The education-job mismatch among Italian PhD graduates

Francesca Gallo, Emiliano Mandrone[1]

Istat

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1. Introduction

The constant growth in the average levels of education tends to have positive effects on the labor market, increasing the demand for qualified occupations and the potential growth in the overall productivity of the economic system. The complexity that awaits us, the rapid technological change, the effects of cultural integration and the digital innovations encourages companies to undertake product and process innovation strategies and to invest in more advanced technologies. However, in our country a supply of skilled labor force that is not adequately absorbed by the market generates mismatches between labor supply and demand and negative implication (brain drain, low productivity).

The over-skilling occurs when the skill of workers is higher than the one required by a given occupation. This phenomenon has assumed an increasing dimension and it is apparently not compatible with today's knowledge society. The over-education becomes a *social matter* because leads the under-utilization of our best human capital.

In recent years, the under-utilization of human capital have raised growing concern both in Italy and in Europe given the negative effects both on the economic and social investment returns at individual and collective level (Oecd, 2016). In particular, a productive system such as the Italian one, characterized by a high fragmentation and traditional activities, often seems unable to offer an adequate number of qualified jobs and suitable career progressions, bringing more and more individuals, especially the most educated youth, to migrate abroad.

On the other hand, we are witnessing the paradox that firms find it difficult to engage qualified workforce suitable to their production needs. This highlights on the one hand a gap between the skills required by job and those acquired in the formal educational path; on the other hand, the limits of the institutions dedicated to favoring rapid and satisfying school-to-work transitions are evident (Mandrone, 2011). It is no coincidence that recent reforms have concerned the employment services system, to strengthen the coordination of the actors involved (employment centers, schools, companies, brokerage and training companies) to reduce "displacement risks" and long times for a good match.

The paper focuses the analysis on the education-job mismatch among the PhD holders as their growing number has raised concerns about the negative consequences of their misallocation in the labour market, worsened by the saturation of the academic job market.

Drawing data from the recent survey conducted by Istat in 2018 on two PhDs cohorts, the paper aims to shed more light on the correlates and on the consequences of the mismatch.

The paper proceeds as follows. Section 2 presents a review of the relevant literature assessing the different measurement approaches developed. Section 3 provides a description of the data sources and the main descriptive statistics. Section 4 presents the method and section 5 illustrates the factors conditioning the mismatch among PhD graduates together with the consequences in terms of earnings and job satisfaction. Finally, concluding remarks follow.

2. The measurement approach to the mismatch: a literature review

The educational mismatch has important economic consequences: at the individual level, it affects the grade of job satisfaction and wages; at the firm level, it reduces productivity and increases both turnover and the search for a different job; at the macroeconomic level, it alters the degree of tolerance to unemployment and reduces GDP growth through the loss of human capital and/or the decrease in productivity (Mandrone et al., 2016). So, it is important to identify the key factors of the mismatch and to develop a widespread political strategy to reduce such negative effects.

Skills mismatch can be used to describe vertical mismatch (usually measured in terms of overeducation, undereducation, overskilling and underskilling), skill gaps, skill shortages (usually measured in terms of unfilled and hard-to-fill vacancies), field of study (horizontal) mismatch and skill obsolescence (McGuinness et al., 2018).

There is not a univocal definition of educational mismatch because there are three relevant pending issues (Quintini, 2011, Kucel, 2011 and Hartog, 2000): a) harmonize cross-country difference by economic structure and school system, b) a shared approach to estimate the human capital possessed c) the kind of the indicators used.

In the first place, the ILO has stated the necessity of enhancing the efforts to converge to a definition and a taxonomy of mismatch that is recognised at the international level. The OECD targeted at the systematization of definitions to obtain comparable measures and understand the skills mismatch in different countries, given the costs it generates and the need of designing policy measures to contain or minimize the phenomenon. The economic structure, the career profile, the average size of the companies, the education and training system make up an intricate set of information, different from country to country (Caroleo et al, 2013; 2017).

[1] F. Gallo wrote paragraphs 3,4 and 5; E. Mandrone paragraphs 1 and 2.

Secondly, the mismatch estimation approach sees formal education as a pillar (Leuven and Oosterbeek, 2011), calculated over years of study. However, the complexity of the world of work and the possible combinations makes this approximation insufficient. It should therefore be integrated with the thematic area (scientific-technical, humanistic-social, etc.), contextualised with the current legislation (types of contract, incentives, etc.) and the economic cycle (tensions on the labor market).
Moreover, in the specific case of doctoral graduates, the availability (or not) of opportunities in the Public Administration (especially in the university) is a necessary control for a correct evaluation.
This multidimensional reading makes the estimation of the phenomenon of mismatch and its cases (over-education; over-skill; geographical, monetary, time-based mismatch ...) difficult to carry out. A powerful system of weights risks flattening the results or creating paradoxical rankings (OECD, 2015).
Finally, the measurement of the phenomenon. The generally used indicators can be divided into *subjective* and *objective* measures. Few database comprehend detailed information on workers' skills and abilities and on those required by their jobs. The former category comprises of measurements obtained from workers' responses to questionnaires (self-reported) on the necessaries (direct assessment) and adequacy (indirect assessment) of their own skills and qualifications in their actual jobs. The bound of these measurements' strategies is in the systematic error introduced by the workers assessing their own occupations.
It depends on their sensibilities, their job satisfaction or on an overestimation of their own technical and cultural knowledge. In order to control for the biases introduced by self-assessments, subjective measures are typically complemented with a number of objective indicators derived from the analysis of qualifications and of years spent in education by a reference population in a given job (Franzini, Raitano, 2012).
The objective indicators stem from comparisons with other people employed in similar jobs (by digit occupational classification). This approach takes into consideration both the aspects of job satisfaction and overestimation of competences, as well as the limitations posed by rough classifications. The ISCO-based indicator is an objective one that measures the coherence of i-th individual's educational qualification looking at the correspondence between each large professional group and a given qualification, as established by ISCO. Another objective indicator, may measure the matching between the level of educational qualification of the i-th individual and the modal value of the qualification per profession. The modal value becomes the benchmark qualification for that profession (Mandrone et al., 2015).

3. Data source and descriptive statistics

The Italian National Institute of Statistics carries out the survey on PhD graduates transition to labour market interviewing doctorate holders, with the aim to detect their employment conditions some years after the PhD attainment (Istat, 2018).
The survey belongs to the system of surveys devoted to the study-to-work transition, which also includes the surveys on the university graduates and on the upper secondary school graduates' transitions to university and labour market. All these surveys focus on individuals that have completed a given level of education in a given calendar year (t).
Unlike the other surveys of the system, the one on PhD holders is not a sample survey but a total one and it is carried out on two groups of PhD graduates (cohorts).
So far, three surveys were carried out: the first one, conducted in 2010, observed the cohort 2004 (8,443 individuals) and the cohort 2006 (10,125 individuals); the second survey, carried out in 2014 interviewed the cohort 2008 (11,229 individuals) and the cohort 2010 (11,240 individuals); the 2018 survey is the last one and is devoted to the cohort 2012 (11,459 individuals) and 2014 (10,639 individuals).
The survey questionnaires aim at tracking the work experiences after the PhD, during a time lapse considered suitable for the PhD graduates to consolidate their occupational status. In order to evaluate the employment outcomes, the occupational status of the two cohorts is observed at the time of the interview, which is respectively year t+6 for the older cohorts (i.e 2004, 2008 and 2012) and year t+4 for the younger ones (i.e 2004, 2008 and 2014). Through retrospective questions, the PhD cohorts are also asked about their occupational status at the time of the PhD attainment. Moreover, while the older cohorts are asked about their occupational status three years after the PhD, the younger ones are interviewed about their employment condition one year after the PhD.
Through objective and subjective questions, a large amount of information is gathered to assess whether the occupation performed suits the previous PhD studies and if it is considered satisfactory by the PhD graduates as far as the tasks, the use of knowledge acquired, the income or the level of responsibility are concerned.
The questionnaires widen the field of observation considering many other aspects, which can somehow influence the occupational outcomes, such as the socio-economical context of the original family, the educational experiences or the mobility propensity especially towards other countries.
Data collection of the last two survey editions moved from Cati to Cawi technique, given the high propensity of the target population to use of PC and to have access to the Internet. At the same time, given the high geographical mobility of the PhD graduates, it turned out easier to reach the individuals via web rather than by phone (Istat, 2017). The PhD graduates are first contacted through a letter addressed to their residence and to their email address, presenting the purpose and the general characteristics of the survey and giving the login information to enter the web questionnaire. The availability of the email addresses make it possible to make recalls and eventually achieve an overall response rate of 72,7 % (71,3% for the 2012 cohort and 74,1 % for the 2014 cohort).

The transitions into the labour market

Four and six years since the doctorate the PhD graduates show an almost full employment condition: both the 2012 and the 2014 cohorts have an employment rate of 93.7%. However, different employment conditions are observed among the fields of study, being the PhDs in political and social sciences characterized by a lower employment rate (89.4% for both 2012 and 2014 cohorts), and the ones in industrial and information engineering the most advantaged (more than 97% of 2012 and 2014 cohorts). More than seven out of ten graduates got their job after the completion of the PhD studies. The majority (61.7%) of this set has a dependent job (36.3%

permanent and 25.4% temporary job), 20.7% carries out an activity financed by research grants, and 9.2% is self-employed while 8.5% is an occasional collaborator. The University sector employs 28.6% of the employed graduates while the Education sector the 16.1%; 15.8 % works for public or private research institutes, while one out of ten graduates is employed in the agriculture and industry sector.
The graduates who started their job after the PhD were asked their opinion on whether the doctorate was required to access the current occupation and whether the skills acquired during the doctoral course had proved necessary for the performance of the current work activities. The answers provided on these two aspects make it possible to assess the 'formal' and 'substantial' role played by the PhD title in the individual performance on the labor market. It is possible, in particular, to highlight situations of "poor formal performance", i.e. poor role of the doctorate to enter the occupation, or of "poor substantial performance", i.e. poor role of the doctorate to carry out the work tasks. The concomitant situation of poor formal and substantial performance of the title can be referred to as a 'mismatch condition' of the PhD graduate and can be considered as a proxy for the most negative case of the job-education mismatch (Gaeta 2015).

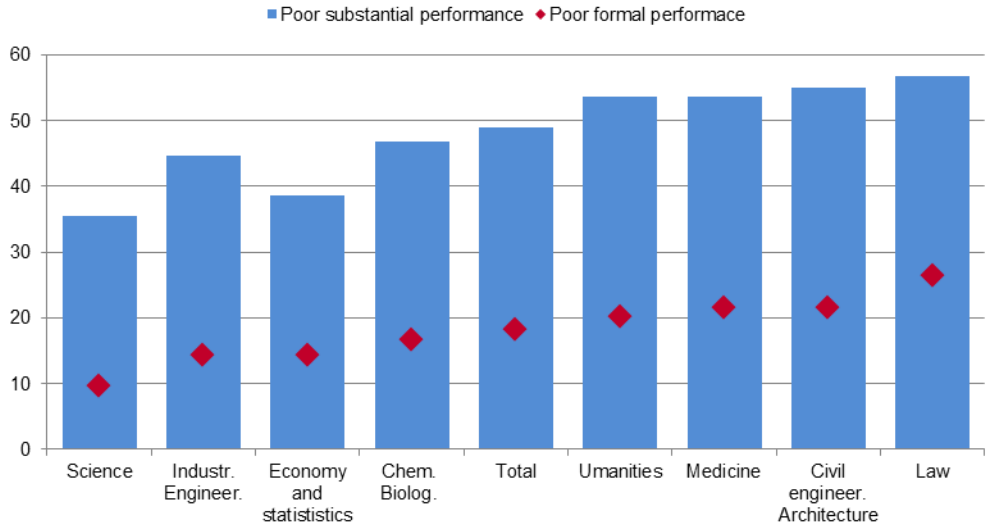
Table 1 – Employed PhD graduates (a) by their opinion on the formal and substantial performance of their PhD. 2018 (percentage values)

Was the PhD required to access the current occupation?	Is the PhD necessary to perform the current work activities?		Formal usefulness
	Yes	No	
Yes, expressly required	37.3	2.6	**39.9**
Not expressly required but helpful	12.5	29.3	**41.9**
Neither requested nor helpful	1.1	17.1	**18.2**
Substantial usefulness	**50.9**	**49.1**	**100**

Source: Istat, Indagine sull'inserimento professionale dei dottori di ricerca
(a) PhDs graduated in Italy in 2012 and 2014

The poor formal performance of the doctorate is declared by 18.2% of the respondents, while for almost half (49.1%) the title seems unnecessary for carrying out their work activities. This result is coherent with the recent literature underlining the discrepancy between the skills acquired in the educational paths, which privilege only some components of human capital, mostly the theoretical ones, rather than the skills required by the labour market (Cedefop 2015). According to this interpretation, the mismatch would express inadequacy of the individual skills to the ones required by the labor market rather than an excess of human capital.
The poor formal or substantial performance of the PhD qualification is reported differently among the graduates depending on the field of study of their PhD (Figure 1). In 2018, less than one PhD graduate out of ten declared a poor formal performance of the title if acquired in the area of mathematics, physics and computer sciences and 35.5% of the graduates in the same area expressed a poor substantial performance. The highest values are observed for the PhD graduates in legal sciences, with a percentage of poor formal and substantial performance respectively equal to 26.5% and 56.7 %.

Figure 1 – PhD graduates (a) employed after the completion of the PhD studies stating the "poor formal performance" or the "poor substantial performance" of the PhD by field of study. Year 2018 (percentage values)



Source: Istat, Indagine sull'inserimento professionale dei dottori di ricerca
(a) PhDs graduated in Italy in 2012 and 2014

About 17% of 2012 and 2014 cohorts who got their job after the completion of the PhD studies is affected by mismatch, having referred that the PhD title was neither an access requirement nor a necessary tool for carrying out the work activities.
Time comparison shows a substantial stability of the phenomenon: in 2010 the share of mismatch was 17.4% and a slightly higher share, equal to 18.8%, was instead observed in 2014 for those PhD cohorts that may have suffered the effects of the economic crisis, having started their search for work in 2008 and 2010.
Although the mismatch of the PhD graduates is not widespread, it needs however to be managed as it can contribute to nourish the brain drain phenomenon, eroding the human capital of the country who made the greatest investment. Reduced adequate job opportunities and low investments in R&D, may indeed push the most educated people to look for a job abroad: in 2018, more than 20% of the 2012 and 2014 PhD graduates worked abroad.

4. Method

In order to explore the determinants of mismatch a probit regression analysis was performed on the probability for the PhD graduates of being mismatched. Hence, the equation has a binary outcome, taking value one if the respondent is in a mismatch condition and zero otherwise.
Since the mismatch condition is only assessed for the employed PhD graduates, a bivariate probit model with sample selection (Heckman, 1979; Van de Ven et al., 1981) is estimated in order to take into account the potential bias arising from the selection process. Some unobservable individual factors (or differences in preferences) may indeed affect the probability of being mismatched and, at the same time, may be correlated with the propensity to get a job. Using a latent variable approach, the model is specified as follows:

$$y_i^* = \beta x_i + e_i$$
$$z_i^* = \gamma t_i + u_i$$

$$\begin{pmatrix} e_i \\ u_i \end{pmatrix} \sim N\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right\}$$

where y_i^* , in the main equation, is a binary variable indicating the mismatch condition for the i-th individual. In the probit sample selection y_i^* is only observed if $z_i^*>0$, being z_i^* the dependent variable in the selection equation indicating whether a respondent i is employed or not; e_i and u_i are the normally distributed error terms.
The rho coefficient indicates whether there is a correlation between the error terms of the two equations: when $\rho=\text{corr}(e_i, u_i) \neq 0$ then unobserved factors jointly affect the probability of being employed and mismatched and, as a result, the selection equation has to be taken into account in order to obtain unbiased estimates; on the contrary, when $\rho=0$ then e_i and u_i are independent and therefore the probit estimation of the first model would give consistent results.
Many independent variables were included and they can be divided into three categories:

1. Socio-demographic variables of the individual: sex, age at PhD attainment, citizenship, family background (patents' educational level and employment condition at the time of university enrollment)
2. Education background: year of PhD attainment, characteristics of the PhD course (field of study, geographical area of the university, regular length of study, financial support), final mark at the university degree;
3. Job-related variables: job tenure, economic sector, job position, place of work, R&D activities.

The three types of independent variables were included using a stepwise procedure in order to observe whether and how socio-demographic variables and education background separately affect the likelihood of being mismatched. To choose the instrumental variables, i.e the variables that do not affect the mismatch condition but do affect the employment condition, the results of some similar studies (Ermini et al., 2017) were followed and the marital status and the presence of children were included in the selection equation.
Moreover, with the purpose to investigate the correlation between the mismatch condition and wage a regression analysis was performed, modelling the logarithm of the net monthly wage as follows:

$$\text{Ln}(W_i)=\beta X_i + \gamma M_i + e_i$$

where X is a vector of control variables, M identifies the mismatch status of the respondent e is the error term and β and γ are vectors of parameters to be estimated.
Finally, the association between job mismatch and job satisfaction is analyzed. PhD graduates scale their overall job satisfaction between 0 and 10 (maximum satisfaction). A logistic regression model was estimated on the probability of being fully satisfied (judgment above or equal to 8).

5. Results

To identify the characteristics most associated with the mismatch condition of the PhD graduates who started working after the PhD, a logistic regression model was estimated, taking into consideration with a stepwise inclusion the socio-demographic characteristics, the peculiarities of the education background and the kind of the work performed.
Two immediate points emerge from the results of the stepwise analysis. First, the effect of the gender and citizenship attributes seem to be indirect as they lose importance once the job-related variables are included in the model. Second, the stepwise inclusion of the three types of independent variables did not cause marked changes in the coefficients of the three estimated models meaning that the general effect of the conditioning factors remains almost unchanged.

As far as the selection bias is concerned, the correlation estimate turns out not to be significant (rho= -0.017).
Focusing on the complete model (Table 2), the first general result is the weak impact of the socio-demographic characteristics of the PhD graduates on the mismatch condition.

Among the socio-demographic characteristics, the age at PhD attainment is the only variable showing a slight impact on the mismatch condition: the younger the PhD graduates (doctorate age below 28) the lower the probability to incur in job-education mismatch compared to older graduates (over 35 years at the doctorate). This is an expected result since the young age generally reflects a study career completed without interruption and it may associate with a perseverant attitude of the PhD graduate to finalize the education investment, getting an adequate placement in the labor market.
No significant differences are shown between recent and older cohorts of graduates on the probability to get an adequate matched job.
Social background, as proxied by parents' education and employment condition, proves not to be significantly associated with the mismatch. Furthermore, parent social class seems not to influence even the probability of getting a job as it turned out not to be significant in the selection equation.

Regarding the education background, the results report a strong positive impact of the mobility experiences carried abroad, as studying abroad for at least three months during the PhD course reduces of 26% the competitive risk of mismatch. Even though this result may hide the effect of unobserved individual features, nevertheless visiting a foreign University seems to provide more opportunities to build relational networks and to acquire useful skills for job. This is indeed confirmed by the high significant impact of international mobility even after controlling for job related variables.

The field of study of the PhD course confirms to have a moderate impact on the chance to get a job appropriate to the education path (Ortiz, 2008). When compared with the field of legal sciences, the area of political and social sciences and, to a lesser extent, the historic and psycho-pedagogic area turn out to be associated with a higher probability of mismatch (odds ratios of 1.74 and 1.39 respectively). The geographical location of the university where the PhD course was completed does not show a significant association.

The job related variables turn out to play a crucial role in determining the relative risk of mismatch. First of all, the analysis of the employment sector points out the reduced recognition of PhD title outside the academic sphere. The sector of services as well as the agriculture, industry and health sectors show a significantly higher risks of mismatch (odds-ratios above 6) if compared with the university education sector, taken as a reference. As expected, even the tasks performed in the workplace are significant determinants of the mismatch condition: in particular, PhD graduates who declared not to be involved in R&D activities show a considerably higher competitive risk (odds ratio 4.2), confirming the PhD course mandate to train for research activity.
Moreover, the mismatch phenomenon shows greater intensity for self-employed compared to permanent contractors; on the other hand, temporary jobs or research grants, although unstable kind of jobs, seem to be better-suited to the PhD path.

The analysis does not provide evidence to support the theory that interprets mismatch as a physiological and transitory phenomenon, a consequence of a job-searching strategy that leads the individual to accept the first job proposals, although not optimal, trying to improve the job position afterwards. The work tenure does not show indeed significant associations with a mismatch condition.

However, the results confirm the most favorable working conditions for the PhD graduates employed abroad, primarily in the United States and the United Kingdom (Istat, 2018). Their risk of mismatch is almost halved (odds-ratio of 0.58) compared to the colleagues who work in the South of Italy.

On the whole, the work characteristics for the PhD graduates who left Italy are more in line with the completed study path than the ones for the colleagues who stayed (Figure 2). R&D activities, which are supposed to require the skills that a doctoral education is in charge to develop and consolidate, involve 88.7% of the PhD graduates who work abroad against the 66.7% of the ones who work in Italy. Besides, the comparison of the employment sector of the two sub-populations (working abroad vs in Italy) shows a better education-job adherence for those who, after getting their doctorate in Italy, decided to migrate abroad: 43.1% works in academic field, compared to 24.7% of those who remained in Italy. Moreover, the share of the PhD graduates employed abroad in the public and private research sector is 11 points greater than the one for those employed in Italy. These evidences ultimately find a synthesis in the mismatch condition, which concerns one fifth of the PhD graduates employed in Italy and 6.5% of the ones employed abroad.

Table 2 – Logistic regression model for the dependent variable 'mismatch condition' for the PhD gradates (odds ratio) – Year 2018

SOCIO-DEMOGRAPHIC VARIABLES			***continues*** **EDUCATION BACKGROUND**	
Age at PhD (ref. >=35)			**Graduation mark (ref. 110 or 110 cum laude)**	
<=28 years	0.66	*	<=104	1.01
29-34 years	0.96		105-109	1.00
Sex (ref. Male)			**Need more time to finish PhD (ref. No)**	
Female	1.20		Yes	1.14
Citizenship (ref. Foreigner)			**Financial support (ref. Yes)**	
Italian	1.22		No	1.29
Parents' employment condition (ref. Workers)			**JOB-RELATED VARIABLES**	
Managers or entrepreneurs	0.98		**Activity sector (ref. University)**	
Professionals	1.03		Agricolture and industry	6.99 *
Clerks or self-employed without employee	1.12		Education	1.51 *
Parents' education level (ref. Low)			Public or private research	1.52 *
Medium	0.79		Health and public activity	6.41 *
High	0.89		Services	7.17 *
EDUCATION BACKGROUND			**Job tenure (ref. >=3 years)**	
Field of study (ref. Law)			< 1 year	0.86
Science	0.93		1-2 years	1.02
Medicine	1.13		2-3 years	0.98
Civil engineering and architecture	1.01		**Workplace area (ref. South)**	
Political and social sciences	1.74	*	Nord	1.17
History, philosophy, pedagogy and psychology	1.39	*	Center	0.97
Economics and statistics	0.88		Abroad	0.58 *
Visiting student during PhD (ref. no)			**Job position (ref. Permanent emplo.)**	
Si	0.74	*	Temporary emplo.	0.77 *
Geogr. Area of univ. (ref. Island)			Collaboration	0.85
Nord-west	0.81		Self-employed	1.35 *
Nord-est	0.78		Research grant	0.24 *
Center	0.83		**Tasks (ref. R&S)**	
South	0.89		Never R&S tasks	4.20 *
Year of PhD (ref. 2012)				
2014	0.96			
Obs.	10431			
Wald (43 df)	1564.7			

As emphasized by many studies (Mandrone et al. 2016), besides being a waste of the investment in education made by a country, the mismatch can also have negative consequences for the individuals, in terms of lower income and job satisfaction. As far as the latter is concerned, table 3 shows the marginal effect of the mismatch condition on the probability of being fully satisfied with the job as a whole.

The analyzes conducted corroborate the results of the literature (Di Paolo et al. 2016) , showing how the probability of expressing full satisfaction for the work done is halved in the presence of a condition of over-education (odds ratio of 0.51).

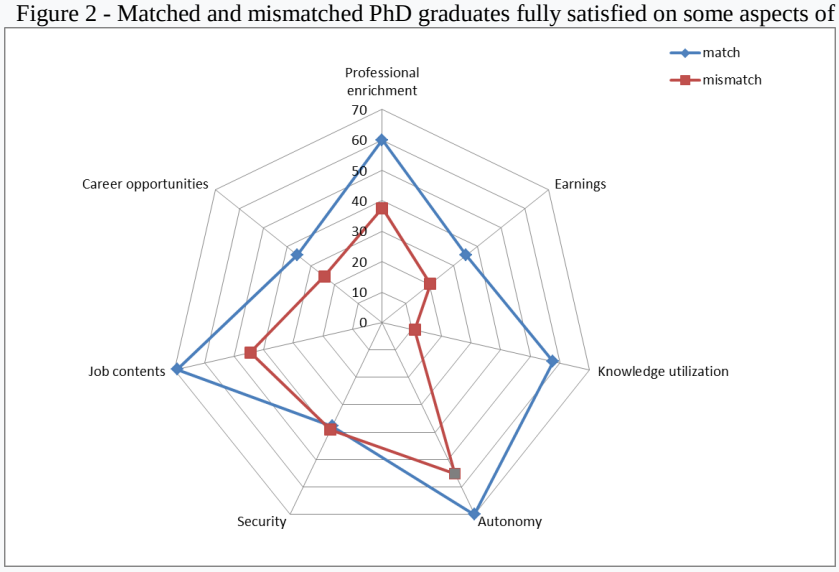
Table 3 - Logistic regression model for the dependent variable PhD graduates 'job satisfaction'(a) (odds ratio) – Year 2018

Mismatch condition	0.51	*	**continues EDUCATION BACKGROUND**	
SOCIO-DEMOGRAPHIC VARIABLES			**Graduation mark (ref. 110 or 110 cum laude)**	
Age at PhD (ref. >=35)			<=104	0.98
<=28 years	1.26	**	105-109	0.97
29-34 years	1.07		**JOB-RELATED VARIABLES**	
Sex (ref. Male)			**Activity sector (ref. University)**	
Female	0.91		Agricolture and industry	0.82
Citizenship (ref. Foreigner)			Education	1.09
Italian	1.13		Public or private research	0.82
EDUCATION BACKGROUND			Health and public activity	1.18
Field of study (ref. Law)			Services	0.79
Science	0.89		**Job tenure (ref. >=3 years)**	
Medicine	0.94		< 1 year	1.05
Civil engineering and architecture	0.90		1-2 years	1.05
Political and social sciences	0.70		2-3 years	0.94
History, philosophy, pedagogy and psychology	0.93		**Workplace area (ref. South)**	
Economics and statistics	0.97		Nord	1.05
Visiting student during PhD (ref. no)			Center	0.96
Si	0.97		Abroad	2.24 *
Year of PhD (ref. 2012)			**Job position (ref. Permanent emplo.)**	
2014	0.97		Temporary emplo.	0.64 *
			Collaboration	0.25 *
			Self-employed	0.69 *
			Research grant	0.33 *
			Tasks (ref. R&S)	
			Never R&S	0.42 *
Obs.	10431			
Wald (32 df)	1048.2			

(a) judgment above or equal to 8 in a [0-10] scale; * p-value <0.01, ** p-value <0.05

Nevertheless, job satisfaction is an aggregate indicator of many different aspects of the occupation that are important to the individual. Survey data make it possible to analyze the association between job mismatch and seven dimensions of job satisfaction, i.e. professional enrichment, earnings, knowledge utilization, autonomy, security, job contents and career opportunities. As shown in figure 2, PhD graduates holding a job that does match with their educational path are always more satisfied than their matched peers on all aspects but security, suggesting that mismatched doctors might enjoy other features of their job and steady employment might at least partially compensate for inadequate knowledge utilization or job contents.

Figure 2 - Matched and mismatched PhD graduates fully satisfied on some aspects of their job (percentage values)



Finally, moving to the income penalty associated with job mismatch, the regression model estimated controlling for the effect of the socio-demographic variables of the individual, of the education background and of the job-related variables shows that the mismatch condition has a statistically significant negative correlation, causing an income reduction of approximately 12%. The estimates relating to the control variables are in line with the results traditionally obtained by other studies (Gaeta et al. 2017). As expected, a significant gender gap is observed. Moreover, the longer the job tenure the higher the income, reflecting human capital accumulation through experience.

Table 4 – Linear regression model for the log net monthly income of the PhD graduates. Year 2018 (OLS coefficients)

Mismatch condition	-0.12 *	**JOB-RELATED VARIABLES**	
SOCIO-DEMOGRAPHIC VARIABLES		**Activity sector (ref. University)**	
Age at PhD (ref. >=35)		Agricolture and industry	0.10 *
<=28 years	0.02	Education	-0.07 *
29-34 years	0.00	Public or private research	0.10 *
Sex (ref. Male)		Health and public activity	0.26 *
Female	-0.12 *	Services	0.10 *
EDUCATION BACKGROUND		**Job tenure (ref. >=3 years)**	
Field of study (ref. Law)		< 1 year	-0.06 *
Science	-0.11 *	1-2 years	-0.04 **
Medicine	-0.04	2-3 years	-0.02
Civil engineering and architecture	-0.05	**Workplace area (ref. South)**	
Political and social sciences	-0.21 *	Nord	0.12 *
History, philosophy, pedagogy and psychology	-0.23 *	Center	0.11 *
Economics and statistics	-0.03	Abroad	0.49 *
Visiting student during PhD (ref. no)		**Job position (ref. Permanent emplo.)**	
Si	0.03 *	Temporary emplo.	-0.06 *
Year of PhD (ref. 2012)		Collaboration	-0.66 *
2014	-0.04 *	Self-employed	-0.47 *
		Research grant	-0.18 *
		Tasks (ref. Never R&S)	
		R&S	-0.12 *
Obs	*10431*		
Pseudo R2	*0.43*		

* p-value <0.01, ** p-value <0.05

Regarding the economic sector, if compared to the university sector, positive income differentials are detected for all the sectors with the only exception of the education. All other conditions being equal, the PhD graduates in law are by far the best payed, showing a sizeable positive earning differential compared to all the other areas, both the socio-political, the literary and also the scientific area. Finally, a positive income return is found for permanent employees compared to all other types of work.

Conclusions

A high presence of PhD graduates in the labor market has often been recognized as a key factor for innovation and technological advancement. The European Union has underlined the relevance of investing more in knowledge and innovation.
The Lisbon strategy stated the crucial role of scientific research for the development of a competitive knowledge-based economy in the Eu area. For a society to make the most appropriate use of the human capital available and for individuals to get the adequate return of the supported costs and of the expected reward of their efforts, the labour market of PhDs should be widened in order to include not only careers at university or research institutes but also in the other economic sectors.
Jobs different from the academic ones should become attractive for PhD holders and the labour market should ask for high skill workforce through stronger investments in innovation, new technologies and research.
At the same time, the PhD programs should be more permeable to the labour market demand and research projects with the participation of the production sectors should be encouraged within all the field of studies, not only the traditional ones.

Finally, strengthened and continued efforts are necessary for collecting data that can help monitoring policy and inform developments in human resource issues.

The extent to which supply matches demand of highly skilled workers on the national labour markets is extremely important to assess. Surveys like the ones described in the paper can provide important insight and can suggest how and where to intervene in order to correct possible imbalances.

References

Ballarino, G. and Colombo, S. (2010), "Occupational outcomes of PhD graduates in Northern Italy", *Italian Journal of Sociology of Education*, No. 2, pp. 149-171.

Campostrini, S. (2011), "After the PhD: A Study of Career Paths, Job and Training Satisfaction Among PhD Graduates from an Italian University" in Attanasio, M. and Capursi, V., *Statistical Methods for the Evaluation of University Systems*, Springer-Verlag, Berlin Heidelberg, pp. 209-222.

Caroleo, F. E. e F. Pastore (2013), "L'overeducation in Italia: Le determinanti e gli effetti salariali nei dati AlmaLaurea", Scuola democratica, 2: 353-378.

Caroleo, F. E. e F. Pastore (2015), "Overeducation: A Disease of the School-to-Work Transition System", in G.L. Coppola and N. O'Higgins (eds.), Youth and their Future. Unemployment, Education and Health in Europe, Routledge, London and New York.

Cedefop (2015), Skill shortages and gaps in European enterprises. Luxembourg: Cedefop Reference Series 102, Publications Office of the European Union

D'Agostino, A. and Ghellini, G. (2011), "Labour Market Outcomes for Ph.D. Graduates in Statistical Methods for the Evaluation of University Systems" in Attanasio, M. and Capursi, V., *Statistical Methods for the Evaluation of University Systems*, Springer-Verlag, Berlin Heidelberg, pp. 209-222.

Di Paolo, A. Mane F. (2016), "Misusing our talent? Overeducation, overskilling and skill underutilisation among Spanish PhD graduates" The Economic and labour relations review. pp 1-21

Ermini B., Papi L., Scaturro F. (2017) "An analysis of the determinants of over-education among Italian Ph.D graduates", Italian Economic Journal: A Continuation of Rivista Italiana degli Economisti and Giornale degli Economisti, Springer; Società Italiana degli Economisti (Italian Economic Association), vol. 3(2), pages 167-207, July.

Franzini, M. and M. Raitano (2012), "Few and underutilized? Overeducation of Italian graduates", in E. Mandrone (ed) Labour Economics: PLUS Empirical Studies, ISFOL, Temi e Ricerche 3, Ediguida, Cava dè Tirreni

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

Gaeta, G.L., Lavadera G.L., Pastore, F. (2017) "Much ado about nothing? The wage penalty of holding a PhD degree but not a PhD job position in Skill Mismatch in labor market pp. 243-277

Heckman, J.J. (1979), " Sample selection bias as a specification error", Econometrica: Journal of the Econometric Society, Vol.47 N.1 pp153-161

Hartog J. (2000) "Over-education and earnings:where arewe, where should we go? Econ educ review 19 (2) pp131-147

Herrera, L., Nieto, N. (2015), "PhD careers in Spanish industry: job determinants in manufacturing vs non-manufacturing firms". *Technological forecasting and social change*. Elsevier vol. 113(PB), pages 341-351.

Istat (2019), Rapporto annuale 2019. La situazione del Paese, Istat, Rome.

Istat (2018), "L'inserimento professionale dei dottori di ricerca, Anno 2018", *Statistiche Report*, 26 Novembre 2018.

Istat (2017), *L'utilizzo della tecnica cawi nelle indagini su individui e famiglie*, Letture statistiche – Metodi, Istat, Rome.

Oecd (2016), Getting skills right. Assessing and anticipating changing skill needs. Oecd publishing, Paris

Leuven, E. and H. Oosterbeek (2011), "Overeducation and Mismatch in the Labour Market", in E. A. Hanushek, S. Machin and L. Woessmann (eds.), Handbook of the Economics of Education, Chap. 3: 283-326.

McGuinness, S., Pouliakas, K., Redmond. P. (2018) *"Skill mismatch: concepts, measurement and policy approaches".* Journal of economic survey Vol. 32 N.4 pp. 985-1015 John Wiley & Sons Ltd

Ortiz, L. Kucel A. (2008) "Do Fields of Study Matter for Over-education?: The Cases of Spain and Germany", International Journal of comparative sociology, vol. 49, 305-327

Van de Ven, W.P.M.M. and van Pragg, B.M.S. (1981), "The demand for deductibles in private health insurance: a probit model with sample selection" *Journal of Econometrics*, Vol. 17 N.2, pp 229-252