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The employment destination of PhD-holders in Italy: Non-academic funded projects as drivers of successful segmentation

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Abstract

In high-income countries in recent years, the non-academic labour market destination of PhD-holders, i.e., the segmentation by industry sector of destination, has emerged as an issue. Universities and other research-intensive institutions can no longer absorb the major share of PhD-holders. Their employment has become a matter of segmentation both horizontally in terms of the economy and vertically in terms of income. The article reports on outcomes from analysis that tested what factors segment labour market outcomes in two dimensions: (1) the economic sector and (2) income. Findings suggest that scientific mobility and type of funding during PhD studies do not play a notable role. Instead, some types of experiences such as a postdoctoral research position, predict exit from academic employment and also a higher income overall. The most significant experiences that contribute to segmentation are in fact projects funded by private companies or international organisations in postdoctoral periods. Implications for policy making are relevant for both PhD-holders, universities and external organisations. For instance, maximising collaborations between non-academic employers and universities is likely to produce beneficial outcomes for PhD-holders.

1 | INTRODUCTION

A wide body of literature has pointed out the critical role of the labour market for PhD-holders; especially noting the importance of non-academic employment (Caparros-Ruiz, 2019; Cruz-Castro & Sanz-Menéndez, 2005; Enders, 2002; Jackson & Michelson, 2015; Mangematin, 2000; Neumann & Tan, 2011; Pedersen, 2016; van der Weijden et al., 2016). PhD-holders have been detected as a group undergoing *segmentation*—meaning that PhD-holders will have to get non-academic positions in any economic sector due to shortage of positions in academia and in other public research institutes, especially tenured or secure positions. Nevertheless, the body of knowledge about what may facilitate segmentation is poor in relation to this increasing phenomenon. What would optimally support the potential of PhD-holders when they cannot or do not wish to continue a career in academia? The importance of this question is underscored by evidence that the arguable attractiveness of such highly qualified education does not necessarily occur spontaneously to non-academic employers (Casey, 2009). Hence, it is important to understand the drivers for such not yet fully developed segmentation.

The topic is intriguing because arguably PhD-holders may prefer to work as researchers although opportunities for permanent positions are poorer in comparison to some decades ago (Haley et al., 2018; van der Weijden et al., 2016). In analysing the context of PhD-holders from universities in Italy, this article explores the circumstances in one of the most difficult OECD countries in which to pursue an academic career; a contextual factor that exacerbates the pressing issue of getting alternative employment.

The article reports on an investigation of which steps in a PhD-holder's career facilitate a transition towards non-academic and non-public research institute careers (this representing the first hypothesis) and which steps make one's career a successful one—meaning resulting in having higher income, the second hypothesis. Push-factors in the contemporary academic labour market are the background theory that generated these two hypotheses regarding sector destination and differentials in wages. By means of using a dedicated survey about PhD-holders employment destination after several years of PhD attainment, the paper contributes to this debate finding that PhD-holders are more likely to get positions outside academia when they worked in projects funded by non-academic organisations. Non-academic postdoctoral projects also predict success in establishing oneself as self-employed, giving further insight and wider perspective to the topic of academic spin-offs. This relationship between PhD-holders and non-academic organisations via postdoctoral projects at universities is also a successful path to higher incomes. The analysis presented builds on the conceptual assumption that multiple events across a career trajectory may constitute patterns for labour market destinations. To take into account this well-known dynamic in life cycles, the paper provides extensive endogeneity analyses using key past events about doctoral and postdoctoral experiences as instrumental variables.

The article is organised in the following way. The literature review outlines the main debates in the field of research on PhD career trajectories. The Data section describes the dataset and variables used for the analysis. The Hypotheses and results section articulates the two hypotheses pertaining to what are predictors for non-academic employment, and a higher salary. A subsection provides evidence from endogeneity tests to verify whether main events sorted chronologically determine following career steps. The Discussion section supplies more in-depth implications with literature. To conclude, recommendations to policy makers at the European level are proposed, and for the specific context of higher education in Italy.

2 | LITERATURE REVIEW

The employment of doctoral degree holders is a relatively recent topic of research in high-income countries and in Europe as a region. Focusing on destination employment within this topic, some clusters of relatively homogenous bodies of research have emerged. These clusters identify the following subtopics: involvement in projects and the relevance of a timeline; spin-off options; appreciation of the PhD degree; the role of postdoctoral positions;

gender discrimination; factors facilitating job matching; retaining an academic profile indefinitely. This section also provides some details of the Italian context in the larger European sphere, which is necessary for the interpretation of these results in a broader European perspective.

2.1 | Involvement in postdoctoral projects

Projects are the main mode of work at doctoral and postdoctoral levels. Projects may differ by their nature: some contribute to publicly funded basic research; some others target specific socio-economic problems within one or more disciplines. The latter typology is arguably the most compelling for non-academic employment development. Non-academic organisations, for instance, may expect from PhD-holders that they bring collaborations with universities along with research, development activities and functions (e.g., research and development capacities), plus other skills (Manathunga et al., 2009). Nevertheless, an ex-post study among non-academic employers found that only around a fifth of them identified specific reasons for having hired such highly qualified personnel (Haapakorpi, 2017). Following this evidence, it is reasonable to investigate patterns of over-education and/or over-skilling (Gaeta et al., 2017).

Involvement in different postdoctoral projects may predict different eventual career steps. For instance, Garcia-Quevedo et al. (2015) analysed PhD-holder destinations in depth, describing the opportunity to have non-academic employment—not necessarily private companies—by previous events. In addition, the perspective of different types of projects carried out as a researcher is relevant, though a surprisingly little explored dimension. A project funded by a company for a scholarship of a PhD student or for a postdoctoral scholar is a joint investment in a specific person holding the post. According to Italian legal frameworks, a PhD student and a postdoctoral researcher may in some cases require the same amount of funding; however, the two position holders may display considerable differences in terms of ability to produce results. This is a cogent point from an employer perspective—if one follows a human capital assumption. Nevertheless, this issue appears underdeveloped in literature.

2.2 | Spin-off enterprises

Enterprises that develop technological inventions from university research, *spin-off* enterprises, are one interesting alternative employer to traditional academic jobs. Spin-off entrepreneurial positions are research and development intensive and put the expertise of PhD-holders to good use (Horta et al., 2016; Meoli et al., 2018). The main difference between these studies and the findings from the analysis on which this article reports is that self-employment as a category includes a larger set of workers in comparison to spin-offs. Self-employment is also not necessarily happening on campuses, in specific labs, or under specific policies, possibly aimed at tackling paucity of opportunities (Rizzo, 2015).

2.3 | Appreciation of PhD degrees

PhD degrees are structured differently in different countries. Also, the structure of the labour market in a country as a whole is important. The Austrian labour market for PhD-holders is very different from the Italian one; for instance, in Austria recent cohorts of PhD-holders are more likely to work in companies and much less likely to work, beyond higher education, in the education sector (Schwabe, 2011). In Italy education and training other than higher education remains a sort of second-best option with lower wages, but also showing less gumption, such as strategic use of social networks (Baruffaldi et al., 2017). Some other specific features by country are worth mentioning. Literature highlights the importance of connecting doctoral programs to destination employment in

English speaking countries (Rominger, 2018), and more broadly in OECD countries (Gokhberg et al., 2016). This aspect is less developed in Italy. Meanwhile, in Italy the English language expression *PhD* is little known outside academia, and the Italian term *dottore* (Dr.) is used for Master graduates as well, generating confusion in acknowledging the possible added value in terms of competence among PhD-holders.

2.4 | The circumstances of postdoctoral positions

A large corpus of research deals with postdoctoral experiences. Some previous studies highlight the increasing number of fixed-term postdoctoral positions within research-intensive universities, finding that even limited-time postdoctoral positions are nevertheless beneficial to (or with uncertain relation to) the prestige of hosting institutions (Su, 2013). However, other evidence reveals that postdoctoral positions can be associated with long term employment (Powell, 2015). Other authors argue that the circumstances of postdoctoral positions are pernicious inasmuch uncertainty per se is detrimental (Signoret et al., 2019). In a not very stratified higher education system like the Italian one, it is likely that postdoctoral positions constitute a sort of *survival tournament* where some PhD-holders get a tenure as soon as they can, while others may leave for other non-academic or non-public scientific positions. This may happen in an unpredictable mode and with unclear patterns (Wöhrer, 2014). To this regard, it is relevant to understand the role of these postdoctoral positions to determine the extent to which different postdoctoral positions and non-tenured experiences predict exit from academic positions. On top of this point, postdoctoral duration is arguably subject to the rule of diminishing returns (Su, 2013; Webber & González Canché, 2015). At the same time, the higher the scientific productivity, the higher the probabilities to continue to progress in universities or public research institutes, according to new career progression patterns based on scientific production (Marini, 2017). All in all, it is unclear to what extent postdoctoral positions are predominantly positive or negative experiences.

2.5 | PhD-holders and gender

Gender discrimination affects PhD-holders; this is manifested among other things by evidence that shows a pay gap among PhD-holders (Platow, 2012; Schwabe, 2011; Webber & González Canché, 2015). However, people in higher percentiles in earnings are not affected by this disequilibrium (Canal-Domínguez & Wall, 2014). This latter evidence leaves room for speculations about possible family burdens as a concurring factor of the gender pay gap.

2.6 | Factors facilitating job matching

The public debate and the discourse about the role of PhD-holders outside academia in Italy is not systemically covered by any support organisation, like for instance Vitae in the UK. There is also poor attention towards what a PhD student ought to develop in order to increase his or her probabilities to get valuable positions in other sectors (Hancock & Walsh, 2016), resulting in a situation whereby labour market transition is arguably a determinant of personal inclinations or occurring opportunities. Notoriously, in Italy social capital plays a relevant role. Social capital, unfortunately, is seldom measured in research on this topic; it would probably reveal interesting patterns about PhD-holders' eventual employment trajectories. To address this, some proxies for social capital were included in the study on which this article reports, to disentangle why a fresh PhD-holder might happen to stay in academia or to opt for another industry. These proxies derive from different types of contacts a PhD-holder may experience during and after PhD attainment.

2.7 | Realising one's chances

It is reasonable to argue that for PhD-holders any non-academic position is still today perceived as a sort of exit from an academic career. This may happen once a person has pursued research for research's sake and after having accomplished this interest. More likely, to continue to carry on with a personal research agenda, sooner or later may clash with the issue of what to do for a living. In this scenario, PhD-holders realise at different stages that only few people will have the opportunity to do research forever, and, more importantly, PhD-holders realise at different stages whether they are among those few achieving a career in academia. We also cannot assume that PhD-holders are able to realise actual chances promptly and with no biases. They also may realise only after some time, the extent to which they really want to stay in academia, or under which conditions they wish to continue to be academics (Sauermann & Roach, 2012). Only occasionally, research casts light on preferences for salary and career as such—with evidence that disfavours research for the sake of research (Roach & Sauermann, 2010). This problem is exacerbated by the fact that PhD-holders do not accrue particular advantages in the labour market outside academia in comparison to a Master graduate, at least for the private sector (Pedersen, 2016). The conundrum of having spent years in doing research and finding oneself in a precarious and/or dead-end career trajectory remains a reality for many PhD-holders. As a result, the literature is still not fully developed in terms of analysing the employment opportunities for PhD-holders in the mid- to long term, leaving space for essential research to understand, for instance, which skills ought to be developed during PhD studies for the sake of future employability, or to understand which events following the attainment of a doctorate are more likely to help PhD-holders to find a good job in non-academic sectors.

3 | DATA

The analysis is based on a secondary dataset—a dedicated survey about PhD-holder employment destinations from all disciplines released by the national statistical office in Italy (ISTAT, 2018). The data refer to PhD-holders who obtained their qualification in 2008 and 2010 in Italian higher education institutions. This study cannot analyse career paths across a long time span and with events in a timeline like (Webber & González Canché 2018) have done. Nevertheless, the data afford the identification of some events such as doctoral studentship, postdoctoral positions (either ongoing or accomplished) and current employment, along with scientific productivity, participation in projects, and mobility. Descriptive statistics of the dataset are presented in Table 1.

3.1 | Dependent variables

The economic sector of employment is the first dependent variable. To minimise this variable into a few coherent categories, two possible different sectors—other than the academic-scientific one—are disentangled: other education (i.e., non-academic education), and all the rest. This distinction is relevant because the education sector in Italy can be considered a second-best alternative for PhD-holders who might not have found stable employment in academia after a certain number of years. Some PhD-holders thus may opt to become teachers, using their knowledge and qualification for this career. In comparison to academic employment, these jobs are on average lower in wages. All the other sectors instead include anything, and they are more likely employment destinations with more diversified skills demands. In principle, PhD-holders should take up positions in many different sectors regardless of the research and development intensity of a sector. PhD-holders in other sectors, in fact—either public, private, or in the *third sector* (i.e., quasi-governmental organisations, associations, etc.)—may arguably use their skills and knowledge from any discipline in more innovative ways, filling research and development positions in any sector. For this reason, any employment in academia is compared against these two possible destination

TABLE 1 Descriptive statistics grouped by stage of PhD-holders' career

s	Variable	Label	Obs.	Average	*SD*	Min	Max
Ys	Sector	Higher Education and PRIs	4,881	48.78			
	Sector	Other Education	913	9.12			
	Sector	Other	4,213	42.10			
	WPPP	Net Salary per unit of time (€)	7,622	64.46	113.830	6.07	3,000
Biographical	age2	age^2	10,007	115.60	69.894	49	1,225
	d5_10	Education mother (five modes)	10,007	3.095	1.374	1	6
	d5_5	Education father (five modes)	10,007	3.225	1.403	1	6
	d1_7	Graduation mark	10,007	2.595	0.718	1	3
	d0_1	Sex (1 woman)	10,007	0.519	0.500	0	1
	senior	Overall seniority in any employment (years)	10.007	4.519	1.722	1.4	7.8
	d5_4	Child/children (1 yes)	10,007	0.676	0.468	0	1
During PhD	d1_10	Funding of PhD: MIUR national funding					
	d1_10b	Funding of PhD: other public	10,007	0.068	0.252	0	1
	d1_10c	Funding of PhD: private organisation	10,007	0.057	0.231	0	1
	d1_10d	Funding of PhD: international organisation	10,007	0.015	0.120	0	1
	d1_10e	Funding of PhD: Nil—no stipend	10,007	0.184	0.387	0	1
	Mob_dur	Mobility during PhD	10,007	0.460	0.498	0	1
	d1_15	Duration of PhD (1: more than 4 years)	10,007	0.123	0.329	0	1
	d1_14	Teaching during PhD	10,007	1.765	0.820	1	3
	d2_52	Employment at end of PhD (1 yes)	9,301	0.583	0.493	0	1
Post PhD	Ln_prod	Scientific production (ln)	10,007	2.229	1.180	0	4.97
	d2_46h	Scientific production: patents	10,007	0.114	0.657	0	10
	d2_47a	Funding players in postdoc: university	10,007	2.028	0.820	1	3
	d2_47b	Public research institutes	10,007	1.578	0.797	1	3
	d2_47c	Private research organisations	10,007	1.314	0.647	1	3

TABLE 1 (Continued)

s	Variable	Label	Obs.	Average	*SD*	Min	Max
	d2_47d	Research consortia	10,007	1.296	0.637	1	3
	d2_47e	Companies	10,007	1.373	0.673	1	3
	d2_47f	International organisations	10,007	1.240	0.635	1	3
	expostdoc	Finished a post-doc	10,007	0.205	0.404	0	1
	d2_57a	R&D intensity of first job	10,007	0.466	0.499	0	1
	d2_64a	R&D intensity of job in 2011 (1 yes)	10,007	0.540	0.499	0	1
	Mob_post	Mobility after PhD	10,007	0.275	0.447	0	1
Current employment	d2_36	Channel in getting current job (base is "competition"):					
	d2_36b	Personal acquaintance of employer	10,007	0.070	0.255	0	1
	d2_36c	Endorsement from kins	10,007	0.049	0.215	0	1
	d2_36d	Endorsement from university or job agencies	10,007	0.030	0.172	0	1
	d2_36e	After stage or internship	10,007	0.021	0.143	0	1
	d2_36f	Direct call from employer	10,007	0.045	0.207	0	1
	d2_36g	Job alerts	10,007	0.041	0.198	0	1
	d2_36h	Sending CV to employers	10,007	0.125	0.331	0	1
	d2_36i	Public job center	10,007	0.001	0.033	0	1
	d2_36j	Self-employment	10,007	0.046	0.211	0	1
	d2_36k	Private job matching agencies	10,007	0.011	0.104	0	1
	d2_36l	Other	10,007	0.053	0.225	0	1
	d2_39	PhD essential criteria for current job	10,007	1.773	0.760	1	3
	d2_40	PhD essential for current job (1 yes)	10,007	0.440	0.450	0	1
	d2_44	Currently doing R&D job (inverted scale)	10,007	1.777	0.812	1	3
	d2_24	Having moved abroad (1 yes)	10,007	0.161	0.367	0	1

Source: Author.

sectors separately, using the same set of independent variables in hypothesis 1 (horizontal segmentation, see below). The analyses exclude PhD-holders who already were in employment when they started the PhD. This was done to avoid the effect of possible improvement of qualifications, on the evidence that these PhD-holders usually do not change sector, nor even employer, when the PhD is obtained (figures available upon request).

The second dependent variable used for hypothesis 2 (vertical segmentation, see below) is salary (WPPP; average 64.46€ net per day) (see Table 1). Considering the net monthly income declared and the respective weekly worked hours, it is possible to compute this variable. Specifically, this variable has been generated by taking into account the net income of different possible taxation regimes, and after having compared the income at purchasing power parity (PPP) of the country of residence, applying coefficients available from OECD figures for the year 2014. Yet, this variable also considers further possible income from any other work, which is relevant for several PhD-holders active in flexible working conditions. This portion of the income is considered proportionally to the time spent on average in order to have a fair overall average of wage per unit of time. Some supplementary benefits are included, such as *tredicesima* and *quattordicesima* that are typical monetary benefits for employees in Italy. Since the variable is about salary over working time, we overlook whether part-timers are not full-timers on a personal preference or not (around two thirds of respondents declared they would have preferred not to be part-timers). We reckon this caveat a minor limitation. The test for the second hypothesis regresses the natural logarithm of this variable.

3.2 | Independent variables

Independent variables were grouped by biographical information, doctoral experience, employment after PhD attainment (either postdoctoral or other), and current employment. Some of these variables are discussed to facilitate the interpretation of results. The variable *funding of PhD stipend* (d1_10) explains if the PhD was supported with a stipend; and if so, which type of source the stipend was based on. This variable is interesting to understand if at this studentship stage contacts with non-academic sources of funding may predict a future career in non-academic positions (Horta et al., 2018). The dataset also offers the opportunity to check employment trajectories by periods spent abroad, both *during the PhD* (mob_during; pursued by 46%) and afterwards as PhD-holders (mob_post; pursued by 27.5% of the sample). This distinction affords comparisons with previous research (Caparros-Ruiz, 2019; Di Cintio & Grassi, 2016; Marini, 2018) and it is relevant for understanding if and when mobility does happen. A binary variable (d1_15) provides information whether the doctorate *completed the degree on time* (12.3% responded *yes*) or if more time was needed—a variable that is taken up in the literature (Horta et al., 2019). Employment *following the completion of the PhD* (d2_52; 58.3% already had a position when completing) is relevant to understand whether PhD-holders had any frictional unemployment and to discount any respective effect.

A set of variables illustrate what PhD-holders have achieved or have done after PhD attainment. Different types of scientific outputs are grouped together (nprod), keeping patents outside from this computation. Scientific projects PhD-holders may have participated in are provided by type of funding organisation (d2_47 series; universities and public research institutes being the most frequent sources of postdoctoral scholarships, followed by companies). In testing the two hypotheses (Tables 2 and 3), these latter two sets of variables have been normalised by number of years elapsed after PhD attainment—the dataset incorporates two close-range cohorts, those who got the PhD in 2008 and those who got it in 2010. The variable about participation in projects, like that of source of funding of PhD stipend, is relevant to understand whether some types of organisations are more likely to serve as a gateway for PhD-holders to get a job in sectors other than academia or education. These variables referring to participation in projects are categorical (*no projects*, *national projects*, *international projects*). They are kept as continuous on the assumption that international projects are more important, more prestigious, and may convey more social capital than the national ones.

Completion of postdoctoral research (expostdoc; 20.5% of sample) is a binary variable about any possible completed experience as a postdoctoral scholar. This variable includes the typical Italian postdoctoral position (*assegno di ricerca*), such as other atypical contracts that are used to fund relatively short fixed-term contracts in academia. All these contractual forms are not necessary for subsequently achieving a permanent position as assistant professor, or even the fixed-term assistant professorship established more recently in the early 2000s (*ricercatori a tempo determinato tipo A* and *B*). Variables for possible channels through which PhD-holders got the current job were also included (d2_36 series). Table 1 is based on formal competition because this is the way academic positions are obtained in Italy, whereas for other sectors (especially the non-public one) any other option more likely applies. Tables 2 and 3 provide a simplified version of employment channels. The variable *PhD title in getting job* (d2.39; 43% essential; 37% desirable and 20% not useful) and the variable *PhD actually useful in job* (d2.40; 46.5% responded *yes*) further describe the relationship between the PhD and the current occupation at the time of the interview. These variables can be relevant in understanding the capacity of employers to realise the actual value of PhD-holders. A combination of these two variables may individuate a possible bias for not including a PhD degree at least as a desirable criterion when selecting staff.

4 | HYPOTHESES AND RESULTS

The dataset was used for testing the following hypotheses.

Hypothesis 1 (Hp1) *Specific doctoral and postdoctoral experiences determine the extent to which PhD-holders remain in an academic career, with no specific role of teaching experience or research performance.*

Hypothesis 1a (Hp1a) *These predictors are different between PhD-holders who exit academic careers for employment in the education sector (non-academic) and those who work in other economic sectors.*

Hypothesis 2 (Hp2) *PhD-holders have significantly different wages per unit of time according to specific doctoral and postdoctoral experiences, with no specific role of teaching experience or research performance.*

The first hypothesis about the sector of employment was tested with two separate multilevel mixed-effects logistic regressions—layers defined by the main fourteen disciplinary categories used in the Italian higher education system. This hypothesis helps individuate key factors in facilitating horizontal segmentation, assuming that it is useful to understand what facilitates PhD-holders to find alternative careers to academia—either non-academic education (Table 2, Model 1), or another sector unrelated to education (Table 2, Model2). The second hypothesis predicts income expressed as net income per unit of time. At parity of sector of employment and of academic discipline, it is relevant to understand what may predict a more successful use of one's PhD title. This second test is a test of vertical segmentation in that typical and traditional academic careers tend to have uniform pay scales. This hypothesis accounts for two layers of multilevel analysis: the three destination sectors used for hypothesis 1; disciplines as per Hp1. This choice is justified by the evidence that the labour market of PhD-holders by salary varies considerably by type of sector also within a single discipline (McFall et al., 2015). For all regressions, tests were launched accounting for heteroscedasticity in residual distribution (robust standard errors). Also possible multicollinearity was tested, with good outcomes; VIF scores for each variable are below 2.35, the average is 1.41.

4.1 | Factors that lead to PhD degree holders leaving academia

This section addresses the question on which the first hypothesis sheds light; namely, how do PhD-holders leave academia? The results shown in Table 2 are split between what predicts a move from academic employment into other education sector positions on one hand (Model 1), and, alternatively, what predicts a move from academic

TABLE 2 Prediction of sector of employment

		M1	*p*	M2	*p*
age2	age^2	−0.0002		−0.0002	
ln_senior	Seniority in employment (ln of years)	−0.0775		0.4406	***
d5_10	Education mother (five modes)	−0.0885		0.0383	
d5_5	Education father (five modes)	0.0567		−0.0527	
d1_7	Graduation mark	0.2171	*	0.0572	
d0_1	Sex (1 man; 2 woman)	0.1969		−0.1555	*
d5_4	Child/children	−0.1507		0.0320	
2.d1_10	Funding of PhD: other public				
3.d1_10	Funding of PhD: private organisation	−0.2774		0.0423	
4.d1_10	Funding of PhD: international organisation	−0.1028		0.0992	
5.d1_10	Funding of PhD: Nil—no stipend	0.1550		0.6136	*
Mob_dur	Mobility during PhD	−0.0731		−0.1053	
d1_14	Teaching during PhD	−0.0383		0.1894	
d1_15	Duration of PhD	0.0529		−0.0379	
d2_52	Employment at end of PhD	0.2120		−0.2727	**
Ln_prod	Scientific production (ln)	0.1038		−0.1501	***
d2_46h	Scientific production: patents	−0.3820	***	−0.5544	***
d2_47a	Funding players in postdoc: university	−0.6170	**	0.1400	***
d2_47b	Public research institutes	−0.4689	***	−0.4976	***
d2_47c	Private research organisations	0.0153		−0.0931	
d2_47d	Research consortia	0.1773		0.4324	***
d2_47e	Companies	−0.2154		0.0212	
d2_47f	International organisations	0.0505		0.1094	
expostdoc	Finished a post-doc	−0.2168		0.1369	
d2_57a	R&D intensity of first job	−0.0251		−0.0847	
d2_64a	R&D intensity of job in 2011	−0.0610		0.1634	
Mob_post	Mobility after PhD	−0.1882		−0.0674	
Self-empl.	Self-employment	−0.0812		0.1442	
d2_39	PhD essential criteria for current job	1.6111		2.9027	***
d2_40	PhD essential for current job	1.2859	***	1.3213	***
d2_44	Currently doing R&D job	1.5993	***	1.1577	***
d2_24	Having moved abroad	1.8418	***	0.6222	***
_cons		−0.5638		0.5209	*
var(_cons[d0_10])		0.1862 (0.1019)		0.1526 (0.0444)	
var(_cons[d0_10>d0_5])		0.2638 (0.1184)		0.0057 (0.0159)	
N		5,169		8,272	

Note: M1(model 1): Other educational sector against Higher education and Public Scientific Institutes. M2 (model 2): not-academic and not other education against Higher education and public scientific institutes. Both models are multilevel regressions by disciplinary field of PhD attainment.

*$p < .05$; **$p < .01$; ***$p < .001$.

Source: Author.

TABLE 3 Prediction of income per unit of working time

		ln_WPPP	*p*
lnsenior	Seniority in employment (ln of years)	0.014	
age2	age^2	0.000	**
d5_10	Education mother (five modes)	0.003	
d5_5	Education father (five modes)	0.004	
d1_7	Graduation mark	0.012	
d0_1	Sex (1 man; 2 woman)	−0.014	
d5_4	Child/children	−0.079	***
1.d1_10	Funding of PhD: MIUR national funding (base)		
2.d1_10	Funding of PhD: other public	−0.052	
3.d1_10	Funding of PhD: private organisation	−0.009	
4.d1_10	Funding of PhD: international organisation	0.002	
5.d1_10	Funding of PhD: Nil—no stipend	0.006	
Mob_dur	Mobility during PhD	−0.013	
d1_14	Teaching during PhD	0.008	
d1_15	Duration of PhD (1: within 4 years)	0.013	
d2_52	Employment at end of PhD	0.001	
Ln_prod	Scientific production	−0.014	**
d2_46h	Scientific production: patents	0.025	**
d2_47a	Funding players in postdoc: university	−0.038	***
d2_47b	Public research institutes	0.009	
d2_47c	Private research organisations	−0.002	
d2_47d	Research consortia	−0.017	
d2_47e	Companies	0.032	**
d2_47f	International organisations	0.016	
expostdoc	Finished a post-doc	−0.029	
d2_57a	R&D intensity of first job	0.028	
d2_64a	R&D intensity of job in 2011	0.000	
Mob_post	Mobility after PhD	0.076	***
Self-empl.	Self-employment	1.229	***
d2_39	PhD essential criteria for current job	−0.040	**
d2_40	PhD essential for current job	0.015	
d2_44	Currently doing R&D job	−0.019	
_cons		3.968	***
var(_cons[d0_10])		1.13e−10 (8.54e−10)	
var(_cons[d0_10>d0_5])		0.0121 (0.007)	
N		7035	

	Number of group	**Min *N* per group**	**Average *N* per group**	**Max *N* per group**
d0_10 (Discipline)	14	184	502.5	1,034
Sector (as per Table 1)	42	13	167.5	515

Note: Multilevel regressions by sector of employment (as per Hp1) and disciplinary field of PhD attainment with test of endogeneity.

*$p < .05$; **$p < .01$; ***$p < .001$.

Source: Author.

employment into another economic sector (Model 2). This distinction is justified by average salaries, but also by the assumption that pursuing other non-education sector positions implies more gumption in comparison to seeking employment in other positions in the education sector—an argument in line with Baruffaldi et al. (2017). The choice to teach in school, when graduates have not succeeded in pursuing academic careers in their field of study, is here understood—at least to some extent—as an option that requires less effort. The results give substantially different explanations in comparing these two sector destinations. Observing Model1, PhD-holders are more likely to get a job in the non-academic education sector if their performances as undergraduates were successful (d1_7). Nevertheless, there are no other predictors of this outcome related to biography or descriptions of doctoral experience. In terms of scientific productivity, there are no statistically significant coefficients. Participation in projects funded by universities (d2_47 series) is instead a strong predictor for not abandoning academic positions, possibly also the precarious ones. As expected, PhD-holders whose destination sector is the non-academic education sector ("other education") are substantially less likely to have moved abroad (d2_24). Overall, the profile of the PhD-holder who dropped from academia into the broader education sector seems to be that of an excellent student who did not find the way to participate in academic life after PhD-attainment, and moved into a non-research position; possibly also because of a preference to stay at the same place of residence.

Model2 gives different results. People who went to work outside academia, including those who chose to work in the non-academic education sector, are more likely to be older (possibly because people try to persist in academic positions), men, and have more educated mothers. They are also more likely to have spent more time to complete the doctorate (d1_15), but they were already working at the moment of completion (d2_52).

Even more so than is the case in Model1, these PhD-holders are less likely to have continued an academic career if they joined any project funded by universities. They are also more likely to have worked in academia under a project funded by private organisations (d2_47e and d2_27f). There is also a very strong prevalence in becoming self-employed (10.d2_36). In comparison to Model1, those who move on to a non-education sector are less likely to pursue research, but this is sensibly less prominent as a predictor. Overall, the typical PhD-holder described in Model2 is a person who is more likely to have worked with private stakeholders when still at university. Moreover, they are more likely to become self-employed. They also did not always have to give up research entirely (d2_24).

4.2 | Why some PhD-holders earn more

Table 3 shows results for the second hypothesis about better jobs in terms of salary. Multilevel regression is apt for accounting for the assumption that wages are a function also of a sector, and not only of a discipline of doctoral study. Notably, the types of projects held after PhD attainment are relevant in predicting income more than other factors such as publications; projects funded by universities predict lower income whereas projects funded by private firms or international organisations predict higher income. Post-doctoral mobility is also associated with a higher salary (mob_post). A direct call from an employer, and in particular self-employment, as channels to access PhD-holders' current jobs are the strongest predictors for having a higher income. This fact is relevant as self-employment can be either very munificent or precarious, especially in the Italian context. This finding is useful if a non-linear effect between the entrepreneurship of skilled workers and a respective *push* effect enacted to avoid unemployment are taken into account (Horta et al., 2016). This finding calls for future studies to investigate whether self-employment is incentivised by policies, or it is a purely autonomous endeavour.

4.3 | Possible endogeneity factors in the career timeline

Post-estimation tests were carried out to check what might have engendered such a high coefficient for the self-employment condition (Table 4). Three main events in time are considered, as proposed in recent literature (Horta

et al., 2018): funding of PhD studentship (stage0); funding at postdoctoral period (stage1); current employment (self-employment mode; stage2). The tests considered the hypotheses, endogenous variables, and instrumental variables. Projects funded and organised by private and international organisations (stage1) determine self-employment (tests #6, 11, and 12), causing a PhD-holder to be more likely to become a successful self-employed PhD-holder, especially when PhD-holders do not work in other education sectors. The tests demonstrated a link between working as a PhD-holder in partnership with companies and other organisations, and a consequential increasing likelihood in establishing one's own business, which is coherent with the literature (Folta et al., 2010). Lack of funding for PhD studies (no scholarship during PhD studentship—stage0) is a determinant of exiting the academic career pathway into other sectors (test #8), but not for choosing to work in the non-academic education sector—reinforcing the idea that horizontal segmentation is a bifurcation between the non-academic education sector on one side, and other sectors on the other side.

5 | DISCUSSION

Several aspects of the results deserve to be discussed against empirical literature. The most interesting finding pertains to funding providers and the types of collaborations universities may have with companies or other organisations. PhD-holders are more likely to get a job in other sectors than (broadly speaking) academic ones when PhD-holders are involved in projects funded by enterprises or international organisations at the postdoctoral stage. It is worth noting that this is not true when these types of potential future employers fund doctoral stipends, which is coherent with findings about funding PhD studentships (Horta et al., 2018). This is relevant also in relation to the highest coefficient found—that of becoming self-employed predicting higher salaries (vertical segmentation—hypothesis 2). This mode of employment is found to have endogeneity with specific project funding providers at the postdoctoral stage, such as companies or other international organisations—suggesting a specific Italian labour market pattern. Other European labour markets are not necessarily similar in relation to self-employment and how and why one person chooses to establish one's own business or professional activity. Arguably, the relationship with non-academic organisations could favour the absorption of PhD-holders by means of recruiting them in a second instance, if another context with a different labour market pattern was taken as a case. The analysis presented in this article thus offers novel evidence to support arguments in the literature about the importance of partnerships with other sectors (non-higher education and non-public research institute) for increasing PhD-holders' chances for career development. For some funding providers, collaborations in the form of funding projects represent a kind of investment. In this vein, this study confirms Garcia-Quevedo et al.'s (2015) findings on the likelihood of hiring PhD-holders, but it adds that the best matching occurs at the end of postdoctoral relationships. A fair interpretation is that projects with post-doctoral degree holders probably allow PhD-holders and non-academic employers to make sounder reciprocal relationships. Arguably, they also let a given PhD-holder understand how to convert his or her scientific knowledge into a viable business that does not entirely exclude research. Accordingly, the analysis presented supports the idea that self-employment contributes to a smooth transition from wages into entrepreneurship (Folta et al., 2010), rather than a sharp decision.

In any case, PhD-holders find themselves increasingly within specific, fixed-term, projects (Cantwell & Taylor, 2015; Hokanson & Goldberg, 2018; Nielsen & Cappelen, 2014; Signoret et al., 2019; Teelken & van der Weijden, 2018). Ultimately, these results provide a glimpse of the viable solutions to this well-known phenomenon, suggesting that projects with a link to the external world provide valuable opportunities for the career development of doctorates.

In terms of the sector of employment (horizontal segmentation), the findings show that men are more likely to get a job in other sectors, which is in line with other findings on the interplay between gender, tenure and getting jobs (Rudd et al., 2007). In line with other studies (Evers & Sieverding, 2015; Webber & González Canché, 2018), no discernible differences by gender were observed in the employment destination of PhD-holders.

TABLE 4 Tests of endogeneity for checking chronological determinants in career steps

Hp	#test	Dependent variable	Endogenous variable	Instrumental variables	Output
Hp1	1	Academic vs. other Education	selfemployment	fund_PhD (stipend/ no-stipend)	
Hp1	2	Academic vs. other Education	selfemployment	d1_10	
Hp1	3	Academic vs. other Education	d2_47e/f	fund_PhD (stipend/ no-stipend)	
Hp1	4	Academic vs. other Education	d2_47e/f	d1_10	
Hp1	5	Academic vs. Other Sectors	selfemployment	fund_PhD (stipend/ no-stipend)	
Hp1	6	Academic vs. Other Sectors	selfemployment	d1_10	***
Hp1	7	Academic vs. Other Sectors	d2_47e/f	fund_PhD (stipend/ no-stipend)	
Hp1	8	Academic vs. Other Sectors	d2_47e/f	d1_10	***
Hp2	9	Wage per unit of time (ln)	selfemployment	fund_PhD (stipend/ no-stipend)	
Hp2	10	Wage per unit of time (ln)	selfemployment	d1_10	
Hp2	11	Wage per unit of time (ln)	selfemployment	d2_47e/f	***
Hp2	12	Wage per unit of time (ln)	selfemployment	d2_47a-f	***
Hp2	13	Wage per unit of time (ln)	d2_47e/f	fund_PhD (stipend/ no-stipend)	
Hp2	14	Wage per unit of time (ln)	d2_47e/f	d1_10	

* $p < .05$; ** $p < .01$; *** $p < .001$.

The vertical segmentation (differences in salary) is as well relevant. Whilst post-doctoral periods don't appear to give a payoff (Recotillet, 2007), women are more likely to suffer the added burden of caring for family members—although there is no gender pay gap at the highest levels of income. This study also finds no relevance of parents' education in predicting higher income of PhD-holders, as was the case in findings from a study in Spain (Caparros-Ruiz, 2019) and Chile (Chiappa & Perez Mejias, 2019).

Mobility does play a particular role. The findings corroborate the results by Caparros-Ruiz (2019) and Bonnard et al. (2017) in interpreting scientific mobility as a behaviour apt to increase scientific opportunities. It is possible that academic positions nowadays have to be so specific that the probabilities for finding them elsewhere from one's university of PhD attainment are high. This pattern contributes to an international market of academic job opportunities. Mobility, in other terms, could mean a search for better conditions (Caparros-Ruiz, 2019; Di Cintio & Grassi, 2016), and it does not necessarily generate beneficial effects in terms of wage. This study also finds that mobility does not predict the sector of employment, which tends to reinforce the aforementioned interpretation. The overall interpretation regarding mobility is similar to that of a recent debate about Italian PhD-holders and the brain drain of PhD holders from Italy (Cattaneo et al., 2019; Passaretta et al., 2019). However, mobility after PhD attainment positively predicts higher salaries at parity of cost of life in the country of destination, which does not

happen with mobility during PhD studies. This difference could be read analogously with findings about funding providers.

6 | CONCLUSION

Nowadays any practice favouring an exit from the academic labour market for PhD-holders is not just an option. It is increasingly a necessity. The destiny of PhD-holders is that of getting jobs like any other graduate, otherwise biases about the poor contribution of PhD-holders to the whole economy (Santos et al., 2016) may recur. The findings presented in this article contribute by confirming that PhD-holders can be useful for society and holding a PhD-degree contributes to the career development of individuals. More importantly, the article gives novel insights about: (a) how getting a job in the non-academic labour market is more likely to happen; and (b) when PhD-holders more likely yield the most from their highly skilled profiles. From this analysis, the segmentation of PhD-holders' employment destinations can be predicted both at studentship and especially postdoctoral stages due to specific non-academic projects funders. Attempting a more general understanding of the topic, PhD-holders are more likely to benefit from situations where awareness about science-in-the-making (e.g., research funded by private organisations or other organisations) and respective *impact* can stimulate other career pathways, as a seminal study already highlighted (Mangematin, 2000). For the particular context of Italy, this happens via entrepreneurial behaviour. For a tentative generalised conclusion at a European level, the findings support a recommendation for efforts to incorporate novel engaging practices to favour both supply and demand sides of the labour market; such engaging practices are likely to generate reciprocal benefits. Funding schemes at the national and European regional levels might refer in the future to possible conversions of research activities into innovations as part of evaluation criteria. Such evaluations can favour matching between PhD-holders and projects stakeholders. Self-employment is a valuable option, although this is only one possible mode of conversion for the highly specific knowledge and expertise of PhD-holders for viable non-academic employability.

The practice of considering non-academic funders as drivers of segmentation could bring about reciprocal benefits to all: universities might propel more projects; employers might discover unexpected human resources from "young talents"; PhD-holders might be better enabled to pursue a variety of career alternatives as they increasingly will have to demonstrate what a PhD in their portfolio may bring for the "real world".

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are publicly available through the ISTAT website at https://www.istat.it/it/archivio/56512

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