

The Italian brain drain: cream and milk

Mattia Cattaneo¹, Paolo Malighetti, Stefano Paleari

Affiliation:

Department of Management, Information and Production Engineering, University of Bergamo, via Pasubio 7b, 24044 Dalmine (BG), Italy.

HERe (Higher Education Research), University of Bergamo, Dalmine (BG), Italy.

Preliminary draft

March 2017

Abstract

This paper analyses the scientific profile of migrant doctorates in search of better job opportunities as a response to the increased temporariness and employment uncertainty in their native country. Relying on the career trajectory of the population of research-active Italian doctorates in Economics, Finance and Business Management who graduated in the years 2008-2010, we find that scientists who are more likely to move abroad are those registering the best and the relatively worst research performance before migrating, while those remaining in Italy are found to be on average of good quality in scientific terms. Further, we also found that scientific star-doctorates target cross-border reputable universities for a more prestigious career, while the relatively bad performing ones generally internationally move towards not-research oriented institutions simply looking for an occupation. Instead, migrant doctorates registering average research performance do not differ from those staying in their native country. Our results have important policy implications against the popular belief that only the cream of talented brains fled away from their native country.

¹ Corresponding author: mattia.cattaneo@unibg.it. Via Pasubio 7b, 24044 Dalmine (BG), Italy; Tel.: +39 035 2052094

1. Introduction

Brain drain of well-educated people has increasingly become a critical phenomenon that policy makers cannot definitively ignore due to its important detrimental effects for the country of emigration (Carrington and Detragiache, 1999). While this concept has been initially used to identify Britain engineers and scientists moving towards the US in the 1960s (Rhode, 1991), it extends to describe the rapidly grown migration patterns of highly skilled human capital leaving their native country in the most recent decades (Davenport, 2004; Baruffaldi and Landoni, 2012). Today, this phenomenon has more and more exacerbated, becoming even a major concern for some already developed countries (e.g., southern European countries), which are not able to provide individuals appropriate future perspectives. Rationally, educated individuals look for cross border opportunities as response to a lack of satisfactory salaries and permanent job positions in the home country. This is particularly true when considering the highest educated component of the society-i.e., students achieving the PhD. Part-time positions and short-term contracts have indeed become more common in universities, thus increasing uncertainty and temporariness during the career progress (Cruz-Castro and Sanz-Menéndez, 2010; Stephan, 2012).

Although early studies have already pointed out that the migration of educated individuals represents a major concern for the country of emigration² (e.g., Davenport, 2004; Beine et al. 2011; Docquier and Rapoport 2012), the literature has almost neglected to investigate the extent to which educated migrants better embeds the key of future innovation and economic development compared to people staying in the native country. By drawing upon economic development theories, understanding the quality of highly-skilled people migrating in other countries is however essential to understand the competitive advantage that countries might acquire in the long-run (Fleming 2001, Agrawal et al.

² Estimating the cost to educate a student starting from attendance of the primary school to the PhD graduation, the Italian higher education system have supported almost 165,000 €. Data regarding the primary schools-tertiary education period relate to the resources used each year to operate schools/universities (e.g., the salary of teachers and other staff, maintenance of school buildings, students' meals or the rental of school buildings and other facilities, Education at a Glance reports). At a PhD level, the estimate considers the full cost of a PhD scholarship and the standard cost of a student in the field of social science to account for the resources used to operate the graduating higher education institution.

2011). It is worthy to note that despite other fixed factors contributing to the development of a country, such as physical capital, human capital is a flow, a highly mobile factor that can and does relocate together with the individuals embedding it (Florida et al. 2008, pp. 619). The key issue is therefore understanding how much countries are losing really valuable human capital resources. In other words: *Do migrating highly-skilled individuals are comparatively better relative to the not-migrating ones?*

In this regard, Italy has been widely recognized to be one of the most important countries affected by the brain drain phenomenon at high levels of education (Nature 414 - Hellems, 2001). Since the early 2000s, crucial factors have contributed to the highly-skilled human capital's decision to migrate, such as the pathological low levels of investments, the high level of bureaucracy and the difficulty to advance in the academic career (Nature 412 – Abbott, 2011). In the last years, Italy has confirmed its under-investment in research, positioning like an under-developed country in terms of gross domestic spending on R&D (1.33 Italy vs. 1.95 EU28 in 2015 – OECD data) and the number of researchers per 1,000 employed (4.93 Italy vs. 7.87 EU28 in 2015 – OECD data). The opportunities career growth are today not comparable to other developed European countries due to the temporariness and uncertainty of academic positions, and also bureaucratic difficulties. The potential of career advancement has furtherly decreased as an effect of important turnover restrictions. Since the entry into force of the Tremonti Law (Law 133/2008) concerning turnover blocks, tenured academic staff felt by 20%. The most recent report of the Italian Statistical Office highlights that the migration of doctorate holders has continuously increased during the last years (ISTAT, 2014) and that 13% of all PhD students graduating in 2010 migrate abroad to look for better opportunities at 4 years after their graduation; 6 percentage points more compared to those graduating in 2009.

For this purpose, in order to analyse the differential in the scientific standing of internationally moving doctorates, we consider the entire population of Italian doctorates in Economics, Finance and Business Management that graduated in years 2008-2010. Focusing on the population of 1,523

doctorates, we explore the career trajectory of those who have been scientifically active during their career, of whom, 30% move abroad after their PhD graduation. This represents one of the rationales to focus on the subject areas of Economics, Finance and Business Management. Doctorates in these fields are indeed more mobile compared to other disciplines (average migration per discipline: 13%; ISTAT, 2014). This also allows us to consider a really brain intensive area of science thus neglecting the disparity in the average capital dotation (e.g., laboratories) of universities in different countries.

Results suggest that doctorates who are more likely to move abroad are those with the best and the worst research performance, while those remaining in Italy are found to have average research performance. Indeed, we do not find evidence of a significant difference in researcher performance of those migrating abroad and those staying in their native country. This is against the general popular belief that only “brains” are going abroad looking for better opportunities. The effect is instead curvilinear (U-shaped): the probability to internationally move decreases as scientific performance increases, up to a certain level; for high level of research performance (high scientific standing), the relationship reverts. Interestingly, deepening the analyses, findings highlight that those with higher research performance move towards more prestigious universities to address a faster academic career (*cream*) and increase their reputation, while, bad performing doctorates are more likely to move in another country to find a job in a not research-oriented institution (*milk*) given the lack of opportunities in the native country.

The rest of this article is organized as follows. Section 2 reviews the literature on the brain drain phenomenon in light of the human capital theory. Section 3 describes the study’s data, the variables, and the methodology. Section 4 presents the results, while Section 5 concludes.

2. Literature review

Understanding the decision of well-educated people moving towards another country at the end of their educational path is nowadays important for the development of knowledge societies. This study

is conceptually guided by three main themes. The first deals with the choice of migration at an individual level, the second considers the perspective of native countries losing highly skilled human capital, while the third focuses on the nature of the people migrating abroad.

Early research has viewed migration as an important investment in human capital where migrating individuals aim at maximizing their expected utility, thus the difference between the benefits and costs of moving. By drawing on human capital theory, the reasons to migrate in another country lie on the desire to find better job opportunities, higher wages and a greater quality of life towards locations offering higher utilities (Davenport, 2004), and the personal characteristics of the migrant (Sjaastad, 1962). Yet, reputation, career rewards and intrinsic motivations are crucial factors for migration. Interestingly, Kwok and Leland (1982) show that information asymmetry might also play a role in addition to the other determinants, as employers in the host country can determine graduates' potential productivity more precisely than those in the native country. The decision to internationally migrate however implies higher transaction costs (e.g., finding a new location) compared to its inter-regional counterpart and a more forward decision for well-educated people.

From the perspective of the source country, doctorates remaining abroad represent a critical loss of investment (an indirect subsidy to the host country – Altbach, 1991) in talented people that cannot spur innovation at home (Kim et al. 2011). Today, due to the low set of opportunities that also some developed countries are able to offer to well-educated individuals³, international migration patterns are getting highly alarming as a clear “brain drain” phenomenon. While past scholars have commonly examined this dynamic relying on the international migrations occurring from developing to developed countries (e.g., Beine et al. 2011; Docquier et al., 2007), the declining economic conditions of developed home countries (e.g. Southern European countries) at the time of PhD graduation has become a strong predictor of the migration choice (Finn 2007). Today, policy makers have not only

³ The share of people unemployed who attained or completed tertiary education as the highest level has increased in the last decade: 6.40 in 2000 vs. 11.90 in 2014.

to face the migration (and retention) of foreign doctorates and graduates towards the US (Gonzales, 1992; Van Bouwe and Veugelers, 2012; Altbach, 2013; Wang et al., 2013; Roh, 2015), but, the limited budget of developed countries to innovation and research, make them concerned of an outflow of “this cream of the national talent” (Welch and Zhen, 2008 pp. 520) and towards previously competing countries. These critical effects are even more exacerbated in fields where investments in new advanced technology equipment are regularly required, as in the case of the health professions (Pang et al., 2002; Dodani and LaPorte, 2005, Arah et al., 2008).

Notwithstanding the importance to figure out the directionality of international human capital migration, the most striking issue is to understand the value of people leaving their native country (Schuscer, 1994). Indeed, the effects of human capital on innovation and economic development do not solely depend on its quantity, but especially on its quality. Early research pointed out that the quality dimension of human capital has a real impact on countries’ development (e.g., Gennaioli et al., 2013). At a macro level, the difference in the quality of human capital across countries is demonstrated to systematically vary with the level of development (Manuelli and Seshadri, 2014). This is even more crucial assuming that the quality of human capital crucially influences areas’ absorptive capacity, thus implying higher abilities for the hosting country to learn advanced technologies and new knowledge (e.g., Carr et al., 2001).

To the best of our knowledge, no studies have already investigated the migration of doctorate holders from higher education systems that are currently underinvesting in research (but that supported the cost of education), towards the strongest ones by accounting for their scientific quality.

3. Research design

3.1. Sample and data sources

In order to identify the profile of doctorate holders moving in a foreign country after their PhD graduation, we rely on the entire population of Italian doctorates in Economics, Finance and Business

Management graduating in the period 2008-2010 (*PhD cycles: XXIII-XXVI*)⁴. Focusing on 1,523 doctorates (5% of the entire population), we investigate the career trajectory of those who have been scientifically active in at least one occasion up to 31 December 2016-i.e., those registering at least one scientific product (article, book, book chapter) in the *Scopus Sciverse* bibliometric dataset. Data reveal that 35% of all doctorates published at least one scientific product (526 individuals) and that among them 30% (160) move abroad after their PhD graduation.

Figure 1 maps the percentage of fresh doctorates in these disciplines over the entire population of new doctorate holders in Italy in the period 2008-2010 reporting the average value at a provincial level (average value of the universities located in the same province). Interestingly, these PhD programmes are widely offered in Italy. 56 universities indeed provide doctoral programs in Economics, Finance and Business Management out of 96 universities, including also telematics universities (see the Appendix for the list of fresh PhD doctorate per university in the period 2008-2010). The distribution of the share of Italian doctorates in Economics, Finance and Business Management is quite homogenous across the entire peninsula, despite the socio-economic disparities among Italian macro-regions.

[FIGURE 1]

We constructed scientific output measures by matching the list of 526 PhD doctorate holders to publication data on *Scopus Sciverse*. In order to minimize errors, we identified the ID of each specific doctorate in the case the following criteria are successfully met: 1) the last name; 2) the first name; 3) the ORCID digital identifier, if any; 3) the correct university and departmental (if any) affiliation name; 4) the subject area of the majority of indexed products to that specific author ID. Subsequently,

⁴ The data have been provided by the Ministry of University and Research (MIUR) in 19th February 2016.

each scientific product is matched to an author if it was published during the doctorate program and no later than 1 year after the year of the PhD graduation.

3.2. Methodology and variables description

Methodology

In order to analyse whether more or less promising (in scientific terms) doctorates have a higher/lower probability to move abroad after their doctorate, we firstly perform a probit regression on the probability of going abroad after the PhD graduation controlling for both individual, departmental and university level characteristics that might influence their decision. In a second stage, to better explore the international pattern of Italian doctorate holders, we perform a multinomial logit regression⁵, estimated with a maximum likelihood procedure, as to highlight the profile of doctorates internationally moving towards 1) a ranked university; 2) a non-ranked university; 3) another not-research oriented institution (e.g., private research centres, World bank, OCSE) or 4) staying in their home country (our reference case). Ranked universities have been defined as those ranked in the worldwide university ranking published by the Jiao Tong University in Shanghai (*ARWU - Academic Ranking of World Universities*) as in Horta et al. (2016). The outcome variable of the multinomial logit regression is the probability of falling into one of the four categories based a non-linear function considering four outcomes (Maddala, 1983).

Definition of the variables

To account for the scientific potential and standing of Italian doctorate holders just after their PhD graduation we firstly downloaded all authored scientific products that each author published during

⁵ In order to test for the validity of implementing a multinomial logit regression, we test for the independence of irrelevant alternatives (IIA) condition, which has to be met when using this model (e.g., Greene, 2012). The results from the Hausman-McFadden test show that we cannot reject the null hypothesis H₀, which states that the odds (alternative/outcome j vs. alternative/outcome k) are independent of other alternatives. The condition is therefore satisfied.

the doctorate program and no later than 1 year after the year of PhD graduation (*Research performance*). To also account for the quality of their scientific production, each product has been weighted for the journal impact factor of the journal where it has been published (e.g., Gaule and Piacentini, 2011; Abramo et al., 2009; Gonçalves et al., 2009; Rauhvargers, 2014). In this regard, we rely on the Scimago journal rank indicator to account for the quality of each scientific product. Although the literature acknowledged the citations that a scholar is able to receive across her career as an indicator of research quality and visibility (Horta et al. 2016), we decide not to consider the number of citations that papers published during the doctorate (and a year after) have received in the following years. This allows us to avoid problems of endogeneity associated with the gains resulting from migration (Franzoni et al., 2014). People moving towards international groups of research may indeed benefit from greater visibility, more contacts and higher reputation; all aspects that are not directly associated with doctorates' initial scientific potential and that could potentially bias our analysis.

For the aim to analyse whether more or less promising (in scientific terms) doctorates have a higher/lower probability to move abroad after their doctorate, our dependent variable is a dummy variable equal to 1 in the case the doctorate moved abroad after the graduation. In order to find information on the career trajectories after the PhD we relied on three different sources: LinkedIn and Google scholar profiles, online CVs and the official websites of the hosting cross border institutions/firms. Each profile is considered reliable if it clearly reports where the individual attended her PhD and the name of the program.

As long as the probability to move abroad is influenced by different dimensions, our analysis includes known controls of mobility such as gender, age (at the beginning of the PhD program) and the specific sub-field of science (Economics, Finance and Business Management). Additional variables of interest are included to account for the context at the origin.

International mobility: The fact that the student attending the PhD program in Italy is foreign, thus having a higher probability to go back to her home country after the graduation for reasons other than the uncertainty associated to the academic job market in Italy.

Intra-national mobility: Similarly, we control for the fact that an Italian student decide to leave its household and relocate in another area to attend her PhD studies. To this extent, a dummy variable is included in the model and is equal to 1 for intra-national mobile PhD students, namely those attending the PhD in a university located in a different region than that of their household.

PhD program internationalization: Attending more internationalized PhD programs, measured as the percentage of international students attending doctoral programs in a university, would offer higher opportunities of interaction with both public and private institutions in other countries and be also beneficial in terms of curriculum internationalization (Seeber et al. 2016). This might indeed increase the probability that students can create linkages with other cross-border institutions to be exploited after the graduation.

A set of other variables contribute to control for the context and the opportunities at the department/university of PhD graduation.

Doctorates' career competition: The higher is the competition to become a researcher inside the university of PhD graduation the higher is the probability for a doctorate to find a job elsewhere (Cruz-Castro and Sanz-Menéndez, 2010). Increasing mobility might indeed positively increase the change to get tenure in the future (Lutter and Schröder, 2016). As long as becoming a researcher represents the first step of the academic career for a doctorate holder, we control for the percentage of graduated PhDs in the same year, area of science and university relative to the number of active researcher positions.

Career advancement opportunities: In addition to the level of competition that PhD graduates faced after their graduation, we consider a measure of career growth opportunity inside the area of

economics at the university of PhD graduation. We include the difference in the number of researchers between the year of PhD graduation and the year before, in the specific fields of Economics, Finance and Business Management at the university of graduation, relative to the number of professors in the year before. As long as undertaking an academic career is increasingly competitive for postdocs nowadays (Bäker, 2015), we expect that having scarce possibilities at the graduating university would increase the probability to go abroad seeking for a higher salary or a faster path to get a tenured position compared to other Italian universities.

Geographic area of graduation: We also consider a set of three dummy variables to account for the different Italian contexts and inequalities of opportunity (Checchi and Peragine, 2010) and the associated practices typical of the area where the university is located, namely the Southern, Northern and the Central Italian macro-areas, where the South represents the reference case.

University size: The size of the university of PhD graduation, measured as the total number of registered students (bachelor and master students) contributes to account for the breadth of the network and international academic contacts that the institution has been able to develop over time.

Teaching-orientation: The ratio between the number of Bachelor and Master registered students and the number of professors. It is indeed recognized that more teaching oriented universities, i.e. more students per professor, are less research oriented, increasing PhD students' teaching commitments during the doctorate program as resources for professors, instead of only fostering their research formation and build an international network by spending a visiting period abroad.

Private and Doctoral university: we control for the fact that a PhD student graduates in one of the six doctoral universities in Italy (e.g., IMT Institute for Advanced Studies Lucca, Sant'Anna School of Advanced Studies) or a private university (*Private University*), as these institutions are known to be more equipped in providing students consolidated international research linkages and future cross-border opportunities during and after the program. Further, these institutions are less prone to immediately employ doctorates graduating in their PhD programs, discouraging inbreeding practices.

Lastly, we include the ratio of the research and development expenditure (% of GDP) of the country of destination and that of the country of origin (*R&D expenditure D-O ratio*) to account for the attractiveness of countries in the current knowledge society (Roh 2016).

3.3. Descriptive statistics

Table 1 describes the characteristics of our sample of Italian doctorate holders reporting both individual and university level features. Our sample is equally composed by male (50.3 %) and female doctorates, having, on average, 27 years at the beginning of their PhD, up to a maximum of 56 years. Considering their research performance during and within a year after the program, doctorate holders in Economics, Finance and Business Management published a total of 0.81 articles, weighted for their quality, with a maximum of 56.2 for a star PhD student publishing a paper on *Science* (AAAS) among others scientific contributions. Analysing the competition for career at a doctoral level, new doctorates on average account for 50.3% of researchers in the same university, area of science and year, up to crucial cases where the absorption of new researchers would be critical as at the *Napoli - Università degli studi "L' Orientale"* in 2010, where new doctorates were 150% more than already hired researches. Yet, in terms of career advancement opportunities, data reveal that on average the number of researchers increase of 1.8% between the year of PhD graduation and the year before in the specific fields of Economics, Finance and Business Management compared to the number of professors in the year before the PhD graduation. The minimum value is that of the *University of Varese - Insubria*, where the number of researchers has decreased of 5.4% between 2009 and 2008 compared to the number of professors in 2008 (mainly due to turnover blocks).

Once doctorates have decided to migrate abroad they usually chose countries registering a higher R&D expenditure compared to Italy (more than 15%) up to the case of South Korea that has highly invested in research and innovation during the last years (ratio compared to Italy: 2.836). In terms of pre-PhD mobility, 49.4% of doctorates moved from their household to attend the PhD program in a

university located in a different Italian region, while 37 doctorate holders (7.1%) came from abroad to attend a PhD course in Italy.

At an institutional level, the PhD programs offered at the graduating university were not highly internationalized by on average enrolling 10% of foreign PhD students. On average, graduating universities have enrolled approximately 37.5 thousands students per year. In terms of teaching resources, universities in our sample suffered from a relatively high student-faculty ratio (almost 33 students per professor) potentially decreasing the research focus of the academic staff.

Almost 48% of doctorate holders graduated in a university located in a Northern Italian macro-region (only 18.6% in the South) and 72% of them are from the pure field of Economics. In 12.9% of the cases, PhD students graduated in a private Italian university, while 1.5% in a specific doctoral university.

4. Empirical analysis

We firstly examine the equality of means in the research performance of those going abroad after the doctorate considering a univariate analysis. The t-test result indicated that there is no significant difference (P-value=0.585) in the scientific potential of those migrating abroad (0.923 is the sum of the impact factors of the articles published) and those staying in their native country (0.759). In other words, this would imply that research performance seems not to be a determinant of the probability to go abroad after receiving the PhD title.

To in-depth investigate the relationship between the scientific standing of PhD doctorate holders and the probability to move abroad after their doctoral graduation in a multi-variate framework we run two separate analyses. The first model regresses the probability to internationally move after the PhD on the research performance of students during and a year after the program. The most striking result is that the effect of the scientific standing of doctorate holders is curvilinear, a U-shaped (convex)

relationship, meaning that those who are more likely to move abroad are doctorates registering the worst and the best research performance, while those remaining in Italy have an average quality in scientific terms (at a 1% significant level). In other words, the probability to move decreases when research performance increases, up to a certain level; for a greater level of research performance the relationship reverts.

[TABLE 2]

Among other factors, males have a higher probability of moving abroad than do females, and, on average, this is also true when considering younger PhD doctorate holders. In terms of career opportunities, results suggest that the probability to move in another country after graduation is positively associated with the presence of more colleagues concluding the PhD during the same year in the same area of research relative to the number of researchers in the same department (*Career PhD competition*). Interestingly, considering the number of new opened researcher positions at the affiliated department, the results suggest that doctorates are not as concerned about the evolution of the department in the middle run (*Career advancement competition*), while their decision to move is affected by the turbulence and competition resulting from the presence of other colleagues (*Career PhD competition*).

Further, we also found evidence that doctorates who reach Italy to attend the PhD program highly probably get back in their native country after receiving the title. Investigating the pattern of international migration decision, results suggest that doctorates generally choose countries where the R&D expenditure is higher than in Italy. A higher investment on creative work undertaken to foster knowledge in its different forms-i.e. humanity, culture, society might increase countries'

attractiveness in the eyes of individuals working in research at different levels (basic vs. applied) and also dealing with experimental development.

At an institutional level, doctoral universities are associated with a higher probability for doctorate holders to go abroad, while this does not occur when considering more teaching-oriented and bigger academic institutions. In our sample, doctorates in Management are more prone to move cross-border than PhD graduated in Economics do. Further, the probability of internationally moving is higher in universities located in northern and central contexts compared to those located in southern regions.

The second regression model aims to better describe the mobility pattern of PhD holders in relation to the different nature of the destination. Considering the choice of staying in Italy (native country) as the reference case, results suggest that those having the higher scientific profile move towards prestigious universities, while, contrarily, those relatively bad performing in scientific terms are significantly more likely to internationally move towards a not-research oriented institution. We do not found a significant difference (relative to those remaining at home) when considering doctorates moving towards non-prestigious universities. In summary, profiling PhD holders, those internationally moving generally belong to two categories: 1) the best research performing PhD students aiming to address a faster academic career to achieve a reputable position in the scientific market arena (*cream*), and 2) the relatively worst scientific performing doctorates who move cross-border due to the lack of opportunities they found in their home country (*milk*), where research scientific performance have become a stringent requirement in the last years.

[TABLE 3]

On average, those hired in reputable universities are male and younger. Notably, the competition occurring at a PhD level increases the mobility of doctorates towards both ranked and not-ranked universities and also other institutions rather than universities (e.g., private research centres, World bank, OCSE). Interestingly, in terms of career advancement opportunities, the coefficient is negative and significant when considering the mobility towards reputable universities, suggesting that at the

increase of the number of positions (relative to the number of professors in the year before) the probability to go abroad decreases. On the contrary, the effect is positive in the case of international mobility towards other institutions than universities. Doctorates reaching these institutions, who generally have lower scientific research performance, seem to be more concerned than others about the recent opening of new researcher positions at the department of PhD graduation. As a matter of fact, this could make them conscious of the impossibility to enter the academia due to the existing gap between the required scientific level (defined at a Ministerial level) and their research performance.

Ultimately, findings show that doctorates in finance are less moving towards non-ranked universities and other institutions compared to those graduates in economics.

Conclusion

The international migration of researchers has been a growing dynamic in the last decades, being interpreted as a continuous “drain” of talented (“brain”) people from developing to developed countries. Despite early research has largely accounted for the presence of more internationally moving human capital (e.g., Davenport, 2004), it has almost neglected to examine the associated quality of highly skilled migrants departing from already developed countries that under-invest in R&D and innovation. Our research has investigated the scientific profile of doctorates in Economics, Finance and Business Management graduating in the period 2008-2010 moving abroad after graduation compared to those staying in Italy, which represents their native country. We also deepen the analysis by distinguishing the destination of their international migration among 1) reputable university; 2) not ranked university and 3) another not-research oriented institution.

Explorative findings suggest that research-active PhD graduates having a higher probability to migrate are of two classes, those best performing in scientific terms during the PhD program and

those having an opposite profile, thus PhD holders who relatively bad performed in research. We found a curvilinear effect, suggesting that at the increasing of the scientific standing the probability to internationally move decreases up to a certain level, where the trend inverts. Deepening the analysis considering the nature of the cross-border destination, we also provide evidence that those having a high scientific profile more likely target reputable universities, while bad performing doctorates usually move in another country to find a job in a not research-oriented institution.

Our findings might be of help in interpreting the continuous out-flow of well-educated people towards other countries. Mass media and national newspapers⁶ have commonly reported that Italian “brains” have leaved their home country to look for better opportunities abroad preventing Italy to capitalize its educated human resources to seize global challenges. Yet, it is worthy to note that in the current educated diaspora Italy has retained an average good-quality doctorates allowing the migration of extreme cases, the potential star scientists and those who relatively bad perform in scientific terms during and a year after the PhD student. We therefore discourage to indiscriminately demonize *brain drain*, while we point out that is essential, especially for studies considering other countries, to understand *who* is migrating. Our results open the debate by suggesting some policy implications: 1) countries like Italy might benefit from implementing new policies aiming at increase the retention rate of top performing scientists in the native country and, at the same time, foster the attractiveness of foreign scientists⁷ (stimulating brain circulation and its benefits) by improving the system of post-doc grants and reducing bureaucratic difficulties⁸ 2) increase the admission standards of PhD programs to pursue a highly quality education for PhD students in order to avoid the investment of public money in low-profile PhDs that most likely migrate in foreign “average-level” research institutions.

⁶ La Repubblica – “Quei 3mila cervelli in fuga ogni anno da un'Italia che non saprebbe cosa farne”, Salvo Intravaia, 26 febbraio 2016.

⁷ Santos et al. (2016) highlight the importance to implement active public policies to both attract and retain PhDs in the Portuguese case.

⁸ ICREA's grants proposal initiative is a valid example.

Our study, however, does not come without limitations, which can lead to promising avenue for future research. First, our findings might be extended and furtherly corroborated by considering a more extensive analysis across all different disciplines, from engineering to health areas. It is indeed recognized that there are significant differences in mobility profiles across disciplines (Cañibano et al., 2011). Second, although we do not have at our disposal human capital features, such as individual social and cultural experiences, household characteristics, language skills and psychological traits, by considering the data provided at a Ministerial level, we acknowledge their importance for future contributions aiming at in-depth assess the likelihood of individuals to migrate (Sjaastad, 1962; Rho, 2015). At the same time, collecting further data to investigate whether the brain drain phenomenon could be also associated to brain circulation dynamics might contribute to a better understating of the international migration pattern of doctorates (Gribble, 2008). A further caveat associate to data constraint is the impossibility to investigate the role of mentors in the relationship between scientific performance and the probability to migrate abroad after the PhD. We leave this to future research.

Acknowledgements

We are grateful to the General Director of the Ministry of University and Research (MIUR), Daniele Livon, for having provided data on Italian doctorate holders.

References

- Abbott, A., 2001. Forza scienza! *Nature* 412, 264-265.
- Abramo, G., D'Angelo, C.A., Caprasecca, A., 2009. Allocative efficiency in public research funding: Can bibliometrics help? *Research Policy* 38, 206-215.
- Agrawal, A., Kapur, D., McHale, J., Oettl, A., 2011. Brain drain or brain bank? The impact of skilled emigration on poor-country innovation. *Journal of Urban Economics* 69, 43-55.
- Altbach, P., Impact and adjustment: foreign students in comparative perspective. *Higher Education*, 21, 305-323.
- Altbach, P., 2015. Brain drain or brain exchange: developing country implications. *International Higher Education*, 2-4.
- Arah, O.A., Ogbu, U.C., Okeke, C.E., 2008. Too Poor to Leave, Too Rich to Stay: Developmental and Global Health Correlates of Physician Migration to the United States, Canada, Australia, and the United Kingdom. *American Journal of Public Health* 98, 148-154.
- Bäker, A., 2015. Non-tenured post-doctoral researchers' job mobility and research output: An analysis of the role of research discipline, department size, and coauthors. *Research Policy* 44, 634-650.
- Baruffaldi, S.H., Landoni, P., 2012. Return mobility and scientific productivity of researchers working abroad: The role of home country linkages. *Research Policy* 41, 1655-1665.
- Beine, M., Docquier, F., Oden-Defoort, C., 2011. A Panel Data Analysis of the Brain Gain. *World Development* 39, 523-532.
- Cañibano, C., Otamendi, F.J., Solís, F., 2011. International temporary mobility of researchers: a cross-discipline study. *Scientometrics* 89, 653-675.
- Carr, D.L., Markusen, J.R., Maskus, K.E., 2001. Estimating the Knowledge-Capital Model of the Multinational Enterprise. *The American Economic Review* 91, 693-708.
- Carrington, W.J., Detragiache, E., 1999. How extensive is the brain drain? *Finance and Development* 36, 46.
- Checchi, D., Peragine, V., 2010. Inequality of opportunity in Italy. *The Journal of Economic Inequality* 8, 429-450.

- Cruz-Castro, L., Sanz-Menéndez, L., 2010. Mobility versus job stability: Assessing tenure and productivity outcomes. *Research Policy* 39, 27-38.
- Davenport, S., 2004. Panic and panacea: brain drain and science and technology human capital policy. *Research Policy* 33, 617-630.
- Docquier, F., Lohest, O., Marfouk, A., 2007. Brain Drain in Developing Countries. *The World Bank Economic Review* 21, 193-218.
- Docquier, F., Rapoport, H., 2012. Globalization, Brain Drain, and Development. *Journal of Economic Literature* 50, 681-730.
- Dodani, S., LaPorte, R.E., 2005. Brain drain from developing countries: how can brain drain be converted into wisdom gain? *Journal of the Royal Society of Medicine* 98, 487-491.
- Finn, M. (2007). Stay rates of foreign doctorate recipients from US universities, 2005. Oak Ridge, TN: Oak Ridge Institute for Science and Education.
- Florida, R., Mellander, C., Stolarick, K., 2008. Inside the black box of regional development—human capital, the creative class and tolerance. *Journal of Economic Geography* 8, 615-649.
- Franzoni, C., Scellato, G., Stephan, P., 2014. The mover's advantage: The superior performance of migrant scientists, *Economics Letters*, 122, 89-93.
- Gaulé, P., Piacentini, M., 2012. Chinese Graduate Students and U.S. Scientific Productivity. *Review of Economics and Statistics* 95, 698-701.
- Gennaioli, N., La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 2013. Human capital and regional development. *The Quarterly Journal of Economics* 128, 105-164.
- Gonçalves, R.R., Kieling, C., Bressan, R.A., Mari, J.J., Rohde, L.A., 2009. The evaluation of scientific productivity in Brazil: An assessment of the mental health field. *Scientometrics* 80, 529-537.
- Gonzales, A., 1992. Higher education, brain drain and overseas employment in the Philippines: towards a differentiated set of solutions. *Higher Education*, 23, 21-31.
- Greene, W. H. (2012). *Econometric analysis*, 7th Ed. Upper Saddle River, NJ.

Gribble, C., 2008. Policy options for managing international student migration: the sending country's perspective. *Journal of Higher Education Policy and Management*, 30, 25-39.

Hellemans, A., 2001. Beating the European brain drain. *Nature* 414, 4-5.

Horta, H., Cattaneo, M., Meoli, M., 2016. PhD funding as a determinant of PhD and career research performance. *Studies in Higher Education*, 1-29, DOI: 10.1080/03075079.2016.1185406.

ISTAT (2014). L'inserimento professionale dei dottori di ricerca: informazioni sulla rilevazione.

Kim, D., Bankart, C., A., S., Isdell, L., 2010. International doctorates: trends analysis on their decision to stay in US. *Higher Education*, 62, 141-161.

Kwok, V., Leland, H., 1982. An Economic Model of the Brain Drain. *The American Economic Review* 72, 91-100.

Lutter, M., Schröder, M., 2016. Who becomes a tenured professor, and why? Panel data evidence from German sociology, 1980–2013. *Research Policy* 45, 999-1013.

Manuelli, R.E., Seshadri, A., 2014. Human Capital and the Wealth of Nations. *The American Economic Review* 104, 2736-2762.

Pang, T., Lansang, M.A., Haines, A., 2002. Brain Drain and Health Professionals: a Global Problem Needs Global Solutions, *British Medical Journal*, 324, 499-500.

Rauhvargers, A., 2014. Where Are the Global Rankings Leading Us? An Analysis of Recent Methodological Changes and New Developments. *European Journal of Education* 49, 29-44.

Rhode, B., 1991. East-West migration/brain drain. *European Co Operation in the Field of Scientific and Technical Research COST*, Kommission der Europäischen Gemeinschaften, Brussel.

Roh, J.-Y., 2015. What predicts whether foreign doctorate recipients from U.S. institutions stay in the United States: foreign doctorate recipients in science and engineering fields from 2000 to 2010. *Higher Education* 70, 105-126.

Schuster, J., H., 1994. Emigration, Internationalization, and "Brain Drain": Propensities Among British Academics. *Higher Education*, 28, 437-452.

Santos, J., M., Horta, H., Heitor, M., 2016. Too many PhDs? An invalid argument for countries developing their scientific and academic systems: The case of Portugal. *Technological Forecasting & Social Change*, 113, 352-362.

Seeber, M., Cattaneo, M., Huisman, J., Paleari, S., 2016. Why do higher education institutions internationalize? An investigation of the multilevel determinants of internationalization rationales. *Higher Education* 72, 685-702.

Sjaastad, L.A., 1962. The Costs and Returns of Human Migration. *Journal of Political Economy* 70, 80-93.

Stephan, P. (2012). *How Economics Shapes Science*. Cambridge, MA: Harvard University Press.

Van Bouwel, L., Veugelers, R., 2012. An 'Elite Brain Drain': Are foreign top PhDs more likely to stay in the US?

Wang, X., Mao, W., Wang, C., Peng, L., Hou, H., 2013. Chinese elite brain drain to USA: an investigation of 100 United States national universities. *Scientometrics* 97, 37-46.

Welch and Zhen, 2008. Higher education and global talent flows: Brain drain, overseas Chinese intellectuals, and diasporic knowledge networks. *Higher Education Policy* 2, pp. 519-537

Figure 1. Percentage of PhDs in Economics, Finance and Business Management in each university, aggregated at a province level

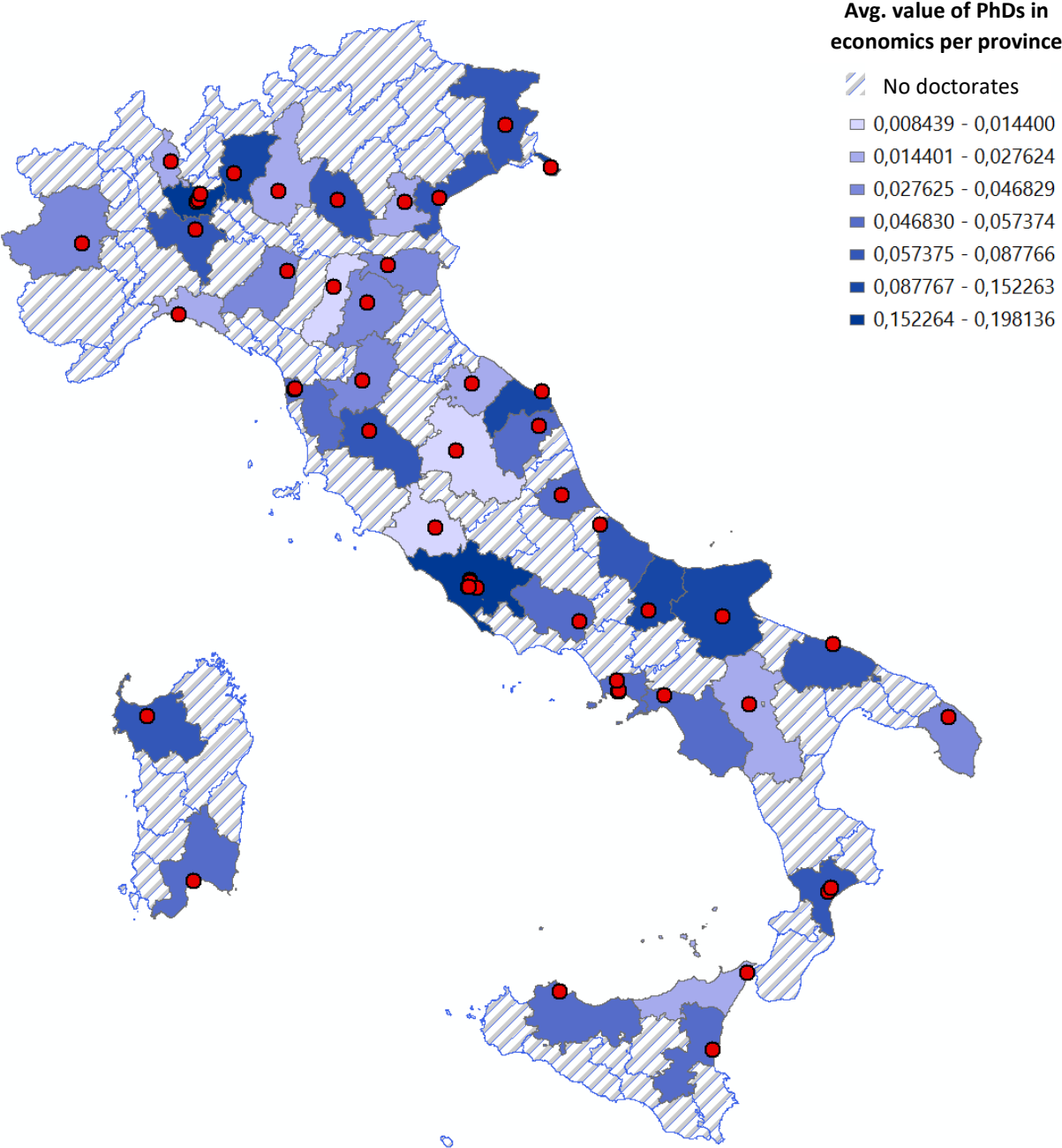


Table 1. Descriptive statistics

	<i>Obs.</i>	<i>Mean</i>	<i>S.D.</i>	<i>Min</i>	<i>Max</i>
<i>Independent variable</i>					
Research performance	521	0.809	3.157	0	56.234
<i>Control variables</i>					
<i>Individual-level</i>					
Gender (Male =1)	521	0.503	0.500	0	1
Age (At the beginning of the PhD)	521	26.975	4.010	22	56
Intra-national mobility	521	0.494	0.500	0	1
International mobility	521	0.071	0.257	0	1
R&D expenditure D-O ratio	521	1.171	0.384	0.160	2.838
<i>University/Departmental-level</i>					
PhD program internationalization	521	0.100	0.269	0	1
Doctorates' career competition	521	0.503	0.324	0.040	1.500
Career advancement competition	521	0.018	0.070	-0.054	0.800
University size	521	37,528.44	27,843.3	273	142,796
Student- faculty ratio	521	32.857	14.301	0	109.901
Private university	521	0.129	0.335	0	1
Doctoral university	521	0.015	0.123	0	1
<i>Fields of science</i>					
Economics	521	0.724	0.448	0	1
Finance	521	0.088	0.284	0	1
Management	521	0.094	0.292	0	1
<i>Geographic area of graduation</i>					
North	521	0.484	0.500	0	1
Centre	521	0.330	0.471	0	1
South	521	0.186	0.390	0	1

Table 2. The probability to move abroad after the PhD in Italy

Variables	Probit model
Research performance	-0.047*** (0.017)
Research performance squared	0.002*** (0.000)
Gender (Male =1)	0.397*** (0.085)
Age (At the beginning of the PhD)	-0.023*** (0.002)
Intra-national mobility	0.044 (0.032)
International mobility	1.295*** (0.107)
R&D expenditure D-O ratio	3.226*** (0.559)
PhD program internationalization	0.308*** (0.071)
Career PhD competition	0.409*** (0.138)
Career advancement competition	0.487 (2.019)
University size	0.001 (0.002)
Student- faculty ratio	0.003 (0.003)
Private university	-0.346 (0.304)
Doctoral university	0.283** (0.126)
<i>Fields of science</i>	
Finance	-0.102 (0.077)
Management	0.191*** (0.069)
<i>Geographic area of graduation</i>	
North	0.639*** (0.015)
Centre	0.511*** (0.035)
Constant	-4.833*** (0.266)
Pseudo R-squared	0.459
Log-pseudolikelihood	-173.414
Observations	521

Table 3. Estimated multinomial logistic regression results

Variables	Ranked university	Not-ranked university	Other institutions
Research performance	0.134*** (0.025)	0.041 (0.080)	-0.238*** (0.019)
Gender (Male =1)	0.496*** (0.080)	0.833* (0.433)	0.768*** (0.213)
Age (At the beginning of the PhD)	-0.061*** (0.023)	-0.054* (0.028)	-0.011 (0.040)
Intra-national mobility	0.167 (0.193)	-0.359 (0.222)	0.555** (0.260)
International mobility	2.219*** (0.300)	2.810*** (0.270)	1.976*** (0.627)
R&D expenditure D-O ratio	8.190*** (2.891)	7.309** (3.301)	8.498*** (2.620)
PhD program internationalization	0.076 (0.207)	0.552 (0.474)	0.554* (0.297)
Career PhD competition	1.028*** (0.276)	0.173** (0.071)	0.462* (0.273)
Career advancement competition	-1.852*** (0.546)	2.172 (4.452)	2.399*** (0.436)
University size	0.001 (0.001)	0.008*** (0.002)	-0.002** (0.001)
Student- faculty ratio	0.009 (0.020)	0.006 (0.024)	0.011** (0.005)
Private university	-0.959 (0.911)	0.125 (0.283)	-0.537 (0.752)
Doctoral university	1.604*** (0.355)	0.172 (0.571)	-12.183*** (1.712)
<i>Fields of science</i>			
Finance	0.393 (0.341)	-0.377*** (0.030)	-1.065*** (0.149)
Management	0.359*** (0.100)	0.514*** (0.116)	-0.448*** (0.101)
<i>Geographic area of graduation</i>			
North	1.060*** (0.231)	0.221 (0.556)	2.137*** (0.192)
Centre	0.153*** (0.055)	0.800*** (0.164)	1.911*** (0.323)
Constant	-11.866*** (4.268)	-10.409*** (1.771)	-14.784*** (3.072)
Pseudo R-squared		0.373	
Log-pseudolikelihood		-310.341	
Observations	521	521	521

Appendix – Fresh doctorate holders per university

University	2008	2009	2010	Tot
Milano - Università commerciale "Luigi Bocconi"	25	37	21	83
Roma - Università degli studi "La Sapienza"	21	34	20	75
Bari - Università degli studi	18	31	19	68
Bologna - Università degli studi	18	22	24	64
Ancona - Università Politecnica delle Marche	15	30	17	62
Roma - Università degli studi di "Tor Vergata"	15	17	29	61
Palermo - Università degli studi	16	19	25	60
Trieste - Università degli studi	25	16	19	60
Roma - III Università degli studi	27	19	8	54
Siena - Università degli studi	15	17	19	51
Firenze - Università degli studi	17	9	22	48
Torino - Università degli studi	18	10	20	48
Pisa - Università degli studi	11	14	23	48
Catania - Università degli studi	20	18	9	47
Napoli - Università degli studi "Federico II"	17	18	10	45
Milano - Università Cattolica del "Sacro Cuore"	11	24	2	37
Foggia - Università degli studi	17	11	9	37
Pavia - Università degli studi	13	13	9	35
Roma - Libera Università internazionale degli studi sociali Guido Carli (LUISS)	13	5	15	33
Udine - Università degli studi	9	9	15	33
Chieti e Pescara - Università degli studi Gabriele D'Annunzio	10	10	12	32
Padova - Università degli studi	15	9	8	32
Venezia - Università degli studi "Cà Foscari"	10	3	13	26
Verona - Università degli studi	6	11	9	26
Salerno - Università degli studi	7	7	10	24
Lecce - Università del Salento	12	0	9	21
Cagliari - Università degli studi	8	7	6	21
Sassari - Università degli studi	8	8	5	21
Messina - Università degli studi	8	8	4	20
Parma - Università degli studi	11	4	5	20
Genova - Università degli studi	7	7	4	18
Ferrara - Università degli studi	5	7	4	16
Campobasso - Università degli studi del Molise	6	3	7	16
Bergamo - Università degli studi	5	5	5	15
Milano-Bicocca - Università degli studi	5	6	4	15
Macerata - Università degli studi	5	4	5	14
Napoli - Università degli studi "Parthenope"	4	3	6	13
Milano - Università degli studi	4	7	2	13
Milano - Libera Università di Lingue e Comunicazione (IULM)	4	5	3	12
Catanzaro - Università degli studi "Magna Grecia"	5	0	6	11
Reggio Calabria - Università degli studi Mediterranea	7	1	2	10
Cassino - Università degli studi	6	2	1	9
Perugia - Università degli studi	2	2	5	9
Pisa - Scuola superiore studi universitari e perfezionamento "S. Anna"	7	1	0	8
Napoli - Seconda Università degli studi	7	0	0	7
Reggio Calabria - Università degli studi Mediterranea	3	4	0	7
Teramo - Università degli studi	4	3	0	7
Modena e Reggio Emilia - Università degli studi	0	0	5	5
Varese - Università dell' Insubria	2	1	2	5
Urbino - Università degli studi "Carlo Bo"	1	0	3	4
Potenza - Università degli studi della Basilicata	0	2	2	4
Brescia - Università degli studi	1	0	2	3
UNINT - Università degli studi Internazionali di Roma	3	0	0	3
Napoli - Università degli studi "L' Orientale"	0	0	3	3
Viterbo - Università della Tuscia	0	0	2	2
Pavia - Istituto universitario di studi superiori	0	0	2	2
Tot.	529	503	491	1523