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Exploring mobility of Italian Ph.Ds over the last decades

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Migration is a permanent phenomenon rooted in history and it involves high-skilled workers (HSWs), high-educated workers (HEWs) and students. Among them, a crucial role is played by PhDs. Both HSWs and HEWs face the risk of not finding a job matching their skills and they can opt to accept a job for which they are overeducated or move to another country or region. The mobility of HSWs can be interpreted as a positive issue that can help to match jobs and skills. However, the emergence of a clear path between areas of countries or regions (e.g., from Southern to Northern Italy) highlights the risks of a drain of human capital from areas with low development to more developed ones. In this paper, we focus on a category of HSWs who have been almost neglected by the literature, PhDs. The aim of this study was to shed light on the mobility pattern of Italian PhDs. This aim was pursued by using microdata from the 2014 ISTAT Survey on the professional conditions of Italian PhDs four and six years after the end of their studies. This work highlights that southern PhDs had a higher probability of moving to another area of the country, while northern PhDs seemed to prefer to move abroad, thus confirming a previous study which identified a similar pattern for graduates. While the northern part of the country compensates for the drain of human capital with the mobility from the other part of Italy, the southern part faces a relevant drain of 'talents'.

keywords: Mobility, PhD, high-skilled workers, simultaneous equation model, Italian Higher Education System, brain drain.

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1 Introduction

The role of PhDs, talents and high-skilled workers (HSWs) in fostering the development of a country is undoubted, and governments around the world have begun to adopt specific policies to attract foreign talents while also retaining local workers. The European Union has also adopted several policies to tackle the scientific leadership of the USA, with the aim of becoming the most important knowledge-based environment in the world. In particular, following the Bologna Process (2003), the importance of PhD programmes has grown and the number of PhDs has strongly increased (Keeling, 2006). This push towards an increased number of PhDs must be interpreted as a way to improve the human capital within the European Union.

With reference to the Italian higher education system, the number of students (per year) increased from about 21,000 in 2000 to more than 30,000 in 2016. Similarly, the number of PhDs awarded each year grew from about 3,000 in 1998 to more than 10,000 in 2017 (Source: Open Data – Italian Ministry of Education). At the same time, the strong reduction in public funds available to Italian universities (Ezza et al., 2017) and in the number of academic staff, as weell as, the growing competition to access academia have forced PhDs to search for jobs outside academia, and the increased riskI of being unable to access a qualified job has incentivised their mobility. Perhaps for the same reasons, Italy is characterised by a scant ability to attract high-educated individuals from other countries. Indeed, according to the Talent Attractiveness index elaborated by the OECD for the member countries of the organization, only Greece, Mexico and Turkey have a lower ability to attract high-educated people from abroad.This index aims to capture the capacity of OECD countries to attract and retain three specific categories of talented migrants: high educated workers (those with master's and doctoral degrees), foreign entrepreneurs and university students. The above reported rank characterises high-educated workers. In general, the indicator is based on seven dimensions, each representing a distinct aspect of talent attractiveness: (1) quality of opportunities; (2) income and tax; (3) future prospects; (4) family environment;, (5) skills environment; (6) inclusiveness; and (7) quality of life. For more details on the construction of this indicator see Tuccio (2019)

In line with these data, according to the 2018 AlmaLaurea Survey on the Occupational Status of Italian PhDs, 71.3% of the interviewed individuals stated that their level of satisfaction concerning the job prospects offered by their doctorate was equal to 5.9 (on a scale of 1 to 10). In addition, 71% of the respondents believed that there were more opportunities outside Italy to gain a foothold in the labour market. Considering income, these beliefs seem to be supported, as according to the 2014 data from the National Statistical Office (Istituto Nazionale di Statistica – ISTAT), Italian PhDs who work abroad earn a monthly wage that is 800 euros higher than that of those working in Italy. In addition, the AlmaLaurea survey shows that around 15% of Italian PhDs declared that they wanted to continue their careers in other countries. At the same time, 61% obtained their PhD in the university in which they had graduated, while 29% received theirs from another Italian university. In addition, 83.5% of PhDs had a job (half of them in the education and research sector) one year after the conclusion of their studies. These data

Table 1: OECD Attractiveness index for highly educated workers, OECD countries, 2019

Country	Index	Country	Index	Country	Index
Australia	0.63	Germany	0.57	Japan	0.5
Sweden	0.63	Iceland	0.56	Hungary	0.49
Switzerland	0.62	Estonia	0.55	Spain	0.48
Canada	0.61	U.K.	0.55	Chile	0.46
Ireland	0.61	Austria	0.54	Latvia	0.46
New Zealand	0.61	Finland	0.54	Israel	0.45
Netherlands	0.59	Belgium	0.53	Poland	0.45
U.S.A.	0.59	Portugal	0.53	Italy	0.42
Luxembourg	0.58	Slovak Rep.	0.53	Greece	0.4
Norway	0.58	France	0.52	Mexico	0.38
Slovenia	0.58	South Korea	0.52	Turkey	0.35
Denmark	0.57	Czech Rep.	0.51		

seem to draw a picture of general dissatisfaction concerning the opportunities opened by the doctorate; however, there is also a good labour market absorption capacity, a willingness to remain in Italy and a low propensity for Italian PhDs to leave the university from which they have graduated (Ruiu and Ruiu, 2019). However, it must also be noted that the 2018 AlmaLaurea Survey included only one university from Southern Italy[1]. This lack of geographical coverage could hide a completely different story of PhDs coming from the south of the country, considering the traditional shift that exists between Northern and Southern Italy in terms of wealth, socioeconomic development, the quality and availability of public or private services, and so on.[2] Indeed, Southern Italy is characterized by a negative migration balance of graduates. Unfortunately, the same statistics are not available for PhDs.

This work focuses its attention on Italian PhDs as a specific subgroup of HSWs. PhD programmes have traditionally been seen as a privileged door to access academia or a scientific research career (Woolf, 2003). In the last few years, due to the technological

[1] AlmaLaurea does not ex-ante define the sample, since each university member of the consortium can voluntarily request to participate in the survey. In the 2018 edition, only 27 out of 97 Italian universities (jointly considering public, private universities and special institutions such as Scuola Normale di Pisa, Istituto Superiore Sant'Anna, etc.) participated to the survey. Hence, the results of this survey could be hardly (as recognised by the same AlmaLaurea) considered representative of the entire Italian higher education system.

[2] According to ISTAT data, the total unemployement rate in 2018 was 18.41% in southern Italy, 6.6% in northern Itay,9.4% in central Italy. See also Lagravinese (2015) for an analysis the effect of the recent economic crisis in widening the gap between southern and northern Italy.

evolution on the one hand and the reduced accessibility of academia on the other hand, PhDs have expanded their entry into the labour market to other sectors and/or other countries. With reference to the Italian university system, the 2010 reform (the so-called Gelmini Reform) was aimed at increasing the sustainability and performance of the Italian university system, which had been harshened by the competition, thus making it more difficult to access an academic position. Together with the reduction in public funds allocated annually by the government, the recent reform introduced a competitive mechanism to share funds among universities based on performance. As highlighted by the managerial literature (Jongbloed and Vossensteyn, 2016; Dougherty et al., 2014), the introduction of competitive mechanisms in the allocation of public subsidies (i.e., performance-based funding or budgeting mechanisms, quasi-market incentives) can stimulate universities to change their strategic behaviour to improve their performance. It has been argued that the introduction of such an approach to funding allocation could potentially penalise universities located in low-income regions (in particular in Southern Italy) by perpetuating the existing differences and favouring universities situated in better locations. With specific reference to academic recruitment, in 2012 (Rossi, 2015) a formula-based mechanism (McKeown, 1996) was introduced to allocate the annual budget for recruitment. It should be noted that this mechanism seems to favour northern universities, which receive a higher share of funds compared to those located in the south. In other words, this mechanism can potentially foster domestic mobility for PhDs, who are pushed to move across the country (with a clear south-to-north pattern) to find a job within academia.

Given this context, the aim of our stydy was to shed light on the mobility pattern of Italian PhDs. This aim was pursued by using microdata from the 2014 ISTAT Survey on the professional conditions of Italian PhDs at four and six years after the end of their studies. Although some studies have been conducted analysing the macro and micro-determinants of both student (D'Agostino et al., 2019) and graduate mobility (Cutillo and Ceccarelli, 2012; Iammarino and Marinelli, 2015), to the best of our knowledge, there has been no systematic study which has investigated the mobility choices of Italian PhDs at the individual level, with the important exception of the analysis conducted by Ermini et al. (2019). However, it should be noted that the main focus of Ermini et al. was whether a wage premium was obtained by those who decided to move for working purposes from the region where the doctorate was gained to another region.

This paper is structured as follows: in the next section, we present a brief review of the literature on the determinants of mobility for high-educated individuals and provide a short description of the Italian university system. In the third section, we present our data source and the empirical strategy. The fourth and the fifth sections are devoted respectively to presenting and commenting on our results. In the last section we discuss some final considerations.

2 Literature review

2.1 Mobility of talents: students, PhDs. and high-skilled workers

Mobility is a worldwide phenomenon (Massey et al., 1993) which involves the movement of people searching for a better degree course, job opportunities and a higher quality of life. Migration is a permanent phenomenon rooted in history (Rystad, 1992), but the recent emergence of technologies and their fast-paced evolution has changed the conventional pattern. In line with the traditional model of migration (Borjas et al., 1992), migrants make their decision following a rational approach by comparing the potential benefit they will receive with the costs they will bear when leaving their home country or region (Sjaastad, 1962). While there is no general consensus on the existence of a positive impact on earnings for 'movers', the literature shows that high-educated or high-skilled workers are more likely to benefit from an increase in earnings as a result of their movement (Di Cintio and Grassi, 2017; Ermini et al., 2019). Within the HSW set, we can identify a smaller group of workers that can be defined as high educated workers (HEWs). The HEWs are pooled by a doctoral or a post-doctoral education. Among them, PhDs - awarded the highest academic titles and trained to perform scientific research inside or outside academia – play a pivotal role.

The choices made by talents, HSWs or HEWs can be usefully interpreted in light of the human capital theory of education (Becker, 1983, 2009; Schultz, 1971), which postulates that an increase in skilled demand creates an incentive for higher schooling, and consequently allows education, job training and schooling to be considered an investment. People will devote effort to develop skills and acquire the knowledge needed to play complex roles within firms and obtain and adequate return (both pecuniary and not pecuniary). Following Blaug (1976), human capital can be improved and fostered by six main factors: formal schooling, on-the-job training, job searching, information retrieval, migration and improvement in health. The HSWs or HEWs who choose to migrate are exploiting two of the most important levers people can use to pursue future returns: HEWs or students leave their countries or regions to seek opportunities to develop their skills or benefit from those already acquired, thus relying on migration and education as viable ways to improve their human capital. The local, national and international labour markets of developed countries have changed profoundly since the emergence of new and specialized jobs, thus favouring the migration of HSWs and not only from developing or less developed countries (Bauer and Kunze, 2004). The emergence of newer and high-tech jobs led to both the increase in the individual demand for higher-level schooling and the demand for high specialised jobs. In line with the traditional approach of human capital theory, migration is primarily linked to the choices and needs of an individual who uses migration as a strategy to improve his/her living conditions or to seek a better quality of life. However, at the same time, migration has an impact on both the sending and host countries due to the action of the so-called brain-drain/brain-gain process (Boeri et al., 2012; Straubhaar, 2000) According to the literature (OECD, 2004; Solimano, 2008; Greenwood, 1997), the international migration of educated and skilled people can be driven by several factors, which can relate to

personal motivations and to the characteristics of the economic environment of the host country. High-educated people or students are pushed to leave their home country to seek better job and life opportunities or if there is a lack of prospects in their home country (e.g., fewer specialised degree courses, a lack of research facilities) and their decision aims to maximise the future return in terms of a higher wage or better life conditions. Accordingly, HSWs or HEWs are mainly influenced by the wage gaps; however, they also consider non-monetary elements and they can be attracted by those labour markets that offer satisfaction, power and recognition. Moreover, HEWs also tend to be attracted to those countries that have a vibrant scientific or technical community.

Focusing on undergraduate or post-graduate students, it worth noticing that the choice of the university or the PhD programme to which they apply is mediated by the quality of a university (Ciriaci, 2014), a factor capable of influencing future job prospects and earnings. In this sense, it should be noted that the attractiveness of a university can be hard for students to assess and the choice can be strongly influenced by external factors, such as the perceived quality of the host city, the attractiveness of the labour market and the wealth of the territory (Dotti et al., 2013; Ezza et al., 2017, 2019). The mobility pattern and the careers of PhDs, and HEWs and HSWs more generally can be analysed with a consideration of the occurrence of job-matching and the risk of overqualification. Indeed, they invest in their qualification and the underlying risks are failing to find a matching job and failing to fully exploit their investments. As such, PhDs indeed seek jobs in line with their background, which may not be available close to their residence due to low technological, economic or social development. If no suitable job is available, HSWs can choose to move to find a matching job or stay and accept being overeducated for a job (i.e., the skills they have acquired exceed those needed to perform the job). Generally, the occurrence of overeducation is related to the lack of jobs on the market. In line with the seminal work of Büchel and van Ham (2003), overeducation is related to the distribution of job opportunities and the extent of the job market. The borders of a job market are flexible and they depend on the individual orientation of the job-seekers: the higher their willingness to move far from their residence, the higher the dimension of the job market. In addition, the risk of overeducation is also increased by unemployment since those who have no job are more likely to accept one below their qualification. The main issues linked to overeducation are the reduced income HSWs will receive (Verdugo and Verdugo, 1989; Dolton and Vignoles, 2000) and, as a consequence, the reduction of their work satisfaction. In this sense, migration is seen as an effective way to match HSWs' skills with a job position open abroad (Jackman and Savouri, 1992). However, from a broader point of view, migration and overqualification should be seen as important issues for the sending countries since, in the first case, they do not benefit from the investments made in educating people who ultimately leave the country, and in the second case, they do not fully exploit their skills.

According to human capital theory, the prosperity of a country is strongly affected by the education, level of skills and the quality of the human resources. The underlying rationale is that investing in education is a viable way to improve the productivity and wellness of communities. In connection with this view, the loss of high-educated people can be seen as a critical issue for the sending country, especially for the publicly funded

education systems in which the costs are covered by public subsidies. This issue emerges most clearly in the case of PhDs as PhD programmes are mainly financed by government or public agencies with the final aim of improving the human capital of a region and ultimately fostering the economic and social development of a country. The PhDs forced to leave should be considered a lost investment, since a country must bear the overall cost of their education without receiving the related benefit. For instance, the cost to train an Italian PhD to obtain his/her doctorate in a public University is close to 100,000 euros. This amount has been assessed using a conservative approach, using only official sources and when no supplementary data were available, only direct costs. To define the cost of an average five years graduation programme the "national average standard cost per student" (as defined by the ministerial decree 585/2018) has been used (6,670 euros per year per student). Using this value, an average graduate in an Italian state university costs 33,350 euros for a five year programme. To define the cost for the PhD programme, only the cost for the three years scholarship has been considered (56,533.85 euros). It should be highlighted that several direct costs (e.g., the additional funds for research support; the additional resources awarded for visiting abroad, etc.) and all the indirect costs (organizational costs, personnel expenses, etc.) have not be considered.

2.2 PhDs in the Italian context

Italy, similar to other European countries, promoted a season of reform inspired by the New Public Management rhetoric (Donina et al., 2015; Donina and Paleari, 2019) and the policies of the European Union (Bologna Process, Lisbon Strategy) toward the development of the European Higher Education Area (Keeling, 2006). The strong push exerted by the EU policies on the development of high-level research was aimed at tackling the predominance of the United States and its higher attractiveness to young researchers and HSWs. Accordingly, a growing interest in research activity, dissemination and training emerged. In this sense, researchers' mobility (both international and domestic) is considered a positive feature in higher education and it is clearly encouraged, since it is perceived as an instrument to support research development throughout the European Higher Education Area (Morano-Foadi, 2005). The EU policies are clearly in line with the rhetoric of human capital theory (Schultz, 1971; Sakamota and Powers 1995). Human capital theorists argue that there is a relationship between the level of the economic welfare and people level's education. Accordingly, the effort expended educating people, retaining domestic talents and attracting HEWs from abroad should be viewed as an effective lever to improve the productivity of a population.

In this sense, the effort made by the European countries to develop PhDs programmes is not surprising, to date PhDs comprise the highest rank of the higher education path in line with the Bologna Process and a key tool to achieve the objectives of the Lisbon Strategy. There has been a growing interest in PhD programmes within the European Union. Introduced in Italy in the 1980s (Decree n. 382, art. 68), PhD programmes started their development in the 2000s (Ballarino and Colombo, 2010). It is worth noting that PhD programmes aimed only to provide research training and in this sense, were intended as the first step of an academic career. Especially in the first phase, the

doctorate was interpreted as "a new institutionally favoured step on the uncertain ladder of a future university career" (Woolf 2003, p. 354). For this reason, the analysis of the career and mobility patterns of Italian PhDs is inextricably linked to the evolution of higher education recruitment policies. The Gelmini Reform in 2010 changed the pattern of academic careers and the regulation of access to tenured positions. First, the role of *ricercatore* or university researcher (Degli Esposti and Geraci, 2010), a permanent position which represented the first level of the academic hierarchy as designated by law 382/1980, was replaced by the introduction of two forms of fixed-term research fellows (Geraci and Degli Esposti, 2011), resulting in an increase in job insecurity in accessing academia. Second, the reform also changed the regulation of access to the academic role by introducing the national qualification (i.e., *Abilitazione scientifica nazionale*) for the position of associate or full professor.

As a result of the conjoined effect of the introduction of higher job insecurity and the reduction of the number of academic positions, working in universities has become harder and less attractive (Di Cintio and Grassi, 2017). Subsequently, PhDs are incentivised to search for jobs in other sectors, with the aim of maximising their job-matching (Ermini et al., 2019). This issue is critical within the Italian context, since there is a clear trend of mobility from the southern to the northern parts of the country (Iammarino and Marinelli, 2015), which has fostered significant concern regarding the brain-drain process. Hence, PhDs can be forced to accept a non-matching job or move across the country or abroad. In this sense, as Gaeta (2015) highlighted, a relevant share of Italian PhDs consider themselves overqualified and overskilled in relation to their job when working outside R&D or academia. It should be noted that domestic mobility in academia is not pushed or influenced by wage gaps since the level of wages is fixed and homogeneous throughout the country.

The Italian university system has often been described as a 'feudal' system, headed by a limited group of professors (the so-called barons) who wield significant power in the process of recruitment and can exert pressure in attracting and retaining talent. Several attempts to break the power of the barons have been made over the last few decades by changing the regulation of the public competition mechanism to access academic positions (*concorsi*) to foster merit and promote higher competition among researchers (Clark, 1979; Moscati, 2001; Moss, 2012).

In addition, it should be noted that the introduction of competitive mechanisms to allocate funds to public universities in line with the performance-based funding or budgeting literature (Burke et al., 2000; Glennerster, 1991; Jongbloed, 2004; Jongbloed and Vossensteyn, 2016; Layzell, 1999; McKeown, 1996) and the introduction of research assessment exercises (*Valutazione della Qualità della ricerca – VQR*) exert the intended pressures on universities, which are driven to attract and retain talent in order to increase their performance and, consequently, the amount of funds they receive. Specifically, a performance-oriented mechanism has recently been adopted for academic and administrative staff recruitment (Rossi, 2015). The annual budget for recruitment policies is allocated to each public university through a formula-based mechanism using two economic and financial performance indicators. Further, the funding mechanism of doctoral schools is also linked to a range of indicators aimed at evaluating the different dimen-

sions of the schools' activities, such as the research quality of the committee members, the degree of internationalization and attractiveness gauged on the basis of students' provenance, and the collaboration with the social and economic environment and the consequential beneficial effects on the latter (D'Uggento et al., 2016).
Performance-based funding mechanisms (PBFs) should push towards an improvement of universities' quality through the adoption of indicators used to assess performance, thus promoting competition within the whole system. It is worth noting that the performance assessed in PBF is likely to be only partially manageable by universities. Indeed, attractiveness is linked to contextual factors such as the university's location (Farhan, 2016) and is enhanced by other university characteristics that depend on the surrounding environment, such as the alignment between offerings and the labour market, in which there is easy entry into the labour market due to the relationships between universities, and the economic and social fabric (Cattaneo et al., 2017; Chan and Lin, 2015). These contextual variables influencing universities' outcomes could produce a further increase in the resources allocated to those universities that already enjoy a privileged position (Iammarino and Marinelli, 2015). These effects have been previously identified in relation to the contributions of PBF in higher education and defined as unintended consequences linked to the adoption of PBF in a heterogeneous context (Frank and Cook, 2010; Jeon and Kim, 2018; Merton, 1968). The adoption of a PBF mechanism to provide funds to universities can boost mobility throughout the country. Universities located in richer areas, which are favoured by contextual variables, are likely to perform better and thus obtain more resources to attract and retain talent. Consequently, PhDs and HSWs are incentivised to move to wealthier areas of the country where they have more chances of finding matching jobs. The adoption of competitive mechanisms in the Italian higher education system should deal with the traditional shift between the north and the south of the country, a shift that clearly exists within the system. This issue is clearly demonstrated by observing data about the allocation of reward funding to the 180 best performing departments (*"Dipartimenti di eccellenza"*). By observing the ranking provided by the Italian Ministry of Education, the higher concentration of rewarded departments in the northern part of the country is clear: 106 out of 180 rewarded departments are in northern Italy (58 in the North-East and 48 in the North-West), while only 22 are located in Southern Italy, and four in the Islands. The different distribution of departments and consequently, of the rewarding funds allocated to each department, testify to the wide gap that exists between the different areas of the country.

3 Data and Methods

3.1 Data

The data used in this study were obtained from the 2014 ISTAT survey on the occupational status of Italian PhDs four and six years after obtaining their doctorate. In the survey, 16,322 out of 22,459 PhDs were interviewed (a response rate of 72.64%). Specifically, 7,888 out of 11,229 PhDs and 8,434 out of 11,240 PhDs were interviewed for the 2008 and 2010 cohorts, respectively. The same ISTAT provides weights to ensure

representativeness. These cohorts were the first to have been exposed to the Gelmini Reform.
Table 2 reports an initial descriptive picture of the data. Table 3, 4 and 5 report some

Table 2: Descriptive statistics of the sample

Variable	N (in % over total sample size)
Gender = Male	7,805 (47.8)
Gender = Female	8,517 (52.2)
Status: Married or Cohabitation	7,418 (45.5)
Status: Single	8,279 (50.7)
Status: Separated or Divorced	625 (3.8)
Age at PhDs 25-29 years old	4,847 (29.7)
Age at PhDs 30-34 years old	7,694 (47.1)
Age at PhDs $\geq$ 35	3,781 (23.2)
Comp. Sc. & Maths	517 (3.2)
Physical Sc.	745 (4.6)
Chemistry	899 (5.5)
Earth Science	399 (2.4)
Biology	1,598 (9.8)
Medicine	2,420 (14.8)
Agricultural And Veterinary Science	1,071 (6.6)
Civil Engineering And Architecture	1,172 (7.2)
Industrial and Information Eng.	1,963 (12.0)
Antiq., phil.gy, lit. st., Art hist.	1,402 (8.5)
Hist., phil., pedag. psych.	1,480 (9.1)
Law Studies	1,171 (7.2)
Economics and Statistics	925 (5.7)
Political and Soc. Sc.	560 (3.4)

descriptive statistics on the mobility patterns of Italian PhDs from their undergraduate studies to their current residence. Italian doctors from Northern and Central Italy tended to obtain a university degree while remaining in their own macro-area [3] , but PhDs from Southern Italy tended to change macro-area more frequently (Table 3). Interestingly, when we considered mobility from the area in which the university degree

[3]In this paper, macro-areas, regions and provinces are identified in line with the NUTS classification; see hhttps://ec.europa.eu/eurostat/web/nuts/nuts-maps.

was obtained to the area in which the doctorate was obtained (Table 4), there was little difference across Italian macro-areas, with more than 80% of Italian PhDs having obtained their titles in the same area in which they obtained their university degrees. Furthermore, it should be noted that there were cases in which even though an individual moved from one macro-area to another, the actual distance travelled was only a few kilometres (e.g., movements from Messina (Islands) to Reggio Calabria (South), Caserta (South) to Frosinone (Centre), Piacenza (North-East) to Pavia (North-West)). Finally, considering mobility from the area in which the PhD was completed to their current area of residence (Table 5), it becomes clear that northern Italian PhDs appear to have moved to other countries more often than their southern Italian counterparts. Moreover, movements from Northern to Southern Italy seem to have been rare.

Table 3: Mobility patterns of Italian PhDs, broken down by macro-area; 2014 – Macro-area before university vs. macro-area where univ. degree was obtained.

Macro-area	Macro-area of graduation						
Before Un.	NE	NW	C	S	Is	Other Country	% Grad. in their own region
NE	2610	65	50	5	4	9	95.15
NW	138	3017	88	5	5	5	92.60
C	106	36	3749	31	4	9	95.27
S	205	109	553	3091	43	2	77.22
Is	40	52	106	9	1728	2	89.21
Other Country	21	18	32	16	8	216	.

Note: 134 individuals for which the region before graduation is unknown.

2 Individuals for which is not known the region of the university degree

These simple descriptive statistics seem to suggest that PhDs from Southern Italy tended to anticipate the move when they were at the undergraduate level and left Italy less frequently than Northern Italian PhDs. The latter, both in their undergraduate studies and in their PhD, tended to move mainly inside the northern area and to a lesser extent to Central Italy. Note that sometimes the movement from a university where the degree was obtained to another one for a PhD programme could be due simply to the fact that the first university did not offer a PhD programme in the field of the aspiring doctor. Even though the reader is invited to consider that this sort of "forced" mobility is possible, it seems difficult to conclude that the movements from a macro-area to another one (or from a region where there are several universities to another one) were simply due to the lack of an appropriate PhD programme.

Table 6 reports the occupational outcomes of the interviewed PhDs, broken down into the

Table 4: Mobility patterns of Italian PhDs, broken down by macro-area; 2014 – Macro-area where univ. degree was obtained vs. macro-area where PhD was obtained.

	Macro-area Ph.D.					
Macro-area Degree	NE	NW	C	S	Is	% Ph.D. in the same univ.
NE	2625	182	213	80	20 5	84.13
NW	225	2841	150	51	30	86.17
C	215	135	3897	271	60	85.12
S	111	70	224	2683	69	84.99
Is	52	53	135	71	1481	82.65
Other Country	104	112	122	23	15	.

Table 5: Mobility patterns of Italian PhDs, broken down by Macro-area; 2014 Macro-area where PhD was obtained vs. current Macro-area.

	Macro-area after Ph.D.							
PhD Macro-area	NE	NW	C	S	Is	Other Country	% not moved	% in other country
NE	2215	298	205	75	39	497	66.54	14.93
NW	162	2610	132	47	36	490	75.06	14.09
C	233	240	3322	222	110	607	70.17	12.82
S	138	196	391	2133	73	249	67.08	7.83
Is	57	115	84	94	1224	101	73.07	6.03

macro geographic areas where the PhDs were obtained. The table combines the 2008 and 2010 cohorts. It should be noted that the incidence of unemployment in both Southern Italy and the Islands is almost double that of Northern Italy. This could signal a greater difficulty for PhDs to be absorbed by the private labour market in these areas when they are unable to obtain an academic position. It must be noted that the label 'post-doc position' included both individuals who had won a short-term research scholarship (the so-called *borse di ricerca*) and those who were temporary research fellows (the so-called *assegni di ricerca*) and that only some of these positions (2,514 out of 3,374 PhDs) are in the ambit of a university. Another interesting statistic is reported in Table 7 and concerns the sector of employment of those who declared they were dependent workers.

Table 6: Occupational Outcome of Italian Doctors in 2014

	Total		North East		North West		Center		South		Island	
		In %		In %		In %		In %		In %		In %
Dependent work	8094	49.59	1742	52.27	1633	48.13	2423	51.11	1519	47.77	777	46.39
Term-contract work	1080	6.62	193	5.79	241	7.1	339	7.15	205	6.45	102	6.09
Occasional work	395	2.42	64	1.92	56	1.65	124	2.62	98	3.08	53	3.16
Autonomous work	2148	13.16	399	11.97	406	11.97	652	13.75	454	14.28	237	14.15
Post-doc position	3374	20.67	753	22.59	855	25.2	848	17.89	604	18.99	314	18.75
Unemployed	1231	7.54	182	5.46	202	5.95	355	7.49	300	9.43	192	11.46
	16322	100	3333	100	3393	100	4741	100	3180	100	1675	100

Note that we grouped toghether the 2008 and the 2010 cohorts

Only about 20% of those who were dependent workers were employed by universities (about 1,700 out of 16,300 PhDs). If we sum those who were in a post-doc position at a university and those who were employed in a university or in research outside academia, it turns out that only about 37% were involved in research activities. The PhDs from Southern Italy or from the Islands seem to have been less frequently employed in research activities outside academia, giving further support to the idea that the local economy is less able to absorb high-qualified individuals.

Table 7: Sector of employment of Italian PhDs.

	Total		North East		North West		Center		South		Island	
		In %		In %		In %		In %		In %		In %
University	1694	20.9	387	22	398	24.4	477	19.7	281	18.5	151	19.4
Research in public sector (not university)	634	7.83	122	7	116	7.1	244	10.1	111	7.3	41	5.3
Research in private sector	337	4.16	85	4.9	105	6.43	83	3.43	50	3.3	14	1.8
Education	1442	17.8	278	16	222	13.6	414	17.1	356	23.4	172	22.1
Public Admin.	788	9.74	133	7.6	95	5.82	263	10.9	189	12.4	108	13.9
Health	872	10.8	195	11	149	9.12	270	11.1	135	8.9	123	15.8
Agriculture	163	2.01	35	2	26	1.59	43	1.77	41	2.7	18	2.3
Financial sector	181	2.24	33	1.9	38	2.33	66	2.72	34	2.2	10	1.3
Information and Communication	209	2.58	49	2.8	43	2.63	63	2.6	39	2.6	15	1.9
Other	1774	21.9	425	24	441	27	500	20.6	283	18.6	125	16.1
	8094	100	1742	100	1633	100	2423	100	1519	100	777	100

Finally, Table 8 highlights another possible problem faced by doctors in Italian regions: the mismatch between competencies and actual job duties. In particular, we created a cross table using two questions of the ISTAT survey. The table reports the answers to a question that asked the employed doctors if their title of study was: i) explicitly required

for getting the job; ii) not required but considered a preferential title; or iii) completely not required. We crossed these answers with the responses to another question, in which doctors were asked to assess if their competencies were actually needed to accomplish their job duties.

Table 8: The mismatch between competencies and actual job duties ot Italian PhDs

		PhD actually necessary for doing the job?				
		Yes		No		Tot (% w.r.t. n. of employed doctors in the area)
	PhD Required for getting the job?		% w.r.t. row total		% w.r.t. row total	
NE	Yes	625	90.71	64	9.29	689 (39.48)
	No, but appreciated	256	38.91	402	61.09	658 (37.71)
	No	13	3.27	385	96.73	398 (22.81)
NW	Yes	749	92.01	65	7.99	814 (38.43)
	No, but appreciated	322	37.27	542	62.73	864 (40.79)
	No	20	4.55	420	95.45	440 (20.77)
C	Yes	691	89.39	82	10.61	773 (33.64)
	No, but appreciated	396	40.37	585	59.63	981 (42.69)
	No	24	4.41	520	95.59	544 (23.67)
S	Yes	484	90.47	51	9.53	535 (36.72)
	No, but appreciated	281	45.77	333	54.23	614 (42.14)
	No	20	6.49	288	93.51	308 (21.14)
IS	Yes	319	93.82	21	6.18	340 (41.31)
	No, but appreciated	137	48.58	145	51.42	282 (34.26)
	No	11	5.47	190	94.53	201 (24.43)
OC	Yes	1,115	98.41	18	1.59	1133 (72.35)
	No, but appreciated	132	42.04	182	57.96	314 (20.05)
	No	8	6.72	111	93.28	119(7.60)

First of all, in all the Italian areas, about 20% of doctors had a job for which their title of study was neither required nor a preferential title. Note that the situation was very different for Italian doctors who were currently working in other countries. Indeed, only 7.6% had a job for which the doctorate was not required or appreciated by the employer. At least among those who got a job for which the PhD was explicitly required, the vast majority (about 90% in all areas) declared that their skills were actually needed to

accomplish their job duties. Again, this percentage rose to 98.4% for the emigrated doctors.
When the doctorate was appreciated by the employer even though not explicitly required, more than half of the doctors did a job for which their skills were not needed (in this case the result was very similar for the Italian doctors in other countries). The fact that this percentage was higher in the north than in the rest of the country could suggest an eventual exploitation by the employers in the latter part of the country. In order to lower employees' wages, they may tend to offer contracts that do not formally recognize the high skill requirements of the job. However, we remark that this is only a hypothesis and that more investigation is needed on this point.

3.2 Methodology

Having presented this general picture of the direction of the mobility flows, we will focus on the movement from one region (NUTS 2) to another. To correct for the above-mentioned problem of also classifying those small movements from one province to an adjacent one (but located in another region) into mobility, we created three dummy variables, defined as follows:

BA_mover =1 when an individual obtained his/her university degree in a region (NUTS 2) that differed from his/her region of origin, with the exception of those who moved to another province (NUTS 3) located in another region (NUTS 2), but one geographically adjacent to the province of origin..
BA_mover =0 when an individual obtained his/her degree in his/her region of origin or moved to a province (NUTS 3) which belongs to another region (NUTS 2), but one geographically adjacent to the province of origin (e.g., Rimini and Pesaro-Urbino, Messina and Reggio Calabria, Piacenza and Pavia, Isernia and Frosinone, Aosta and Turin).
PhD_mover =1 when an individual obtained his/her PhD in a region that differed from the region where he/she got his/her university degree, with the exception of those who moved to another province (NUTS 3) located in another region (NUTS 2), but one geographically adjacent to the province in which he/she got his/her degree.
PhD_mover =0 when an individual obtained his/her PhD in the same region where he/she got his/her university degree or moved to a province (NUTS 3) which belongs to another region, but one geographically adjacent to the province where he/she got his/her university degree.
PostPhD_mover =1 when an individual relocated to a region different from that in which he/she obtained his/her PhD, with the exception of those who moved to another province (NUTS 3) located in another region (NUTS 2), but one geographically adjacent to the province in which he/she got his/her PhD.
PostPhD_mover =0 when an individual remained in the same region where he/she got his/her PhD or moved to a province (NUTS 3) which belongs to another region, but one geographically adjacent to the province where he/she got his/her PhD.

Finally, all the dependent variables were set to zero if the individual i, after all the

movements (for the degree or for the PhD), returned to his/her region of origin (i.e., the region in which he/she lived before university); in other words, we excluded back movers. Therefore, we were not interested in those who moved mainly to acquire skills and competencies that were subsequently utilized in their places of origin, but focused on those who definitively relocated, meaning they represented a loss of human capital for their region of origin (at least within the time window that we were able to observe). We focused on Italian PhDs, thus excluding from the sample all those who obtained an Italian PhD (376 individuals) after obtaining a university degree in another country, as well as 95 other PhDs who moved to Italy to obtain their university degree, since for all these individuals, we did not have variability in the modalities of the dependent variable PhD_mover or BA_mover.

These three dummy variables were used as dependent variables in a recursive trivariate probit model as follows:

$$Pr = (y_1 = 1, y_2 = 1, y_3 = 1|x_1, x_2, x_3) = \Phi_3(x_1'\beta_1, x_2'\beta_2 + \theta y_1, x_3'\beta_3 + \delta_1 y_1 + \delta_2 y_2, \rho_{12}, \rho_{13}, \rho_{23}) \quad (1)$$

where y_1, y_2, y_3 are, respectively, BA_mover, PhD_mover, PostPhD_mover; x_1,x_2,x_3 are the set of explanatory variables inserted into each equation and θ_3 is the trivariate standard normal cdf. In addition, note that y_1 and y_2 also appear in the r.h.s of the equation explaining the probability of $y_3 = 1$. Accordingly, we wanted to verify whether being a 'mover' during the PhD or during the university degree increased the probability of also moving during the post-doc phase. In a similar vein, we also tested whether the probability of moving to obtain the PhD was in turn influenced by the previous choice of mobility. The error terms among the three equations could be correlated, as they originated from the same individual.

The explanatory variables included individual characteristics (e.g., gender, age, type of high school) and a dummy for the region of departure. This means that in the equation estimating the probability of moving to obtain a university degree, the regional dummy associated with individual i captured the region in which individual i lived before starting his/her studies; in the equation estimating the probability of moving to obtain a PhD, the regional dummy for individual i captured the region in which the university degree was obtained by i. Finally, in the equation in which PostPhD_mover is the dependent, the regional dummy of individual i captured the region in which his/her PhD was obtained. The names attributed to the other explanatory variables are for the large part self-explanatory, so we refer the reader to the results section for the complete list of regressors included in each equation.

The ρ terms are generally interpreted as the correlation between the outcomes after the influence of the included factors is accounted for, so the eventual significance of the parameter is interpreted as evidence of the fact that the two choices are not independent. However, as recently underlined by Filippini et al. (2018), this interpretation could be misleading when the true model is recursive. Indeed, in these cases, the correlation between outcomes is captured by the parameter associated with the endogenous binary variable and when we are not able to reject the null that $\rho = 0$, we must conclude that there is a correlation between the error terms of the equations and not directly among the

outcome variables. Furthermore, when the true model is recursive but a non-recursive model is estimated, then even when the ρ parameters turn out to be zero, this is not indicative of the fact that the choices are independent, since, as shown by Filippini and colleagues, the ρ parameter is a weighted average between the correlation of the binary outcome variables and the correlation between the error terms; hence when these two correlations have opposite signs, they may cancel each other out.
The three equations model was estimated by the simulated maximum likelihood (SML) method. In particular, the estimator used the Geweke-Hajivassiliou-Keane (GHK) simulator to assess the three-dimensional normal integrals in the likelihood function (for details, see Greene 2000). As suggested by Cappellari and Jenkins (2003), we set the number of draws for the simulation as equal to the square root of the number of observations.

4 Results

Table 9 reports the results of the estimation of equation 1. In particular, columns 1,2,3 report, respectively, the results associated with BA_mover, PHD_mover and Post-PHD_mover.

Table 9: The determinants of PhD movements. A recursive trivariate probit.

	(1) BA_mover	(2) PhD_mover	(3) PostPhD_mover
Gender=female	-0.059* (0.029)	-0.005 (0.031)	-0.126*** (0.023)
Type of secondary school			
Scientific lyceum	-0.125*** (0.032)	.	.
Linguistic lyceum	-0.038 (0.092)	.	.
Human Sciences lyceum	-0.155 (0.093)	.	.
Artistic lyceum	-0.065 (0.161)	.	.
Technical college	-0.329*** (0.052)	.	.
Vocational college	-0.221 (0.121)	.	.
Classical lyceum	Ref.	.	
Family background			
Father_low_educated	-0.099** (0.035)	.	.
Father_high_educated (university level)	0.030 (0.034)	.	.
Father_high_school	Ref.	.	.
Region of origin/degree/PhD			
Abruzzo (South)	1.273*** (0.086)	0.094 (0.115)	0.423*** (0.078)
Basilicata (South)	1.996*** (0.111)	0.025 (0.259)	0.738*** (0.141)
Calabria (South)	1.475*** (0.076)	0.178 (0.113)	0.425*** (0.076)
Campania (South)	0.289*** (0.071)	0.155* (0.063)	0.342*** (0.047)
Molise (South)	2.079*** (0.138)	-0.155 (0.334)	0.761*** (0.164)
Apulia (South)	1.293*** (0.067)	0.178* (0.079)	0.067 (0.057)
Sardinia (Islands)	0.701*** (0.092)	0.337*** (0.096)	-0.151 (0.084)
Sicily (Islands)	0.491*** (0.070)	0.149* (0.067)	0.107* (0.050)
Tuscany (Center)	0.127 (0.086)	-0.058 (0.067)	0.311*** (0.045)
Marche (Center)	1.172*** (0.086)	-0.026 (0.114)	0.351*** (0.069)
Umbria (Center)	0.567*** (0.113)	0.252* (0.104)	0.370*** (0.080)
Emilia R. (North E)	0.312*** (0.081)	0.197** (0.063)	0.248*** (0.048)

Table 9: The determinants of PhD movements. A recursive trivariate probit.

	(1) BA_mover	(2) PhD_mover	(3) PostPhD_mover
Friuli V. G. (North E)	0.774*** (0.097)	0.166 (0.104)	0.364*** (0.067)
Trentino A. A. (North E)	1.304*** (0.119)	0.174 (0.148)	0.156 (0.102)
Veneto (North E)	0.588*** (0.075)	0.241*** (0.067)	0.188*** (0.051)
Liguria (North W)	0.855*** (0.091)	-0.101 (0.119)	0.090 (0.078)
Lombardy (North W)	0.277*** (0.070)	-0.023 (0.060)	-0.027 (0.044)
Piedmont&Aosta V. (North W)	0.425*** (0.083)	-0.008 (0.083)	0.031 (0.056)
Latium (Center)	Ref.	Ref.	Ref.
Age at the un. Degree/ PhD	.		
25 - 29 years old	.	-0.050 (0.034)	Ref.
30 - 34 years old	.	-0.258*** (0.071)	-0.130*** (0.026)
$\geq$ 35 years old	.	-0.662*** (0.184)	-0.182*** (0.033)
$<$ 25 years old	.	Ref.	.
Final grade at the univ. degree			
104/110 - 107/110	.	-0.041 (0.060)	.
108/110 - 110/110	.	0.001 (0.048)	.
<104/110	.	Ref.	.
Scientific area of the PhD			
Comp. Sc.& Math.	.	0.372*** (0.093)	0.251*** (0.068)
Physical Sc.	.	0.544*** (0.078)	0.311*** (0.060)
Chemistry	.	0.040 (0.086)	-0.078 (0.056)
Earth Science	.	0.130 (0.122)	0.103 (0.076)
Biology	.	0.247*** (0.071)	0.123* (0.048)
Medicine	.	0.103 (0.067)	-0.023 (0.045)
Agrarian And Veterinary Science	.	0.056 (0.083)	-0.047 (0.055)
Civil Engineering And Architecture	.	0.037 (0.081)	0.074 (0.052)
Industrial and Information Eng.	.	Ref.	Ref.
Antiq., phil.gy, lit. st., Art hist.	.	0.345*** (0.071)	0.245*** (0.049)
Hist., phil., pedag. psych.	.	0.223** (0.073)	0.255*** (0.048)
Law Studies	.	0.327*** (0.074)	0.317*** (0.052)
Economics and Statistics	.	0.450*** (0.076)	0.315*** (0.056)
Political and Soc. Sc.	.	0.364*** (0.092)	0.125 (0.068)
Occupational status			
Term-contract worker	.	.	-0.197*** (0.046)
Occasional worker			-0.175** (0.072)
Autonomous worker			-0.248*** (0.035)
Post-doc			-0.174*** (0.029)
Not Working	.	.	-0.191*** (0.043)
Dependent worker	.	.	Ref
Visiting Graduate Student in OC			
Yes, mandatory in my PhD	.	.	0.256*** (0.042)
Yes, not mandatory	.	.	0.279*** (0.027)
Yes, not mandatory and self-financed	.	.	0.360*** (0.041)
No	.	.	Ref.
Civil status			
Single	.	.	-0.011 (0.058)
Married	.	.	-0.163*** (0.057)
Separated	.	.	Ref.
Do you have children? -Yes	.	.	-0.119*** (0.029)

Table 9: The determinants of PhD movements. A recursive trivariate probit.

	(1) BA_mover	(2) PhD_mover	(3) PostPhD_mover
PhD_mover	.	.	0.834*** (0.082)
BA_mover	.	0.583*** (0.106)	0.231*** (0.060)
_cons	-1.669*** (0.062)	-1.774***(0.085)	-0.566*** (0.076)
ρ_{12}	-0.013(pval 0.829)		
ρ_{13}	0.040 (pval 0.192)		
ρ_{23}	0.063 (pval 0.066)		
N	15,849		

Standard errors in parentheses; Graduated in Other countries and people coming from other countries for obtaining an Italian university degree are excluded from the sample.
Survey weights (provided by Istat) are used to ensure representativeness.
* p < 0.05, ** p < 0.01, *** p < 0.001

First of all, note that the final N used in the analysis is the result of the exclusion of the above-mentioned 471 individuals who moved to Italy from other countries and of two individuals for whom the region in which the university degree was obtained was unknown.

5 Discussion

Considering our results, note that the choice of moving after a PhD seems to be highly correlated with previous choices of mobility. Those who moved to obtain their university degree were also more likely to move in a later stage of their life. Various explanations can be formulated to interpret these findings. For instance, according to Cutillo and Ceccarelli (2012), movers are likely to be more motivated and able than their peers. Hence, there exists a self-selection mechanism which induces more able individuals to move in all the stages of their lifecycles. However, it should be noted that if one is willing to accept the idea that the final grade obtained at university reflects, at least in part, ability, then our results suggest that there is no statistically significant difference between individuals who obtained a grade lower than 104/110 and those who obtained a grade higher than 108/110. Furthermore, even excluding that grades are good indicators of ability, one should expect that ability should end up in the error terms of our system of equations. This means that if ability is driving the choices of Italian PhDs, then all the ρ parameters should be positive and statistically significant. On the contrary, in one case we found that ρ_{12} (the correlation between the error terms in the equation explaining the mobility for degree and the mobility for PhD) was negative while not statistically different from zero. Moreover, the parameter ρ_{13} was not statistically significant. The parameter ρ_{23}, capturing the correlation between mobility for PhD and mobility after PhD, was very close to zero (0.06) and only weakly statistically significant (at the 10% level). As such, there is little evidence to sustain the 'unobserved ability' explanation. It must be remarked that the sample of Cutillo and Ceccarelli (2012) included graduated individuals and did not focus on doctors of philosophy. Hence, it is plausible that since we are focusing on all those who have successfully completed their doctoral studies, we

are picking the 'cherries' among the graduate population. Therefore, at least in principle, we have a lower degree of heterogeneity in the level of ability with respect to the sample used by Cutillo and Ceccarelli.

Other important elements for explaining mobility highlighted by the literature are the characteristics (e.g., job opportunities, location amenities, quality of life) of both the places of departure and places of arrival (Greenwood, 1997). The economic divide between Northern and Southern Italy is not a new story, high-qualified individuals therefore have more chances of finding a good job match when they move from the south to the north of the country. In addition, the performance-based funding mechanisms which give economic premiums to those universities that are able to attract students will make Northern Italian universities increasingly attractive by increasing the possibilities that these universities can hire new talent. In our analysis, we used a central region, Latium, as a reference, since this is where the largest Italian public university is located (University "La Sapienza" of Rome), it has the second-largest total number of universities (after Lombardy), the main Italian Institutes of Research have their headquarters in Rome (e.g., the Consiglio Nazionale delle ricerche, ISTAT, Bank of Italy) and it is the region where the central offices of the public administration are located. Hence, this region should be one of the most attractive for new PhDs. In line with this view, only PhDs from northern regions, such as Lombardy, Piedmont, Liguria and Trentino Alto Adige, were as likely as PhDs from Latium to move after the completion of their studies. PhDs from the three north-eastern regions of Veneto, Friuli Venezia Giulia and Emilia Romagna had a greater probability of moving after their PhD. If we take the number (per million inhabitants) of high-tech patent applications to the European Patent Office as a proxy for the intensity in R&D activities, we see that Piedmont, Liguria, Lombardy and the two autonomous provinces of Trentino Alto Adige (Bolzano and Trento) indeed stand out with respect to other Italian regions (see Table 10). Therefore, it is not surprising that these regions are the most attractive to researchers. The PhDs from the other central and southern Italian regions seem to be characterized by a higher probability of moving with respect to Latium, with two exceptions: Apulia and Sardinia[4]. However, it must be remarked that in both these regions individuals tend to anticipate moving both in the undergraduate phase (especially Apulia) and when studying for a PhD (especially Sardinia).

Looking at the results associated with other individual-level variables, there are no surprises. As usual in this kind of study, males tended to move more frequently than females. Being married and having children was negatively correlated with the probability of having changed region after the PhD (Ermini et al., 2019). We included the controls for civil status and parental status only in the last equation, since the average age at first marriage and at first birth in Italy is among the highest in Europe (according to Eurostat, 35 years old for marriage and 31.1 years old for women at first birth) [5]. The

[4]Hall et al. (1986) concluded that the number of patents applications reflects current R&D activity. However, it should be noted that it reflects only a part of those research projects that have ended up in a patent application and not all the research fields have the same propensity to apply for patents. Therefore, our proxies may simply reflect the geographical concentration of research sectors.

[5]https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190318-1.

Table 10: Applications for high-tech patents over millions of inhabitants; Italian regions.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Piedmont	11.5	17.4	22.6	21.8	21.9	20.3	14	17.1	12.2	7.4	13.6
Aosta Valley	25.2	51.7	8.3	8.2	48.8	41.7	NA	13.3	42.3	17.8	14.1
Liguria	11.5	5.2	9	8.8	10.1	12.8	18.8	22.4	13.9	17.6	20.3
Lombardy	18.6	25.6	19.3	18.2	18.8	16.8	14	12.3	12.7	10.2	9.8
Bolzano	NA	5	1.4	2.7	9.3	7.3	5.6	4.1	15.7	5.4	12
Trento	NA	10.4	6.2	2.1	13.2	4.4	9.4	2.1	14.1	4.5	6
Veneto	3.6	4.1	4.5	5.1	6.1	5.9	6.6	4.2	8.5	6.4	6
Friuli-Venezia Giulia	6.4	5.6	5.6	9.2	11.4	8.8	5.3	10.5	10.2	20.4	8.3
Emilia-Romagna	5.5	7.3	5.6	6.8	9.6	9	10	8.4	8.9	5.8	8.7
Tuscany	11.8	8.4	8.2	5.9	7.9	4.7	10.1	8	8.4	8.5	7.5
Umbria	1.8	1.2	5.4	0.3	2.8	NA	7.4	1.6	2.1	3.1	1.9
Marche	3.8	1.7	2.5	2.6	3.4	3.8	2.7	6.7	5	2.8	5.7
Latium	9.4	7.8	11.7	8.2	12.6	9.7	8.5	10.4	7.8	10.2	6.3
Abruzzo	2.4	2.5	4.6	5.9	2.6	2.9	3.9	1.7	2	0.3	1.3
Molise	2.6	NA	NA	1.6	0.8	0.8	0.8	NA	NA	0.9	0.5
Campania	1.5	1.7	1.9	4.2	3.9	4.5	3.5	6.1	5.1	3.3	2.6
Apulia	1.2	1.4	1.2	1.4	3.3	2.1	2.1	2.6	2	2.1	1.7
Basilicata	0.6	2	5.4	1	4.6	1.4	1.6	NA	0.6	NA	0.6
Calabria	0.2	1.4	1	1.3	1.7	NA	0.5	1.1	0.3	1.1	1.1
Sicily	6.1	8	6.7	6.8	7.6	4.3	2.2	2.5	4	4.4	2.6
Sardinia	0.8	1.2	1.6	3.2	1	1.4	2.1	0.1	0.6	1.3	0.8

Source: Eurostat

ISTAT survey did not ask for the date of personal events such as marriage or childbirth; accordingly, given that 47% of our sample declared having finished their doctoral degree at between 30 and 34 years of age, our assumption was that marriage and eventually the birth of a child happened during or at the end of the PhD. Considering occupational status, 'dependent worker' was used as a reference and our results suggest that all other considered categories had a lower probability of moving after PhD. This confirms previous findings obtained by Iammarino and Marinelli (2015) for Italian graduates. In particular, they found that intraregional mobility increases the probability of graduates obtaining a good job match, especially for individuals coming from Southern Italy. A similar mechanism is possibly working for Italian PhDs, for whom it is even more difficult to locally find a job in which their skills can be fully exploited.

It also seems that those who have completed a period of formation outside Italy during the doctorate also had a higher probability of moving after the doctorate was finished, especially if this experience was self-financed, thus reflecting a higher preference for moving. Finally, considering the scientific area of the PhDs, it was found that the field of study was an important determinant of mobility, with doctors in literature, languages,

psychology or education, physics, biology, mathematics, economics and law associated with a higher probability of moving than those in engineering (all sub-fields), medicine[6], veterinary science, earth science and political science. These results contrast in part with those obtained by Cutillo and Ceccarelli (2012), according to whom engineering and economics are the fields in which mobility is more frequent. However, we want to underline once more the difference between Cutillo and Ceccarelli's sample and our data. For instance, it is likely that an informatics graduate who does not continue his/her studies in a PhD is more interested in an operative (generally better paid) job in the private sector than in the theoretical aspects of computer programming. Accordingly, it is possible that in this field the job search efforts of graduates are more intense and more extensive from a geographical point of view than those who continue to do a PhD.

6 Conclusions

Recently, a new tradition seems to have emerged in Italy in that every time a new ISTAT report on the working conditions of high-qualified individuals is published, a heated public debate about la *fuga dei cervelli* (the brain drain) is reopened. Each time, concerns are expressed for the waste of human capital and for the widening of disparities between Northern Italy (net receiver of human capital from other areas of the country) and Southern Italy (net sender); however, this debate is little more than a flash in the pan. After a few weeks, the debate subsides and other issues become priorities on the political agenda. Even if the mobility of HSWs and HEWs can be interpreted as a positive issue (Morano-Foadi, 2005), particularly the domestic mobility that can help to match jobs and skills, the emergence of a clear path between areas of the country highlights the risks of a drain of human capital from areas with low development to more developed ones.

In this paper, we investigated an aspect of this problem by focusing on a category of high skilled individuals who have been almost neglected by the literature, the PhDs. By analysing PhDs, the paper aimed to focus on a specific group of highly-trained individuals in order to observe their pattern of mobility. The 2014 ISTAT survey on the working conditions of Italian PhDs was used to accomplish this investigation. It was found that 33% and 27% of PhDs from Southern Italy and from the Islands, respectively, relocated to another macro-area after the completion of their doctorate. In addition to the movement of PhDs from Southern to Northern Italy, even in the latter area, about the 15% of PhDs belonging to the 2008 and 2010 cohorts worked outside Italy six and four years, respectively, after the end of their studies. However, at least in this area, this loss of human capital was in part compensated by incoming PhDs from the southern part of the country. Our individual-level analysis confirms the pattern already observed for undergraduate students (D'Agostino et al., 2019). The PhDs coming from Southern and Central Italy (with the exception of Latium) were those who were more likely to move after the completion of the doctorate. These results seem to confirm the propensity of

[6]This works analyses only data about PhDs, since no data about post-graduate students in others formative paths (e.g. medical doctors who attend *"scuole di specializzazione"*) are available.

HSWs to widen their job market in order to achieve higher job matching opportunities and thus limit overeducation (Büchel and van Ham, 2003).
Two exceptions were Apulia and Sardinia; however, for both regions, the results of our analysis suggest that the movement was simply anticipated during the undergraduate or post-graduate phase. This conclusion seems to be consistent with the human capital theory of education, since students from those regions tried to increase the benefit of their education by anticipating their moves. A partly unexpected result is also that PhDs from Veneto (the Italian region with the second highest GDP after Lombardy) tended to move more readily than other northern PhDs. However, these movements were mainly directed towards the north-western regions or outside Italy. If mobility is to some extent natural for high-qualified individuals (Ermini et al., 2019), the fact that Italian flows are unilateral and also involve people who have reached the maximum level of education in the country should deserve more attention from the policymakers in Italy since it could lead to a wider gap in economic and social development throughout the country. At the opposite end, as recently argued by D'Agostino et al. (2019), the fact that the Italian public university funding mechanism is partially based on the number of enrolled students could further exacerbate this situation by creating a vicious circle. Since the southern universities have low chances to attract students from more developed regions, they will receive fewer resources and subsequently will be less able to retain talents in which they have invested, and thus they become progressively less competitive both in teaching and in research, which in turn makes them less attractive to students and so forth.
A limitation of this work is that we were able to observe the two cohorts of PhDs only four and six years after the completion of their doctoral studies. Hence, we cannot exclude that they will return to their place of origin after a temporary experience in another region. However, as recently pointed out by Fiaschi and Tealdi (2018), Italian back migration seems to particularly involve low-educated individuals during the age of retirement. This seems to also be confirmed by the results obtained by the Master and Back programme realised in Sardinia. This programme, which shares the underlying assumption of human capital theory was established to proivde financial help to Sardinian graduates willing to continue their studies in post-graduate programmes outside Sardinia, with the idea that these individuals would return to the island with new skills and competencies to foster an increase of the productivity and wellness of the region. Indeed, the report assessing the effects of this programme highlights that a large proportion of those who have benefitted from it (more than 60%) have not returned to Sardinia, mainly because the local labour market has not been able to absorb them [7].
Considering these pieces of evidence, it is tempting to conclude that migration from Southern to Northern Italy tends to be definitive; however, more research is needed to clarify this point.

[7] https://www.sardegnaprogrammazione.it/documenti/35_528_20150917105314.pdf

References

Ballarino, G. and Colombo, S. (2010). Occupational outcomes of PhD graduates in Northern Italy. *Italian Journal of Sociology of Education*, pages 149–171.

Bauer, T. K. and Kunze, A. (2004). The Demand for High-Skilled Workers and Immigration Policy. SSRN Scholarly Paper ID 500902, Social Science Research Network, Rochester, NY.

Büchel, F. and van Ham, M. (2003). Overeducation, regional labor markets, and spatial flexibility. *Journal of Urban Economics*, 53(3):482–493.

Becker, G. S. (1983). *Human capital: a theoretical and empirical analysis, with special reference to education*. Midway Reprint. The Univ. of Chicago Pr, Chicago, 2. ed ; repr edition.

Becker, G. S. (2009). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. University of Chicago Press, Chicago.

Blaug, M. (1976). The Empirical Status of Human Capital Theory: A Slightly Jaundiced Survey. *Journal of Economic Literature*, 14(3):827–855.

Boeri, T., Brücker, H., Docquier, F., and Rapoport, H., editors (2012). *Brain drain and brain gain: the global competition to attract high-skilled migrants*. Reports for the Fondazione Rodolfo Debenedetti. Oxford University Press, Oxford, 1st ed edition.

Borjas, G. J., Bronars, S. G., and Trejo, S. J. (1992). Self-selection and internal migration in the United States. *Journal of urban Economics*, 32(2):159–185.

Burke, J. C., Rosen, J., Minassians, H., and Lessard, T. (2000). Performance Funding and Budgeting: An Emerging Merger? The Fourth Annual Survey (2000).

Cappellari, L. and Jenkins, S. P. (2003). Multivariate Probit Regression using Simulated Maximum Likelihood. *The Stata Journal: Promoting communications on statistics and Stata*, 3(3):278–294.

Cattaneo, M., Malighetti, P., Meoli, M., and Paleari, S. (2017). University spatial competition for students: the Italian case. *Regional Studies*, 51(5):750–764.

Chan, S.-J. and Lin, L.-W. (2015). Massification of higher education in Taiwan: Shifting pressure from admission to employment. *Higher Education Policy*, 28(1):17–33.

Ciriaci, D. (2014). Does University Quality Influence the Interregional Mobility of Students and Graduates? The Case of Italy. *Regional Studies*, 48(10):1592–1608.

Clark, B. R. (1979). The many pathways of academic coordination. *Higher Education*, 8(3):251–267.

Cutillo, A. and Ceccarelli, C. (2012). The internal relocation premium: are migrants positively or negatively selected? Evidence from Italy. *Journal of Applied Statistics*, 39(6):1263–1278.

D'Agostino, A., Ghellini, G., and Longobardi, S. (2019). Out-migration of university enrolment: the mobility behaviour of Italian students. *International Journal of Manpower*, 40(1):56–72.

Degli Esposti, M. and Geraci, M. (2010). Thirty Years of Higher-education Policy in

Italy: Vico's Ricorsi and Beyond? *Bulletin of Italian Politics*, 2(2):111–122.

Di Cintio, M. and Grassi, E. (2017). International mobility and wages: an analysis of Italian Ph.D. graduates. *The Annals of Regional Science*, 59(3):759–791.

Dolton, P. and Vignoles, A. (2000). The incidence and effects of overeducation in the UK graduate labour market. *Economics of education review*, 19(2):179–198.

Donina, D., Meoli, M., and Paleari, S. (2015). Higher education reform in Italy: Tightening regulation instead of steering at a distance. *Higher Education Policy*, 28(2):215–234.

Donina, D. and Paleari, S. (2019). New public management: global reform script or conceptual stretching? Analysis of university governance structures in the Napoleonic administrative tradition. *Higher Education*, 78(2):193–219.

Dotti, N. F., Fratesi, U., Lenzi, C., and Percoco, M. (2013). Local Labour Markets and the Interregional Mobility of Italian University Students. *Spatial Economic Analysis*, 8(4):443–468.

Dougherty, K. J., Jones, S. M., Lahr, H., Natow, R. S., Pheatt, L., and Reddy, V. (2014). Performance Funding for Higher Education: Forms, Origins, Impacts, and Futures. *The ANNALS of the American Academy of Political and Social Science*, 655(1):163–184.

D'Uggento, A. M., Ricci, V., and Toma, E. (2016). An indicator proposal to evaluate research activities based on Scimago Institutions Ranking (SIR) data: an application for Italian high education institutions. *Electronic Journal of Applied Statistical Analysis*, 9(4).

Ermini, B., Papi, L., and Scaturro, F. (2019). Wage returns to interregional mobility among Ph.D graduates: Do occupations matter? *Papers in Regional Science*, 98(2):995–1025.

Ezza, A., Fadda, N., Pischedda, G., and Marinò, L. (2019). Il "grande gap": gli effetti del performance budgeting sulle politiche di reclutamento delle Università italiane. *MANAGEMENT CONTROL*, (2):99–121.

Ezza, A., Pischedda, G., and Marinò, L. (2017). Performance-Based Funding In Public Competition. Lights And Shadows In The Italian Higher Education System. *Journal of International Business and Economics*, 17(2):5–22.

Farhan, B. Y. (2016). Competitive Behaviour in Publicly Funded Academic Institutions. *Interchange*, 47(4):357–373.

Fiaschi, D. and Tealdi, C. (2018). Some Stylized Facts on Italian Inter-regional Migration. *Discussion Paper n. 231, Collana di E-papers del Dipartimento di Economia e Management – Università di Pisa*, (231):13.

Filippini, M., Greene, W. H., Kumar, N., and Martinez-Cruz, A. L. (2018). A note on the different interpretation of the correlation parameters in the Bivariate Probit and the Recursive Bivariate Probit. *Economics Letters*, 167:104–107.

Frank, R. H. and Cook, P. J. (2010). *The winner-take-all society: Why the few at the top get so much more than the rest of us*. Random House.

Gaeta, G. L. (2015). Was it worth it? An empirical analysis of over-education among PhD recipients in Italy. *International Journal of Social Economics*, 42(3):222–238.

Geraci, M. and Degli Esposti, M. (2011). Where do Italian universities stand? An in-depth statistical analysis of national and international rankings. *Scientometrics*, 87(3):667–681.

Glennerster, H. (1991). Quasi-markets for education? *The economic journal*, 101(408):1268–1276.

Greenwood, M. J. (1997). Chapter 12 Internal migration in developed countries. In *Handbook of Population and Family Economics*, volume 1, pages 647–720. Elsevier.

Iammarino, S. and Marinelli, E. (2015). Education–Job (Mis)Match and Interregional Migration: Italian University Graduates' Transition to Work. *Regional Studies*, 49(5):866–882.

Jackman, R. and Savouri, S. (1992). Regional Migration in Britain: An Analysis of Gross Flows Using NHS Central Register Data. *The Economic Journal*, 102(415):1433–1450.

Jeon, J. and Kim, S. Y. (2018). Is the gap widening among universities? On research output inequality and its measurement in the Korean higher education system. *Quality & Quantity*, 52(2):589–606.

Jongbloed, B. (2004). Funding higher education: options, trade-offs and dilemmas. *Centre for Higher Education Policy Studies*.

Jongbloed, B. and Vossensteyn, H. (2016). University funding and student funding: international comparisons. *Oxford Review of Economic Policy*, 32(4):576–595.

Keeling, R. (2006). The Bologna Process and the Lisbon Research Agenda: the European Commission's expanding role in higher education discourse. *European Journal of Education*, 41(2):203–223.

Lagravinese, R. (2015). Economic crisis and rising gaps North-South: evidence from the Italian regions. *Cambridge Journal of Regions, Economy and Society*, 8(2):331–342.

Layzell, D. T. (1999). Linking performance to funding outcomes at the state level for public institutions of higher education: Past, present, and future. *Research in Higher Education*, 40(2):233–246.

Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., and Taylor, J. E. (1993). Theories of International Migration: A Review and Appraisal. *Population and Development Review*, 19(3):431.

McKeown, M. P. (1996). *State Funding Formulas for Public Four-Year Institutions.* SHEEO-State Higher Education Executive Officier, Denver.

Merton, R. K. (1968). The Matthew effect in science: The reward and communication systems of science are considered. *Science*, 159(3810):56–63.

Morano-Foadi, S. (2005). Scientific mobility, career progression, and excellence in the european research area1. *International migration*, 43(5):133–162.

Moscati, R. (2001). Italian university professors in transition. *Higher Education*, 41(1-2):103–129.

Moss, D. (2012). When Patronage Meets Meritocracy: Or, The Italian Academic Con-

corso As Cockfight. *European Journal of Sociology / Archives Européennes de Sociologie*, 53(2):205–231.

OECD (2004). *Local Economic and Employment Development (LEED) Global Knowledge Flows and Economic Development*. OECD Publishing. Google-Books-ID: amjWAgAAQBAJ.

Rossi, P. (2015). Il Punto Organico: una storia italiana. *RT. A Journal on Research Policy and Evaluation*, 3(1).

Ruiu, G. and Ruiu, M. L. (2019). The Complex Relationship Between Education and Happiness: The Case of Highly Educated Individuals in Italy. *Journal of Happiness Studies*, 20(8):2631–2653.

Rystad, G. (1992). Immigration History and the Future of International Migration. *The International Migration Review*, 26(4):1168–1199.

Schultz, T. W. (1971). *Investment in human capital: the role of education and of research*. Free Press, New York.

Sjaastad, L. A. (1962). The costs and returns of human migration. *Journal of political Economy*, 70(5, Part 2):80–93.

Solimano, A. (2008). *The international mobility of talent: types, causes, and development impact*. Oxford University Press, Oxford; New York.

Straubhaar, T. (2000). International mobility of the highly skilled: Brain gain, brain drain or brain exchange. Technical report, HWWA Discussion Paper.

Tuccio, M. (2019). Measuring and assessing talent attractiveness in OECD countries. OECD Social, Employment and Migration Working Papers 229.

Verdugo, R. R. and Verdugo, N. T. (1989). The impact of surplus schooling on earnings: Some additional findings. *Journal of Human Resources*, pages 629–643.

Woolf, S. (2003). On University Reform in Italy: Contradictions and Power Relations in Structure and Function. *Minerva*, 41(4):347–363.