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The impact of Ph.D. funding on time to Ph.D. completion

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Abstract

The time for completing a Ph.D. continues to be longer than desirable in most higher education systems worldwide. This is a concern for research funding agencies, universities, academics, and doctoral students facing increasingly constrained labour markets, particularly in academia. This study assesses the role of Ph.D. funding on the time to Ph.D. completion, revisiting literature that has mainly focused on the USA and used single university case studies as the main methodological approach. In this study, a representative national sample of doctorate holders working in Portugal is examined. Following the premise of previous studies, and using Breneman's and the concept of credentials as our main key theoretical approaches, it adds a new element to the analysis: publishing during the Ph.D. related to research funding and time to completion. Our analysis shows that the time to complete the Ph.D. generally results from a combination of funding conditions, publishing during the Ph.D., and an associated time strategy. In particular, our results show that Ph.D. funding increases the time to complete the Ph.D. However, if those receiving Ph.D. funding also publish during their Ph.D. programme, it reduces the time to complete the degree. Funded students who publish finish the Ph.D. earlier than funded students who do not. Unfunded Ph.D. students who are highly research productive take longer to complete the degree. The results also show that STEM students are more susceptible to the effects of funding and research productivity than non-STEM students. The types of funding support do not affect the time to the degree.

Key words: doctoral studies; doctorate; publishing during the Ph.D.; time to completion; time to degree; funding; grants.

1. Introduction

In an era of increasing massification of Ph.D. programmes, and with the growing relevance of Ph.D. holders to the creation and dissemination of knowledge, more attention is being paid to the key aspects, characteristics, and outcomes of doctoral education. Ph.D. students engagement with research (Stubb et al. 2014), studying abroad (Elliot et al. 2016), their relationships with supervisors and the importance of mentorship (Lindén et al. 2013), and the intentions and considerations related to postdoctoral careers (Gu et al. 2018) are among the aspects highlighted in the literature. The characteristics of the Ph.D. for future careers in and out of academia are also being increasingly studied. In addition to assessing the income premium of the Ph.D. in relation to other qualifications (Pedersen 2016), researchers have assessed: (1) the effects of studying for a Ph.D. abroad in relation to career research productivity and networking (Lin and Chiu 2014); (2) the generational engagement of doctorate holders with knowledge dissemination (Lee and Jung 2017); (3) the effects of publishing during the Ph.D. on career research productivity and impact (Horta and Santos 2016); and (4) the effects of funding sources during the Ph.D. on research productivity during and after doctoral studies (Horta et al. 2018; Nisticò 2018).

One aspect that has been somewhat overlooked, particularly in studies outside the USA (and recently, even in the USA), is the time required to complete the Ph.D. and the determinants that may affect

it. In most countries, completing the Ph.D. has generally taken longer than the expected 3–4 years. In England, for example, the Higher Education Funding Council for England reported that in 2013 around 73% of those starting Ph.Ds. in 2010/11 were projected to take 7 years to receive the degree (HEFCE 2013). The same report also found that the time to complete the Ph.D. was bound to change, based on the university and field of knowledge. In the USA, all fields of knowledge reported median times of more than 6 years to complete the Ph.D., and some were around 9 years. These times have remained reasonably stable from 1995 to 2015 except for the field of education, which declined from 16 years in 1995 to 12 years in 2015 (NSF 2017).

Everyone involved in doctoral education prefers that the Ph.D. be completed within the time specified for the degree, and if possible, even before then. In general, rapid completion of the Ph.D. degree is indicative of someone with high potential because it means he or she has managed the work and deliverables faster than expected and is highly qualified to enter the job market (research oriented or not) earlier than others in their cohort. Accelerating Ph.D. completion may thus offer a potentially desirable advantage to securing stable employment in increasingly uncertain job markets where temporary and precarious contracts abound (see Waaijer et al. 2017). Early completion also guarantees that Ph.D. funding will be adequate for the length of study, eliminating the potentially detrimental situation of having to do part of the degree unfunded, possibly leading to its non-completion (see Kim and Otts 2010).

For universities, there is an interest in having new Ph.D. students, given their potentially high human capital and because, at least in some systems, they also bring funding.[1] In contrast, the accumulation of large numbers of students who, by taking longer than expected, occupy otherwise free slots, may be detrimental in those systems where this implies overloading supervisors or lead to the rejection of new candidates. In general, to postpone the Ph.D. date tends to be harmful to the candidate, and potentially may lead to project a negative image for prospective Ph.D. students and funding agencies.

The funding of Ph.Ds. has been a key aspect of studies focusing on its time determinants, and it is relied upon in this study, in which representative microdata on doctoral degree holders in the Portuguese research system are used to explore funding and time to Ph.D. completion in all fields of knowledge. The study contributes to the literature and differs from previous research in three ways. First, it focuses on an entire research system and not on the so far prevalent analyses of single university cases studies, or selected fields of knowledge. Second, it considers the type of funding supporting the Ph.D. degree, and the publications produced during the Ph.D. (the latter being a variable that has not been considered so far) as they relate to the time to Ph.D. completion. Both are treated as 'credentials'. Our analysis shows that the time to complete the Ph.D. generally results from the strategic combination of funding and publication during the Ph.D. Third, it uses methodological instruments that are bound to minimize selection bias when comparing groups of students who were funded and who were not.

This article is organized as follows. The next section provides the theoretical framework and reviews the results of previous empirical work on the subject. The methods, data, and variables are then explained. The fourth section presents the results, and the study concludes with a discussion of the results, specifying their contributions to the literature and the policy implications.

2. Time to Ph.D. completion and funding: what do we know so far?

2.1 Theoretical framework

This study uses Breneman's (1976) theoretical model to assess the impact of funding on time to Ph.D. completion.[2] Departing from human capital theory in which education is viewed as an investment (Becker 1962; Schultz 1961), Breneman posits that time to complete the Ph.D. is related to the incentives that influence students' decisions during their doctoral studies. These include the financial means Ph.D. students have to support their graduate studies and the perceived labour market conditions. They also involve the resources students have that give them advantages in the post-Ph.D. labour market, where the academic labour market still plays a major, though decreasing, role. Breneman's theoretical model suggests that the support mechanisms associated with Ph.D. funding, like teaching assistantships, lead to lengthier completion times. The work related to these mechanisms is often time intensive and disruptive to the Ph.D.'s objectives, given that it diverts the students' focus from their doctoral research. Alternatively, research-related funding can shorten the time to Ph.D. completion if it is aligned with the student's research.

In terms of the perceived labour market conditions, Breneman's (1976) theoretical framework presupposes that in labour markets that are actively hiring Ph.Ds., the time to completion is shorter due to existing job vacancies. Students do not want to lose the window of opportunity within which to apply. It is expected that constrained labour markets will have a more nuanced set of effects. In such markets, being funded works as an incentive to continue working on the Ph.D. Expanding the time to complete it is better than graduating without any ability to generate income or obtain the expected premium for investing in the doctorate[3]. A constrained postdoctoral labour market will likely lead students to adopt a 'wait and see' attitude, hoping for a more favourable market, unless they have a strong set of credentials with which to face a labour market offering limited employment, that is career, opportunities (Tomlinson 2008). In sum, according to Breneman, Ph.D. students are expected to respond to incentives and gamify their time to completion based on the perceived environment and the credentials they have.

The credentials Ph.D. students have to face the labour market are important to this discussion. Credentials are a key component of signalling theory (Spence 1973, 1974), which departs from the principle that although a learning process has occurred and the person experiencing it has acquired a number of skills specific to a given degree,[4] employers have no means of ascertaining who among the pool of eligible recruitment candidates possesses those skills. Skills are tacit, innate and cannot be observed directly (Arrow 1973). Indirect observation is required, which acts as codified evidence or a proxy for such skills, known in the literature as credentials (Albert 2017). In higher education settings, the university from which a degree is obtained is the most useful credential because of the prestige of the university, reflecting the specific activities, traditions, and mission of the university, associated with positional goods, one of the most powerful commodities in higher education (Hirsch 1976). This, in turn, is associated with the difficulty of the university's entry barriers. Universities with stricter entry barriers are favoured due to the belief that they accept only the best and most promising individuals (Parker et al. 2016).

For the Ph.D. labour market, and particularly the academic labour market, the literature underlines three further credentials as

being relevant. First, those who complete the Ph.D. in a shorter time are projected to have greater research output during the careers (Clemente 1973). This determinant can be a key credential for career success in the eyes of employers. However, some studies have found that this credential may not be as relevant as it once was, depending on the time it takes to obtain tenure. The authors of such studies have also cautioned that this finding may be the result of 'informal queues' based on time of entry (seniority in the 'waiting position') or the reward for institutional loyalty at Spanish universities (see Cruz-Castro and Sanz-Menéndez 2010; Sanz-Menéndez et al. 2013). Second, publishing during the Ph.D. has been found to be a strong predictor of research output, impact and collaboration throughout one's career, independent of the where the Ph.D. holder ends up working (Horta and Santos 2016). Publications and the new programmatic modalities, such as Ph.D. by publication, have become increasingly common and are encouraged to promote doctorate holders' career success (see Jackson 2013; Pinheiro et al. 2014). Finally, being funded during the Ph.D. is a sign of ability, particularly for those who obtain fellowships or scholarships through competitive funding, and it can act as a powerful signal for recruiters in the academic and non-academic sector (Waaijer et al. 2018). Further, this type of funding support allows for better access to universities' research infrastructure and generates greater levels of satisfaction (Waaijer et al. 2016).

Following the publication of Breneman's (1976) model, there is awareness of his view that Ph.D. students are rational actors who maximize self-interest (i.e., *homo economicus*). This could be problematic in the sense that individual's perceptions of reality and themselves are mostly based on limited information. Decisions are based on that limited information and other factors that dictate bounded rationality (Thaler 2015). However true this may be, several studies have shown that Ph.D. students are generally well informed about and well aware of the current postdoctoral labour market's characteristics and the credentials needed to succeed in it (e.g., Gu et al. 2018).

2.2 Brief overview of the empirical studies

The impact of funding sources and the time to completion have primarily been addressed in the US-based literature and case studies of single universities. Probably the most widely known study on this was conducted at Cornell University by Ehrenberg and Mavros (1995), who focused on doctoral students in Economics, English, Physics, and Mathematics over a period of 25 years, ending in 1986. They found that students with teaching assistantships took longer to complete their degrees than students with research assistantships, which aligned with Breneman's (1976) theoretical expectations. Similar results were also found by Kim and Otts (2010). Ehrenberg and Mavros also found substantial differences in time to graduation according to the field of study. The study of Seagram et al. (1998) on doctoral students in the natural and social sciences and humanities at York University (Canada) obtained similar results. Students receiving financial support took more years to complete their Ph.D. (mainly teaching assistantships), and this varied by field of study. In particular, those in STEM fields completed the Ph.D. in a shorter time than those in the social sciences and humanities.

Not all studies, however, have arrived at the same results. The findings of Stock et al. (2011) in a study of Ph.D. economics programs in the USA showed that Ph.D. students receiving fellowships (meaning no work duties outside of their Ph.D. during the first year of study) and those with no financial support took longer to finish the Ph.D. compared to students benefiting from teaching assistantships. The authors found no statistically significant differences in terms of time to Ph.D. completion between students with research and teaching assistantships.

Mixed results on the effects of funding on time to completion can also be observed in two further studies. In the first, University of California, Los Angeles (UCLA) students who self-financed their Ph.D. studies, with their own earnings and family support, took longer to complete the doctorate compared with those with fellowships or grants (Abedi and Benkin 1987). In the second study, at Rutgers University in the USA, different financial support for Ph.D. students did not affect their expected time to completion, except for international students who took longer if they had a teaching assistantship and less time if they benefitted from a research assistantship (Gilligham et al. 1991). These findings seem to be at odds with de Valero's (2001) study at a land-grant university in the USA, where most of the funding support came from teaching assistantships and extended the time to completion. de Valero argued that the type of funding support mattered more to the time of completion than the funding support itself.

Empirical studies in the literature to date have tended to produce mostly ambiguous or even mixed findings, which may have been the result of the studies being based on single case studies of universities or specific fields of study. Therefore, analysing a national system encompassing all fields of knowledge is expected to provide a more comprehensive set of findings and make a more robust contribution to the relevant literature and policymaking.

2.3 Funding doctoral studies and the Ph.D. labour market in Portugal

Within the Portuguese doctoral system, students usually have three main funding sources to support their studies: their own resources (savings, work, or family, or all those combined), a *Ph.D. grant* (a fellowship), or a *research project grant* (similar to a research assistantship). Student loans and teaching assistantships, two types of Ph.D. funding support found in the USA and UK, are uncommon in Portugal. Even for students enrolled in Bachelor's degree programs, loans are not an accepted form of financing for education (Heitor et al. 2016). This is unlike the USA, where loans often finance education, including at the Ph.D. level (see Kim and Otts 2010). Teaching assistantships are also rare in Portugal. Ph.D. students may engage in some teaching at Portuguese universities, if invited, but this seldom happens. When it does, payment is not necessarily involved. Therefore, supporting the Ph.D. with a teaching assistantship is not financially viable.

In this study, the three forms of financing available to Portuguese doctoral studies are used in the analysis. Self-funding (*no grant funding*) is treated as the baseline. *Ph.D. grants* and *research project grants* are briefly explained forthwith.

No grant funding refers to students who do not receive any kind of competitive funding but rely on self-funding, usually derived from salary or personal/family savings.

Ph.D. grants are competitive public research funds that are often awarded by the Portuguese Foundation for Science and Technology (FCT) through an annual call for Ph.D. grant applications. The grants are given directly to individual Ph.D. students by the FCT,[5] and those who receive them are entitled to an annual co-payment for registration, tuition, and other fees. The monthly amount of the

grant (€980) is slightly above the net average monthly salary in Portugal, which is €925. To apply for the Ph.D. grant, candidates must submit a proposal to the funding agency, supported by designated documentation and the written recommendation of a Ph.D. supervisor. These applications are evaluated by committees, which then recommend some applicants for funding. Individual grants are awarded for 1 year, with a possibility for an annual renewal upon submission of the candidate's own assessment/evaluation of the work in progress supplemented by a recommendation from the Ph.D. supervisor. The grants are renewable for up to 4 years and require exclusivity (the Ph.D. candidate cannot be employed in any other job or earn additional income) to ensure that the doctoral students are completely focused on the proposed Ph.D. research agenda.

Research project grants are given to Ph.D. students who work as research assistants on research projects attributed to research centres or universities. Research assistants are usually hired based on the decision of the project's principal investigator or a committee associated with the research project. The candidate selection process tends to be competitive and based on the skills deemed necessary to the successful conclusion of the project in question. The research assistants are hired based on how well their skillsets match the project's tasks. However, it is also common for the research assistants to be the Ph.D. students of the principal investigator or one of the senior academics involved in the project, often Ph.D. students who were unable to obtain *Ph.D. grants*. The length of *research project grants* vary according to the duration of the project and/or the specific activities the grantees have been hired to work on. *Research project grants* offer an opportunity for doctoral students to initiate studies on topics related to the research project. However, most work on unrelated topics. Ph.D. students who finance their doctoral studies by working on projects may become involved with more than one project over the course of their degree.

The labour market for Ph.D. holders in Portugal is primarily within the higher education sector, in which entry into the professoriate track requires a doctorate. By the end of 2009, 85% of Ph.D. holders in the country were employed in this sector, with 3% more employed in the private non-profit sector. The two sectors are closely linked (Duarte and Mendonça 2009). Vacancies among higher education institutions have been stagnant for years, leading to the gradual aging of the academic staff (Machado-Taylor et al. 2017). Despite the diminishing net salaries of academics (Horta and Hasanefendic 2015), inbreeding in recruitment (with all of its detrimental associated effects; Tavares et al. 2015), a growing number of non-secure academics working under parallel 'special contracted personnel' status (Carvalho and Santiago 2010), and a growing number of Ph.Ds. in postdoctoral positions subsisting on temporary contracts (Araújo 2009), the higher education sector continues to be the most appealing market for Ph.D. candidates. The business and government sectors do not hire in sufficient numbers, and in many cases they do not represent an attractive career choice (Cabral-Cardoso 2001; Duarte and Mendonça 2009). This means that for decades, the environment for those undertaking the Ph.D. in Portugal has been an unchanged and constrained labour market.

3. Research design

3.1 Sample and data

Our analysis of the determinants of time to Ph.D. completion relied on the 2009 Careers of Doctorate Holders (CDH) dataset, covering 4,095 doctorate holders surveyed by the Portuguese Ministry of Science, Technology and Higher Education (MCTES).[6] All doctorate holders were resident in Portugal on 31 December 2009, and 2,253 declared that they had been full-time students during their doctoral studies. The survey provided abundant information on the socio-demographic features of each holder of the doctorate, the sources of financial support, the field of knowledge of the doctoral degree, and other information relative to the holder's educational path.

The doctorate holders (hereinafter, the 'respondents') were asked to list their publications at the time of the survey. This proved to be extremely useful for two reasons. First, it made it easier to match the publications with the authors in Clarivate AnalyticsWeb of Science (WoS), permitting validation of the authors' names and minimizing the issues associated with homonyms or namesakes. This validation was based on a two-step process in which reconciliation algorithms were first used (Maali et al. 2011), followed by manual validation. When this process was completed, 26,165 publications (articles only) were identified. Second, it allowed us to use (for analytical purposes) articles published in international peer-review journals indexed by Clarivate's WoS, a common practice in research performance studies (e.g., Ossenblok et al. 2012). Taking into account that some of the respondents finished the Ph.D. in 2009 (the questionnaire was implemented in 2010), articles published by 2012 were collected from WoS to account for the time lags associated with the increasingly longer review and publication cycles (Aksnes 2003).

3.2 Methodology and variables

The examination of whether Ph.D. funding was a determinant of time to Ph.D. completion was likely to be affected by endogeneity, given that the process leading to students' receiving grants was likely to be driven by the same factors affecting time to Ph.D. completion. In addition, these factors (i.e., determinants) were likely to be partially unobservable (e.g., in terms of skills, quality, and motivation). Consistent with the recent literature investigating the effects of funding on academics' careers (Bloch et al. 2014) and doctorate holders' performances (Horta et al. 2018), a conditional difference-in-difference (DID) methodology (Blundell and Dias 2002) combining the benefit of the DID approach and propensity score matching (PSM) was implemented.

First, PSM with a nearest-neighbour matching approach was implemented by estimating the probability of receiving Ph.D. funding. Through this procedure, the full sample of doctorate holders was reduced by associating each funded (treated) student with the most comparable not-funded (untreated) student (i.e., the student with the closest propensity score). Analytically, PSM was introduced with a common support of 2.5%, thereby excluding observations (Ph.D. students) that were characterized by an extreme (too high or too low) probability of receiving funding as a Ph.D. student. These were not proper candidates for the matching procedure. Matching was then applied using a replacement to avoid sort order and sample size bias (Dehejia and Wahba 1999).

PSM enabled a restricted sample of full-time doctorate holders to be identified. Specifically, 39 cases (1.73% of the full-time student population) were excluded because the candidate had published before starting the Ph.D. In addition, after analysing the distribution of the number of years needed to complete the Ph.D.,[7] outliers were excluded by limiting the sample to those taking more

than two and less than 10 years to complete the degree (145 cases were excluded). After PSM, the sample comprised 2,069 doctorate holders that had been enrolled as full-time Ph.D. students. The first stage of the analysis estimated the probability of being awarded a grant, relying on the main determinants suggested in the literature (e.g., Horta et al. 2018): gender, age, nationality, prestige of the graduate's university, main field of study, number of degrees awarded before the Ph.D., number of years elapsed between the last degree and the beginning of the Ph.D. programme, and the heterogeneity of the education fields before the Ph.D.

Second, the relationship between Ph.D. funding and degree duration was analysed using the matched sample. Consistent with a DID approach, a truncated negative binomial regression was implemented, including: (1) the treatment effect (i.e., being funded or not); (2) a set of characteristics affecting the probability of receiving Ph.D. funding; and (3) a set of characteristics that might potentially influence the number of years to Ph.D. completion. To establish the variable identifying the treatment effect, financially supported Ph.D. students were identified as those who received either *Ph.D. grants* or *research project grants* at the beginning of their programme (e.g., Visser et al. 2007). Besides research productivity during the Ph.D., which was a key explanatory variable, other variables that might potentially affect the time needed to complete the Ph.D. were also included. For example, undertaking the Ph.D. at a Portuguese university (versus abroad) was relevant because Lin and Chiu (2014), using a Taiwanese national sample, found that those who studied for the Ph.D. abroad finished faster than those studying at home by around 9.61 months.

Two variables related to university prestige were included because they act as known signals favouring recruitment, particularly in the academic labour market (see Burris 2004). The first was a dummy variable equal to one for Ph.D. students enrolled in one of the oldest Portuguese universities. The second was a dummy variable equal to one for all universities listed in the Academic Ranking of World Universities. Demographic statistics and the educational path were also known to influence time to Ph.D. Kim and Otts (2010) found that older Ph.D. students and those who changed majors (i.e., field change to the Ph.D.) took longer to finish. To account for changes in the Portuguese research and development system known to have affected the career paths of doctorates (Santos and Horta 2015), three periods of time were introduced: concluding the Ph.D. before 1985, concluding between 1985 and 1995, and concluding after 1995. In the first period, the labour market for Ph.Ds. was expanding within the higher education system in relation to the other periods (the time to Ph.D. completion was 4.06 years). The second period produced mixed scenario, not only with postdoctoral positions but also some vacancies emerging within the higher education system (the average time to completion increased to 4.65 years). The third period was the most constrained in terms of the Ph.D. labour market (average time to complete the Ph.D. grew to 4.98 years). All the variables are described in Table 1.

3.3 Descriptive statistics

Table 1 also reports the average values and standard deviations of the Ph.D. holders' characteristics, splitting the sample into two groups: those who were financially supported (1,562), and those who did not receive either a *Ph.D. grant* or a *research project grant* (507). The two groups significantly differed across several dimensions. Those receiving funding were younger (35.2 vs. 43.2 years old), produced more research during their Ph.D. (0.187 vs. 0.062 papers per individual per year) and started the Ph.D. sooner after their previous degree (3.0 vs. 6.1 years). Further, the percentage of Ph.D. students enrolled in Portugal is smaller for financially supported students than for non-financially supported (61% vs. 70%),[8] as well as the percentage of students enrolled at one of the oldest (and most prestigious) Portuguese universities (34% vs. 42%). The two groups also differed in terms of their fields of study. More students were awarded grants in Agriculture, Engineering and Technology, and Natural Sciences. Fewer received grants in Medical Science, Social Science and Humanities. These differences underline the importance of implementing PSM to find a sample of comparable Ph.D. students.

4. Results

As described above, our empirical analysis was run in two stages. In the first, PSM was used to assess features that affected the probability of receiving funding from one of the two funding resources (*Ph.D. funding*). In the second stage, a truncated negative binomial regression was estimated on the matched sample of funded and non-funded students to assess what the impact of funding was on the time between the beginning and the end of the Ph.D. To assess the impact of funding type on the time to Ph.D. completion, the second stage was replicated twice: once to disentangle the effects for STEM versus non-STEM students and again after adding a dummy variable equal to one for doctorate holders funded by *Research project grants*.

Starting with the sample of 2,069 researchers, Table 2 reports the factors affecting the probability of receiving Ph.D. funding (both *Ph.D. grants* and *research project grants*). The results show that the probability of receiving funding was significantly higher for younger students, suggesting that financial support was more often provided to students who pursued a continuous educational path. This was confirmed by evidence that the shorter the elapsed time from the previous degree to the beginning of the Ph.D., the greater the probability of receiving funding. Gender differences were also observed: females were more likely to be funded than males (at a 1% significance level).[9] Further, Portuguese students were slightly more likely to receive funding.[10] A weak but significant coefficient indicated that Ph.D. funding was more likely to be awarded to those with multidisciplinary educations (*field change between degrees*). With respect to the different fields of science, students studying Agriculture and Natural Science had a higher probability of receiving funding than those in Humanities, and the probability significantly declined for those in Health Sciences.

The validity of PSM was tested according to the previous literature (e.g., Sianesi 2004; Yang et al. 2012). The means of the characteristics presented in Table 1 showed no statistical differences after PSM was implemented, and the propensity scores were identical for both groups. The mean absolute bias of the matched sample was reduced when compared with the matched sample. Finally, the pseudo R^2 of a new probit analysis, performed on the matched sample, was close to zero, confirming that after PSM was introduced, the covariates did not have any further explanatory power in discriminating treated (funded) and untreated Ph.Ds. After PSM, a sample of 1,841 doctorate holders remained, with 1,523 in the treated group (39 excluding the implementation of common support at 2.5%) and 318 in the untreated group.

Table 1. Variables description

Variables	Description	Funded researcher (mean)	Funded researcher (SD)	Non-funded researcher (mean)	Non-funded researcher (SD)
Dependent variables during the Ph.D.					
Ph.D. duration	Number of years elapsed between the beginning and the end of the Ph.D. programme.	4.806	1.347	4.951	1.520
Independent variables					
Productivity Ph.D.	Number of publications authored during the Ph.D. programme, divided by Ph.D. duration.	0.187***	0.483	0.062	0.342
Control variables					
Nationality	Dummy variable equal to 1 if the doctorate holder was born in Portugal, 0 otherwise.	0.943	0.232	0.941	0.236
Gender (male = 1)	Dummy variable equal to 1 if the doctorate holder is a male, 0 otherwise.	0.520***	0.500	0.611	0.488
Age at Ph.D.	Number of years elapsed between the year of birth and the beginning of the Ph.D. programme.	35.157***	7.047	43.231	8.547
Field change to the Ph.D.	Dummy variable equal to 1 if the doctorate holder changed field of study between the last degree attained and the Ph.D., 0 otherwise.	0.191**	0.394	0.142	0.349
Graduated from a prestigious university	Dummy variable equal to 1 if the doctorate holder graduated from a university included in the ARWU ranking (in the year of enrolment), 0 otherwise.	0.250	0.433	0.266	0.442
Time between previous highest degree and start of the Ph.D.	Number of years elapsed between the previous degree attained and the start of the Ph.D.	3.020***	4.009	6.118	6.276
More degrees before Ph.D.	Dummy variable equal to 1 if the doctorate holder attained more than one degree before the Ph.D., 0 otherwise.	0.338	0.473	0.312	0.464
Ph.D. in Portugal	Dummy variable equal to 1 if the doctorate holder received the Ph.D. from a Portuguese university, 0 otherwise.	0.614***	0.487	0.696	0.460
Ph.D. at oldest Portuguese universities	Dummy variable equal to 1 if the doctorate holder received the Ph.D. from one of the three oldest, and therefore, most prestigious, universities in Portugal (i.e., University of Lisbon, University of Porto, and University of Coimbra), 0 otherwise.	0.343***	0.474	0.416	0.493
Field of knowledge	Six dummy variables identifying the field of study before the Ph.D. (i.e., Agriculture, Engineering and Technology, Natural Sciences, Medical Sciences, Social Sciences, Humanities). Humanities is the reference case.				
	Agriculture	0.067***	0.249	0.034	0.180
	Engineering and technology	0.274***	0.446	0.164	0.370
	Natural sciences	0.270***	0.444	0.122	0.328
	Medical sciences	0.092***	0.289	0.176	0.380
	Social sciences	0.200***	0.400	0.341	0.475
	Humanities	0.097***	0.296	0.164	0.370
No. of Ph.Ds.		1,562		507	

Note: ***,**,*Significant at the 1%, 5%, and 10% levels, respectively.

Table 2. Probit regression for the likelihood of receiving Ph.D. funding

Variables	(1) Receive Ph.D. funding
Age at Ph.D.	−0.060***
	(0.005)
Gender (male = 1)	−0.228***
	(0.067)
Nationality (Portuguese = 1)	0.245*
	(0.142)
Field change to the Ph.D.	0.170*
	(0.090)
Graduated from a prestigious university	−0.009
	(0.077)
Time between previous highest degree and start of the Ph.D.	−0.022***
	(0.008)
More degrees before the Ph.D.	0.102
	(0.074)
Agriculture	0.434**
	(0.175)
Engineering and technology	0.129
	(0.121)
Natural sciences	0.227*
	(0.125)
Medical sciences	−0.278**
	(0.131)
Social sciences	−0.117
	(0.109)
Constant	2.896***
	(0.252)
Observations	2,069
Pseudo R^2	0.184

Standard errors are in parentheses.
Note: ***,**,*Significant at the 1%, 5%, and 10% levels, respectively.

Table 3. Truncated negative binomial regression on the time to Ph.D.

Variables	(1) Ph.D. duration	(2) Ph.D. duration
Ph.D. funding	1.019**	0.865**
	(0.441)	(0.386)
Research productivity	−0.093***	0.161***
	(0.016)	(0.018)
Research productivity × Ph.D. funding		−0.283***
		(0.005)
Age at Ph.D.	0.027***	0.024***
	(0.006)	(0.005)
Gender (male = 1)	0.026***	0.018***
	(0.002)	(0.005)
Field change to the Ph.D.	−0.018	−0.013
	(0.017)	(0.017)
Graduated from a prestigious university	0.015***	0.017***
	(0.004)	(0.005)
More degrees before the Ph.D.	−0.065***	−0.061***
	(0.019)	(0.017)
Time between previous highest degree and start of the Ph.D.	−0.010***	−0.011***
	(0.001)	(0.000)
Ph.D. in Portugal	0.069**	0.067**
	(0.031)	(0.031)
Ph.D. in oldest Portuguese universities	0.093***	0.082***
	(0.016)	(0.013)
Concluding Ph.D. in the period 1985–95	0.138***	0.132***
	(0.036)	(0.034)
Concluding Ph.D. after 1995	0.097***	0.107***
	(0.022)	(0.023)
Dummies for field of study	YES	YES
Constant	−0.340	−0.105
	(0.587)	(0.507)
Observations	1,841	1,841

Standard errors are in parentheses.
Note: ***,**,*Significant at the 1%, 5%, and 10% levels, respectively.

The second stage of the analysis was performed on the sample of 1,841 doctorate holders. The results are reported in Table 3 (regressing Ph.D. duration on its determinants). Model (1) shows that Ph.D. funding was positive and highly significant, highlighting that financially supported students took longer to complete the Ph.D. Concurrently, research productivity had the exact opposite effect: the greater the research productivity of the Ph.D. students, the shorter the duration of their Ph.D. studies. This means that the two credentials expected to influence student behaviour related to completion time of the Ph.D. were relevant. Both determined the time to completion, but they also showed opposing effects. From this initial perspective, Ph.D. funding did not appear to act as a credential to signal the post-Ph.D. labour market (it would if it led to less time to complete the Ph.D.). Rather, it projected a 'wait-and-see' approach in which the duration of the Ph.D. programme was extended (supported by grant earnings) while students hoped for interesting work/career opportunities to materialize. Conversely, publishing during the Ph.D. seemed to act as a credential, because it incentivized students to quickly finish the Ph.D. and compete in the post-Ph.D. labour market. There is also the possibility that both credentials were linked. Funded Ph.D. students may be extending their time to completion to increase the number of their publications and become more competitive in the post-Ph.D. labour market. In that case, Ph.D. funding could be used to build-up the signalling power of publications as credentials (at the expense of increased time to completion).

This assumption was tested in Model 2, where an interaction between funding and research productivity was added. The result was a positive coefficient for research productivity and a negative coefficient for the joint effect of research productivity and Ph.D. funding. Thus, the use of Ph.D. funding to build-up the signalling power of publications was not validated (for it to be validated, the coefficient of the interaction would need to be statistically significant and positive). At the same time, this result challenged the hypothesis that research productivity decreases, per se, the time to Ph.D. completion. The findings suggest that the effect of research productivity on the time to Ph.D. completion only affects those supported by Ph.D. funding. In other words, greater research productivity during the Ph.D. decreases the time to Ph.D. completion for those who are funded but increases the time for those who are not funded.

The findings further indicate that funded students having greater research productivity tend to finish the Ph.D. faster, compared with those who are awarded grants and do not publish during the Ph.D. The reason for this may be related to the notion that students combine the effects of competitive funding and publishing to face the job market with more confidence, that is, given that they already have the prestige of being funded and a track record of publications, they are more likely to be competitive on the job market. To summarize, Ph.D. funding gives students more time to complete the Ph.D. Among funded students, those who are more productive experience a strong reduction in their time to the Ph.D. Non-funded students take more time to complete the Ph.D., particularly when they are productive. This suggests that non-funded students increase the duration of their Ph.D. to face the post-Ph.D. market with greater confidence built on a higher number of publications.

As far as the control variables are concerned, the results in Table 3 show that the age of the Ph.D. candidate was a determinant of Ph.D. duration. Older Ph.D. students took more time to finish their programmes. The time to completion also increased for students completing their Ph.Ds. in Portugal and, more so at the oldest Portuguese universities. The latter may be related to waiting for an academic position to open-up. At these universities, one becomes aware of and integrated into internal networks where first-hand information on possible vacancies circulate. Contributing to informal tasks that highlight visibility and loyalty at the same time are features that assume great importance in higher education systems where academic inbreeding is widespread (Tavares et al. 2015). Candidates finishing their Ph.D. programs between 1985 and 1995, and after 1995, *Ceteris paribus*, took more time than those completing their programs before 1985 (reference case in the regressions). This is an indication that the academic labour market was becoming increasingly constrained and that Ph.D. students were developing strategies to cope with it (i.e., by taking longer to complete their studies while waiting for less frequent vacancies to appear). The factors contributing to shorter Ph.D. completion time were the number of degrees awarded to the candidate prior to the doctoral programme and the time elapsed between the end of the previous degree and the beginning of the Ph.D. programme. The explanation behind these factors can be explained from a human capital theory perspective because both variables are expected to imbue these students with more skills and continuity to cope with the demands of the Ph.D. (Deterding and Pedulla 2016).

Table 4 complements the analysis of Table 3 by additionally analysing the effect of Ph.D. funding on the time to Ph.D. completion for students in STEM fields. Given the need to interpret an interaction between coefficients, the models presented in Table 3 were re-estimated on two subsamples: one for STEM (including Medicine) and other for non-STEM fields. Our findings suggest that funding and research productivity played a significant role only for students in STEM fields. The results also showed that Ph.D. students in STEM fields reacted differently to incentives and the environment than non-STEM students. This can possibly be explained by the post-Ph.D. labour market, which offers more and often better paid, safer career paths for STEM students than it does for non-STEM students (Curtin et al. 2016; Marini 2018) even in a country like Portugal that employs most of its doctorate holders in the higher education system (Duarte and Mendonça 2009).

The final component of the analysis focused on the impact different funding sources had on the time to Ph.D. completion.

Table 4. Truncated negative binomial regression on the time to Ph.D. by STEM and non-STEM fields

Variables	(1) Ph.D. duration	(2) Ph.D. duration
	STEM	Non-STEM
Ph.D. funding	0.661**	0.626
	(0.312)	(0.438)
Research productivity × Ph.D. funding	−0.289***	−0.198
	(0.044)	(0.137)
Research productivity	0.180***	0.025
	(0.041)	(0.136)
Age at Ph.D.	0.027***	0.016**
	(0.005)	(0.007)
Gender (male = 1)	−0.013	0.038
	(0.020)	(0.027)
Field change to the Ph.D.	−0.018	0.012
	(0.020)	(0.037)
Graduated from a prestigious university	0.016	0.018
	(0.020)	(0.026)
More degrees before the Ph.D.	−0.089***	−0.033
	(0.019)	(0.028)
Time between previous highest degree and start of the Ph.D.	−0.018***	−0.008***
	(0.003)	(0.003)
Ph.D. in Portugal	0.106***	0.021
	(0.026)	(0.028)
Ph.D. in oldest Portuguese universities	0.065***	0.070*
	(0.022)	(0.037)
Concluding Ph.D. in the period 1985–95	0.070**	0.193***
	(0.031)	(0.066)
Concluding Ph.D. after 1995	0.081***	0.131**
	(0.027)	(0.059)
Sub-fields dummies	YES	YES
Constant	−0.055	0.350
	(0.413)	(0.620)
Observations	1,125	716

STEM disciplines include Engineering and Technology, Natural Science and Medical Science. Standard errors are in parentheses.

Note: ***,**,*Significant at the 1%, 5%, and 10% levels, respectively.

A two-stage Heckman procedure was implemented to account for potential self-selection bias. In the first stage, the probability of receiving funding was estimated through probit regression. In the second stage, time to Ph.D. completion was only predicted for those receiving funding, to understand the different effects of the two sources. Following Heckman (1979), the inverse Mills' ratio was included among the regressors in the second stage, to account for potential selection bias. Given that the dummy variable *research project grant* (0 means receiving a *Ph.D. grant*) was not statistically significant, it supported the argument that the sources of funding for a Ph.D. have an indistinguishable effect on the time to complete the degree.[11] This result also holds when analysing differences in the two categories for students with higher or lower research productivity, suggesting that receiving a fellowship (Ph.D. grant) or a research assistantship (*research project grant*) does not impact time to the Ph.D.

Table 5. Truncated negative binomial regression on the time to Ph.D. by source of funding (second-stage of the Heckman procedure)

Variables	(1) Ph.D. duration	(2) Ph.D. duration
Research project grant	0.010	0.016
	(0.024)	(0.027)
Research productivity	−0.096***	0.029
	(0.017)	(0.021)
Research productivity × Research project grant		−0.004
		(0.033)
Age at Ph.D.	0.027***	0.012***
	(0.004)	(0.002)
Gender (male = 1)	0.025	−0.013
	(0.017)	(0.014)
Field change to the Ph.D.	−0.011	0.009
	(0.020)	(0.018)
Graduated from a prestigious university	0.020	0.031*
	(0.017)	(0.017)
More degrees before the Ph.D.	−0.062***	−0.035**
	(0.017)	(0.015)
Time between previous highest degree and start of the Ph.D.	−0.012***	−0.015***
	(0.003)	(0.002)
Ph.D. in Portugal	0.075***	0.057***
	(0.021)	(0.020)
Ph.D. in oldest Portuguese universities	0.091***	0.052***
	(0.020)	(0.018)
Concluding Ph.D. in the period 1985–95	0.121***	0.088***
	(0.029)	(0.028)
Concluding Ph.D. after 1995	0.102***	0.140***
	(0.025)	(0.025)
Inverse Mills ratio	−2.114***	0.314***
	(0.607)	(0.067)
Dummies for field of study	YES	YES
Constant	1.270***	0.781***
	(0.097)	(0.078)
Observations	1,523	1,523

Standard errors are in parentheses.

Note: ***,**,*Significant at less than 1%, 5%, and 10% levels, respectively.

5. Conclusion

The time needed to complete a Ph.D. is a concern for everyone involved in doctoral education. It remains high in most countries and often leads to increased attrition and non-completion rates (Kim and Otts 2010). The average time to the Ph.D. is not as high in Portugal as it is in countries with more developed research systems and universal higher education (e.g., the USA, UK). However, the time to complete a Ph.D. has been rising. In the wake of several studies on the topic (mostly published during the 1980s, and 1990s) and using Breneman's (1976) theoretical framework to guide the analysis, this study analysed a representative sample of Ph.D. doctorates (thus, all having successfully completed the Ph.D.) from all fields of knowledge working in Portugal, to better understand how funding impacted the time to complete doctoral studies. In addition to using a countrywide sample rather than a single university as the focus of the analysis, and using a methodology that reduced selection bias, this study considered publications produced during the Ph.D. as a credential that was bound to affect (as funding expectedly does) time. This is compatible with Breneman's (1976) idea that Ph.D. students respond to incentives and that these incentives shape the behaviours related to the completion of their doctoral studies. However, this idea has not been followed to date, perhaps because the practice of publishing during a Ph.D. programme has only recently become common (Pinheiro et al. 2014).

The findings show that a one standard-deviation increase in the probability of receiving Ph.D. funding, led to an increase in the time needed to complete the Ph.D. by a semester. This result is consistent with the empirical findings in the literature (e.g., Seagram et al. 1998) indicating that those with funding support tend to take longer than those without support. It is not aligned with the stream of empirical articles showing otherwise (e.g., Abedi and Benkin 1987). In contrast, greater research productivity during the Ph.D. apparently has an opposite effect, that is, a one standard-deviation increase in research productivity during the Ph.D. tended to decrease the time needed to complete the doctorate by 2.5 months, indicating that funding and publishing during the Ph.D. acted differently as incentives in relation to Ph.D. completion time.

This resonates with Breneman's (1976) theoretical framework. However, it also brings an interesting analytical perspective to the analysis because when the two credentials interacted, two things emerged. First, those with an increased probability of receiving Ph.D. funding, and who generated a greater number of publications, finished the Ph.D. in a shorter amount of time than those with Ph.D. funding and fewer (by 4 months) or no publications. This suggests that accumulating credentials gives Ph.D. students more confidence to face the labour market after finishing the degree, knowing they have a signal edge in the competitive (and constrained) market they will be facing (which in Portugal is mainly the academic market even for those graduating with STEM Ph.Ds.; Cabral-Cardoso 2001; Duarte and Mendonça 2009). Second, the effect of publishing during the Ph.D. standing alone had a spurious effect, because the effect of research productivity during the Ph.D. only led to a decrease in the time to completion for those who were funded; whereas it increased the time for completion for others. As such, publishing during the Ph.D. offers a complex dynamic: it has a complementary effect for funding, reinforcing its role as a credential by decreasing the time to the Ph.D.; however, it can also contribute a 'wait and see' strategy, because publications emerge as the only credential available (when there is a lack of funding) leading to an extension of time to complete the Ph.D., and allowing the unfunded to better prepare for the post-Ph.D. market. Nested analyses of Ph.D. students in STEM and non-STEM fields highlighted this dynamic as being particularly relevant for those undertaking the Ph.D. in STEM fields.

The analysis also showed that receiving a fellowship (Ph.D. grant) or a research assistantship (*research project grant*) did not affect the time to completion. Apparently, this does not align with the argument that the type of funding is more important to completion time than having any funding support for the Ph.D. (de Valero 2001). However, some caution is needed in making this assessment. Although these findings are clearly of interest to funding agencies and universities from a policy perspective, they do not allow for a clear-cut comparison with the previous literature (mostly focused in the USA and UK) because in Portugal, teaching assistantships are uncommon (it is important to remember that in the literature those

benefiting from teaching assistantships tend to receive funding and take the longer to complete their Ph.Ds.; see Ehrenberg and Mavros 1995). These results suggest that when students receive funding support to engage in research-related activities (regardless of whether the support is through a fellowship or a research assistantship) the time to the Ph.D. is bound to increase.

This result should not imply that funding to support Ph.D. students should be reduced or constrained to improve the overall time to completion. Without funding, the number of potential doctoral students would substantially decline. This would certainly have detrimental effects for countries trying to raise their human capital, and for universities, where Ph.D. students contribute to the quality of research and the global pool of knowledge (Cuthbert and Molla 2015). Funding support for Ph.D. students appears to be critical to attracting good candidates to doctoral programs and giving them enough time to prepare for the constrained national and global postdoctoral labour markets (Marini 2018; Tomlinson 2008). From a policy perspective, what the findings suggest is that alongside Ph.D. funding support, policymakers and funding agencies should stress the importance of publishing during the Ph.D., to prepare students (from a signal theory standpoint) to enter the postdoctoral labour market with stronger credentials, and at the same time making sure that the research outputs from their doctoral research make a more immediate contribution to national, regional and global knowledge. The findings of this study also underline the need to raise awareness of students starting doctoral studies about the importance of credentials, including what specific credentials mean and how they may benefit them during and after the completion of Ph.D. studies.[12]

Notes

1. This is the case for Portugal the empirical context chosen for this analysis, where Ph.D. students bring with them funding to support their studies (some supported by the main national funding agency, Fundação para a Ciência e Tecnologia).
2. Breneman (1976) is used by other relevant studies assessing students' time to Ph.D. completion (e.g., Ehrenberg and Mavros 1995).
3. In terms of the Ph.D. one does not receive this premium in relation to those with Master's degrees, at least in the private sector (see Pedersen 2016).
4. For a Ph.D., that would be the capacity to independently develop a high level of research, among other skills (see Mantai 2017).
5. There has been a change in this procedure over the past 3–4 years, but this does not affect the analysis because the change is too recent, and none in the data set were subjected to it.
6. The selection of the sample was based on a proportional stratified random sample. Proportional stratification is a type of stratified sampling. With proportionate stratification, the sample size of each stratum is proportionate to the population size of the stratum. This means that each stratum has the same sampling fraction. The design, sampling procedure, and implementation of the CDH questionnaire rest with the MCTES.
7. Median: 5; SD: 2.01; 25th percentile: 4; 75th percentile: 6
8. This aligns with science policies implemented in Portugal to sustain and increase the internationalization of the academic system (Horta and Santos 2015).
9. This difference would suggest controlling for measures of different engagement by gender. However, our data do not allow for such controls.
10. The competition for grants in Portugal is open to applicants from all nationalities.
11. A further analysis was made to understand whether those Ph.D. students who benefited from both a Ph.D. grant and a research project grant might show a significantly different time to Ph.D. Findings highlight that these Ph.D. students did not have a longer time to complete their Ph.D. when compared with those supported only by one of these funding sources, thus confirming that having a second source of finding does not necessarily extends Ph.D. duration.
12. Ph.D. funding works as a credential because it separates those that got funding from a funding agency or from the principal investigators of a research project after undergoing a competitive selection process and were able to be successful in obtaining it, from those that were not. In contemporary societies based on increasing competition and the need to stand out, Ph.D. funding functions as signalling for potential future employers and colleagues of the potential ability of the individual to obtain competitive research related funding (Waaijer et al. 2018). This is arguably as relevant as the benefits that being funded provides the students in terms of financial support for the duration of the studies. The other credential of key relevance during the doctoral studies is publications. These credentials evidence the ability of Ph.D. students to publish research they conducted during their doctoral studies but may also evidence their ability to work in teams (if the research was collaborative), and of contributing to their fields already as early stage researchers. Publications function as a powerful credential as studies have shown that publishing during the Ph.D. is a predictor of career publications independently of the sector of activity where the Ph.D. holder works (Horta and Santos 2016).

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Appendix

Table A.1. Truncated negative binomial regression on the time to Ph.D. (referring to Table 3)

Variables	(1) Ph.D. duration	(2) Ph.D. duration
Ph.D. funding	4.846**	4.113**
	(2.102)	(1.837)
Research productivity	−0.445***	0.766***
	(0.075)	(0.087)
Research productivity × Ph.D. funding		−1.344***
		(0.023)
Age at Ph.D.	0.127***	0.113***
	(0.027)	(0.023)
Gender (male = 1)	0.124***	0.085***
	(0.012)	(0.022)
Field change to the Ph.D.	−0.087	−0.060
	(0.079)	(0.078)
Graduated in a prestigious university	0.070***	0.080***
	(0.020)	(0.026)
More degrees before the Ph.D.	−0.307***	−0.289***
	(0.091)	(0.081)
Time between previous highest degree and start of the Ph.D.	−0.047***	−0.051***
	(0.003)	(0.001)
Ph.D. in Portugal	0.326**	0.317**
	(0.145)	(0.144)
Ph.D. in oldest Portuguese universities	0.447***	0.392***
	(0.078)	(0.065)
Concluding Ph.D. in the period 1985–95	0.690***	0.658***
	(0.190)	(0.177)
Concluding Ph.D. after 1995	0.452***	0.496***
	(0.099)	(0.104)
Dummies for field of study	YES	YES
Observations	1,841	1,841

Note: ***,**,*Significant at the 1%, 5%, and 10% levels, respectively.

Table A.2. Truncated negative binomial regression on the time to Ph.D. by STEM and non-STEM fields (referring to Table 4)

Variables	(1) Ph.D. duration	(2) Ph.D. duration
	STEM	Non-STEM
Ph.D. funding	3.054**	3.107
	(1.443)	(2.173)
Research productivity × Ph.D. funding	−1.334***	−0.982
	(0.206)	(0.681)
Research productivity	0.832***	0.126
	(0.192)	(0.677)
Age at Ph.D.	0.126***	0.081**
	(0.021)	(0.035)
Gender (male = 1)	−0.062	0.191
	(0.092)	(0.134)
Field change to the Ph.D.	−0.083	0.061
	(0.091)	(0.183)
Graduated in a prestigious university	0.072	0.087
	(0.092)	(0.131)
More degrees before the Ph.D.	−0.403***	−0.166
	(0.086)	(0.138)
Time between previous highest degree and start of the Ph.D.	−0.084***	−0.042***
	(0.014)	(0.015)
Ph.D. in Portugal	0.481***	0.105
	(0.116)	(0.137)
Ph.D. in oldest Portuguese universities	0.301***	0.354*
	(0.104)	(0.189)
Concluding Ph.D. in the period 1985–95	0.333**	1.034***
	(0.149)	(0.379)
Concluding Ph.D. after 1995	0.367***	0.622**
	(0.119)	(0.270)
Sub-fields dummies	YES	YES
Observations	1,125	716

Note: ***,**,*Significant at the 1%, 5%, and 10% levels, respectively.

Table A.3. Truncated negative binomial regression on the time to Ph.D. by source of funding (second stage of the Heckman procedure; referring to Table 5)

Variables	(1) Ph.D. duration	(2) Ph.D. duration
Research project grant	0.048	0.075
	(0.116)	(0.130)
Research productivity	−0.456***	0.148
	(0.081)	(0.100)
Research productivity × Research project grant		−0.037
		(0.154)
Age at Ph.D.	0.126***	0.058***
	(0.019)	(0.007)
Gender (male = 1)	0.118	−0.063
	(0.079)	(0.067)
Field change to the Ph.D.	−0.052	0.045
	(0.093)	(0.088)
Graduated in a prestigious university	0.094	0.146*
	(0.081)	(0.083)
More degrees before the Ph.D.	−0.293***	−0.167**
	(0.081)	(0.073)
Time between previous highest degree and start of the Ph.D.	−0.056***	−0.072***
	(0.012)	(0.012)
Ph.D. in Portugal	0.353***	0.273***
	(0.096)	(0.095)
Ph.D. in oldest Portuguese universities	0.437***	0.242***
	(0.098)	(0.088)
Concluding Ph.D. in the period 1985–95	0.598***	0.432***
	(0.148)	(0.140)
Concluding Ph.D. after 1995	0.473***	0.644***
	(0.113)	(0.110)
Inverse Mills ratio	−10.029***	1.516***
	(2.877)	(0.314)
Dummies for field of study	YES	YES
Observations	1,523	1,523

Note: ***,**,*Significant at the 1%, 5%, and 10% levels, respectively.

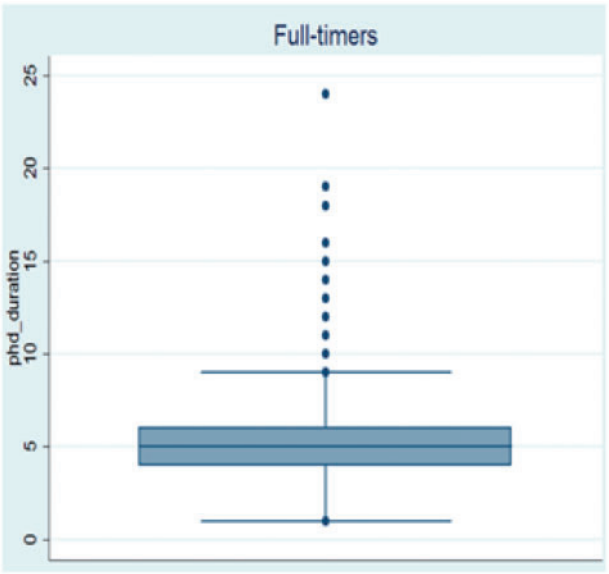

Figure 1. Time to Ph.D. in the sample (including outliers).