricing of educational offerings, the openness and selectivity of universities, international salary differentials and foreign job market access conditions. Self-selection is, again, a key element determining the balance between brain drain and brain gain effects, along with the relative efficacy of countries' optimal educational policies. It is argued that a heterogeneous-agent framework is quite essential for understanding many of the key analytical, empirical and policy issues arising from brain drain, brain gain and brain waste effects. Overall, a central suggestion of this paper is that the determinants of international competition for talent are potentially complex. This suggests a need for nuanced and well crafted educational and labor market policies, aimed at promoting source and/or host countries' economic welfare.

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http://databank.worldbank.org/data/reports.aspx?source=2&series=NY.GDP.PCAP.CD&country=

Technical Appendix II

List of Countries Participating in Erasmus Mobility Programs in 2013

Country Code	Country Name	Country Code	Country Name
AT	AUSTRIA	LU	LUXEMBOURG
BE	BELGIUM	ME	MONTENEGRO
BG	BULGARIA	MT	MALTA
HR	CROATIA	NL	NETHERLANDS
CY	CYPRUS	PL	POLAND
CZ	CZECH REPUBLIC	PT	PORTUGAL
DK	DENMARK	RO	ROMANIA
EE	ESTONIA	SK	SLOVAKIA
FI	FINLAND	SI	SLOVENIA
FR	FRANCE	ES	SPAIN
DE	GERMANY	SE	SWEDEN
GR	GREECE	RS	SERBIA
HU	HUNGARY	GB	UNITED KINGDOM
IE	IRELAND	IS	ICELAND
IT	ITALY	LI	LIECHTENSTEIN
LV	LATVIA	NO	NORWAY
LT	LITHUANIA	CH	SWITZERLAND