The relevance of employment for the time of completion of Ph.D. in Brazil

A relevância do emprego para o tempo de conclusão do doutorado no Brasil

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Abstract: This paper investigates whether employment is a relevant predictor of the time in which Ph.D. students complete the program and earn the degree in Brazil. Based on human capital theory, it is argued that professional activities may alter the costs and benefits faced by students because of the extra effort necessary to balance professional activities with the requirements to continue and progress in the program. Based on this argument, the first hypothesis investigated herein is that there is a positive correlation (conditional on the relevant covariates) between employment during the Ph.D. and the time expected to successfully complete it. It is also hypothesized that public employment predicts a shorter time of completion than private employment. Such associations are empirically tested using a novel dataset with information on Brazilian Ph.D. students from the CAPES database merged with employment data from the 'Annual Social Information Report' (RAIS). The results indicate that, holding all else constant, each year of the Ph.D. in which a student is employed is associated with a 0.145 additional year necessary for completion of the program. Employment in the public sector is found to predict a higher time of completion than employment in the private sector, but the difference between the estimated coefficients is small and not meaningful. These findings provide relevant insights for the design and improvement of Ph.D. programs and evaluation systems that acknowledge and take into consideration the context in which these students develop their studies and research.

Keywords: Graduate education. Higher Education. Ph.D. duration. Program fixed effects.

Resumo: Este artigo investiga se o emprego é um preditor relevante do tempo que estudantes de doutorado levam para concluir o programa e obter o título no Brasil. Com base na teoria do capital humano, argumenta-se que atividades profissionais

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podem alterar os custos e benefícios encarados pelos estudantes, devido ao esforço adicional necessário para equilibrar e emprego com as exigências para permanecer e progredir no programa. Com base nesse argumento, a primeira hipótese investigada é de que há uma correlação positiva (condicionada às covariáveis relevantes) entre o emprego durante o doutorado e o tempo esperado para concluílo com sucesso. A segunda hipótese é de que o emprego no setor público prediz um tempo de conclusão menor do que o emprego no setor privado. Essas associações são testadas empiricamente utilizando uma base nova de dados com informações de estudantes de doutorado brasileiros disponíveis na base da CAPES, combinadas com dados de emprego do Relatório Anual de Informações Sociais (RAIS). Os resultados sugerem que, mantendo as demais variáveis constantes, cada ano do doutorado em que o estudante está empregado se encontra associado a 0,145 ano adicional necessário para a conclusão do programa. O emprego no setor público prediz um tempo maior de conclusão em comparação ao emprego no setor privado, mas a diferença entre os coeficientes estimados é pequena e não significativa. Esses resultados fornecem informações relevantes para o desenho e melhoria de programas de doutorado e sistemas de avaliação, a fim de reconhecer e levar em consideração o contexto no qual esses estudantes desenvolvem seus estudos e pesquisas.

Palavras-chave: Pós-graduação. Educação superior. Duração do doutorado. Efeitos fixos de programa.

Códigos JEL: C41; I23; J45

1 INTRODUCTION

In the last two decades, Brazil has experienced an unprecedented growth in its graduate education system. In 2019, universities in the country awarded nearly 25 thousand Ph.D. degrees, surpassing countries with a strong scientific and technological base, such as Japan, Korea and France (OECD, 2021). However, financial support available to these students did not follow the same trend, and, in 2016, the number of available federal scholarships was around than forty percent of the number of Ph.D. students in the country (CAPES, 2017; BRAZILIAN MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION, 2022b; a). As a result, a significant number of students must rely on other sources to finance their studies and subsistence, and many resort to employment during their Ph.D. This is hardly a particular feature of Brazil, as studies in other countries reported that students face the same challenge (VAN DER HAERT *et al.*, 2014; MALOSHONOK AND TERENTEV, 2019). However, the implications of employment for the trajectories of doctorate students have not been assessed for the Brazilian case and remain largely unknown, with a lack of research to back the design of policies and regulations that take such challenges into consideration.

A growing body of literature has been developed internationally in recent decades to investigate how different factors influence or predict the outcomes of students in the Ph.D. (ABEDI AND BENKIN, 1987; MASTEKAASA, 2006; VAN DER HAERT *et al.*, 2014). Employment during the program is commonly associated with negative outcomes, such as a longer time of completion (ABEDI AND BENKIN, 1987; WAO AND ONWUEGBUZIE, 2011). However, to the best of our knowledge, no quantitative model-based study has attempted to demonstrate the potential associations of employment with the progress of Ph.D. students in Brazil.

This paper aims to address this gap by testing whether employment is a relevant predictor of the time in which Ph.D. students complete the program and earn the degree in Brazil, also assessing the magnitude of this association. The analysis is theoretically grounded in the economic models of human capital investment (BRENEMAN, 1976; PAULSEN, 2001). Following such an approach, it is argued that professional activities may alter the costs and benefits faced by students because of the extra effort necessary to balance professional activities with the requirements to continue and progress in the program (EHRENBERG AND MAVROS, 1995). Based on this argument, the first hypothesis investigated herein is that there is a positive correlation (conditional on the relevant covariates) between employment during the Ph.D. and the time expected to successfully complete it.

A second point of analysis is whether the sector of employment also matters, i.e., whether public and private jobs present distinct associations with time of completion, because of their differences in terms of the labor market (as the government tends to hire a more educated workforce – BETTONI AND SANTOS, 2019), the greater level of job security of public employees (POSTEL-VINAY, 2015) and other rules and incentives applicable to each sector. Based on such features, it is also

hypothesized that public employment predicts a shorter time of completion than private employment.

Such associations are empirically tested using a novel dataset with microdata on Ph.D. students in Brazil and their employment contracts during the program, using information from the Brazilian graduate students' database (CAPES, 2017) and the 'Annual Social Information Report – RAIS' (MINISTRY OF LABOR AND EMPLOYMENT, 2017). The estimation uses a Ph.D. program fixed effects model, which controls for attributes of universities and programs constant across individuals, eliminating any biases arising from such factors (WÖßMANN AND WEST, 2006; OST AND SCHIMAN, 2015).

The results indicate that each additional year in which the student is employed during the Ph.D. predicts a longer expected time of completion, confirming the proposed hypothesis. This finding is consistent with the international literature on the subject (MATUTE, 2014; SPRONKEN-SMITH *et al.*, 2018), indicating that such an argument on the implications of employment is general and applicable to different contexts. On the other hand, the coefficient for public employment was found to be greater than for jobs in the private sector (although the difference is small), thus rejecting the proposed hypothesis on the advantages of government occupations. The paper contributes to such literature by presenting the first model-based assessment on the topic for the Brazilian case, adding to the knowledge of the graduate system in the country and to the limited body of quantitative works on the subject considering developing countries.

The second part following this introduction summarizes the relevant literature that discussed the factors related to Ph.D. students' trajectories and the association of employment with the time of completion. The third part discusses the funding of Ph.D. students and the importance of their employment in Brazil. The fourth and fifth sections present the data and empirical strategy used in the empirical analysis. The sixth part displays and discusses the results of the analysis, and the last section concludes the paper.

2 LITERATURE REVIEW

The literature on Ph.D. students' trajectories and on the time of completion was initially developed in the United States in the 1960s (WILSON, 1965; MOONEY, 1968). The first studies on the topic focused on identifying the causes of delays in students' characteristics and motivations. However, subsequent research acknowledged and investigated the role of institutional and environmental factors on students' progress throughout the program, to propose policy recommendations to increase the number of Ph.D. holders necessary to meet the market demand (WILSON, 1965; MOONEY, 1968).

The economic framework used to explain educational choices and investment comprises the models of human capital and rational choice (BECKER, 1994). These analyses are based on the assumption of rational agents who make their choices to maximize expected lifetime utility. Graduate education has been described as the "quintessential human capital investment decision" (SEIBERT *et al.*, 2013), as individuals sacrifice substantial time and resources in the present to achieve long-term goals. When deciding to pursue a Ph.D., students take into consideration several factors, including direct expenses (such as tuition fees, research materials and books) and indirect costs (mostly represented by foregone earnings and effort – Ehrenberg & Mavros, 1995). On the other hand, the main benefits of doctoral education are the premium or wage differential of the degree (PAULSEN, 2001) and the earned credentials for new career paths or higher-level positions (BRENEMAN, 1976; COLLINS, 2002).

A recent but growing empirical literature has been developed to point out and measure how different factors are associated with students' decisions to shorten (or lengthen) the time of completion of the Ph.D. (BAIR AND HAWORTH, 2004; SVERDLIK *et al.*, 2018). This literature identified three main groups of factors (JIRANEK, 2010; VAN DE SCHOOT *et al.*, 2013). The first comprises the institutional or environmental features of the university, including the field of study, department size, mean academic achievement of students, and structure of the program (GARDNER AND GOPAUL, 2012). The second group includes students' personal characteristics and socioeconomic status, such as gender (MASTEKAASA, 2007; VAN DE SCHOOT *et al.*, 2013), age (PARK, 2005; WOLLAST *et al.*, 2018) race (AMPAW AND JAEGER, 2012; GROEN, 2016), family income and indebtedness (GRISSOM, 1986; KIM AND OTTS, 2010), although there is an open debate on the significance of some of these factors (BAIR AND HAWORTH, 2004). On the other hand, there is a relative consensus that students' ability and previous academic achievements are considered highly correlated with the probability of success (STOCK *et al.*, 2006; VAN DER HAERT *et al.*, 2014). Finally, the quality and effectiveness of supervision is the third category of tested relevant predictors (VAN OURS AND RIDDER, 2003; SPRONKEN-SMITH *et al.*, 2018).

Since the early empirical investigations within this literature, employment has been suggested as a potential factor associated with students' choices and trajectories (WILSON, 1965; GRISSOM, 1986). Despite its relevance, the topic was incorporated into (and somewhat overshadowed by) the broader discussion of types of students' financial support, with employment considered under a general category of 'self-funding' (BEKOVA, 2019). However, some studies addressed employment along with the other abovementioned factors that might affect completion time (BOOTH AND SATCHELL, 1995; BAIR AND HAWORTH, 2004; MATUTE, 2014).

In a human capital framework, job responsibilities are considered in the student's cost-benefit analysis, as they change the level of effort (and therefore the cost) required to continue and progress in the program. A doctorate student has to perform several time-consuming activities in the program (BEKOVA AND DZHAFAROVA, 2019), such as attending classes and conferences, teaching, reading and writing papers, taking exams and developing research (BRENEMAN, 1976). However, for employed students, professional and academic activities are competing duties (GIRVES AND WEMMERUS, 1988; GARDNER AND GOPAUL, 2012), reducing the time and availability to study and research, which may lead to longer completion times (SPAULDING AND ROCKINSON-SZAPKIW, 2012). Assuming increasing marginal costs of effort (EHRENBERG AND MAVROS, 1995), a student who has to dedicate part of his or her time to professional activities faces a higher cost in the effort required to progress in the Ph.D., so it might be advantageous to slow

his or her progress, suggesting a potential higher expected time of completion (GITTINGS *et al.*, 2018; MALOSHONOK AND TERENTEV, 2019).

Although empirical evidence on the subject is limited, the existing studies in different countries mostly confirm this theoretical argument and the positive association between employment and time to degree. Using data from a U.S. university, Abedi and Benkin (1987) found that students employed can take more than two additional years to complete their doctorate. A study with Spanish Ph.D. students also found that those who were working had an average duration of studies of more than a year longer than those with studentships (MATUTE, 2014). There is also evidence that part-time students take a longer time to complete their doctorate (WAO AND ONWUEGBUZIE, 2011; SPRONKEN-SMITH *et al.*, 2018). However, estimates can vary per field (EHRENBERG AND MAVROS, 1995), and an investigation on U.S. students in economics found that each year of employment was correlated with an additional 0.6 months in the expected time of completion (SIEGFRIED AND STOCK, 2001).

Qualitative analyses also confirm that employment is detrimental to Ph.D. progress because of the time and effort taken away from academic development. An analysis with a sample of Russian Ph.D. students found that nearly half of the sample lacked time to research because of the work (MALOSHONOK AND TERENTEV, 2019). And a study using semistructured interviews with U.S. students indicated that professional responsibilities detract students from their research (MYERS, 1999).

A topic that has not been addressed by this literature is whether the sector of employment (i.e., public or private) is relevant for discussing students' pathways along the Ph.D. However, there are arguments and evidence of differences between sectors, suggesting that this may be another important factor to be taken into consideration. A main distinction discussed in the literature is the level of job security, as in different countries public employees are protected from layoffs (POSTEL-VINAY, 2015), while in most cases private employment can be terminated at will by employers. Different studies have reported lower levels of layoffs and turnover among public employees (ALLEN, 1988; LEWIS AND FRANK, 2002). In the case of Brazil, federal civil servants selected by a formal public process usually obtain stability after three years of employment (SALAZAR-MORALES AND LAURIANO, 2020).

Another difference is that the public sector tends to hire workers with a higher educational level than the private sector (GREGORY AND BORLAND, 1999; MCGOWAN AND ANDREWS, 2017). In line with this idea, governments of different countries also hire a higher share of workers with Ph.D. than private companies (AURIOL *et al.*, 2013), in part because of the large number of public educational organizations. In Brazil, more than 70% of the Ph.D. graduates of Brazilian universities work in public organizations, including public universities (CGEE, 2020).

3 PH.D. STUDENTS' FUNDING AND EMPLOYMENT IN BRAZIL

Graduate education (Master's and Ph.D. programs) was formally established in Brazil in 1965, with a conceptual framework based on the experience of the United States (U.S.) and European countries, (CFE, 1965). Although an initial development occurred in the 1970s and 1980s (BRAZILIAN MINISTRY OF EDUCATION, 2010), the most significant expansion started in the second half of the 1990s. The number of functioning doctorate programs in the country increased from seven hundred in 1998 to more than two thousand in 2016 (BRAZILIAN MINISTRY OF EDUCATION, 2004; CAPES, 2021).

However, the funding available for students has not followed this trend. As presented in Figure 1, the number of scholarships granted by the main federal agencies³ to Ph.D. students increased nearly forty thousand between 2016 and 1998, whereas the number of students experienced a much larger expansion (approximately 100 thousand additional students). As a result, the share of students receiving such grants decreased by approximately four percentage points, suggesting that a larger group needed to resort to other options to fund their research and living expenses.

³ These agencies are CAPES (Coordination for Improvement of Higher Education Personnel) and CNPq (National Council for the Scientific and Technological Development).



Figure 1 – Number of Ph.D. students and scholarships granted by the federal agencies (CAPES and CNPq - 1998-2016).

Source: (CAPES, 2017; BRAZILIAN MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION, 2022b; a)

In addition, the real value of these scholarships decreased substantially. In 1995, the value of the federal scholarship was approximately 1,3 thousand U.S. dollars (constant 2016 values),⁴ approximately ten times the minimum wage in the country. However, during the next two decades, the nominal value of such scholarships was not adjusted for inflation, and in 2016, the real value of such grants decreased by approximately half of its initial 1995 value (i.e., approximately 650 U.S. dollars), which represented around 2.5 times the value of the country's minimum wage.⁵

Another shortcoming is that such scholarships do not constitute employment bonds, so students are not entitled to most labor or social security rights. Scholarships commonly include only the monthly installment and tuition fees, with no additional payments or rights (Ordinance CAPES 34/2006, as amended). An exception to such a rule is that women are entitled to paid maternity leave, as provided by Law 13,536/2017 (although such right had already been granted previously by the federal agencies, as per Ordinance CAPES 34/2006).

This scenario highlights the importance of employment for a large share of Ph.D. students in Brazil, a situation that is also common in other countries (VAN

⁴ Nominal value of the federal Ph.D. scholarship in 1995: \$1,073 Brazilian reais (ANPG, 2017); nominal value of the minimum wage: \$100 Brazilian reais (IPEA, 2023). These values were readjusted to 2016 using the IPCA inflation index of the last day of both years (IBGE, 2022), and converted to U.S. dollars using the exchange rate of the last day of 2016 (BRAZIL, 2022).

⁵ Nominal value of the federal scholarship in 2016: \$ 2,220 Brazilian reais. Nominal value of the minimum wage: \$ 880 Brazilian reais.

DER HAERT *et al.*, 2014; MALOSHONOK AND TERENTEV, 2019). Students may have to work during the doctorate either because they do not obtain a scholarship or because the value is not sufficient to pay for research and family expenses. In general, students are allowed to have a job during the program, except those who receive a scholarship, who must comply with the restrictions imposed by the funding authority (Ordinance CAPES 34/2006).⁶ However, they usually do not have favorable conditions to conciliate professional and academic activities, because, as a general rule, employed students must perform the same tasks in the same deadlines as scholarship holders and other non-employed students.

CAPES is the agency under the Ministry of Education responsible for enacting the rules applicable to Ph.D. programs in the country. Two rules are relevant to discuss the trajectories and choices of Ph.D. students. First, both CAPES and CNPq determined that Ph.D. scholarships should not last more than 4 years. This provides incentives for students to complete the program or submit their doctoral dissertation within such a limit or to drop out of the program afterwards (BAIR AND HAWORTH, 2004; GURURAJ *et al.*, 2010). Second, the completion rate and time of completion of the Ph.D. are considered among the parameters of evaluation of programs by CAPES (although each field can define a specific time limit for their programs).⁷ Such rules are taken into consideration by faculty staff and program managers and therefore are likely to also affect the trajectories of students.

4 DATA

The dataset used to investigate the relevance of employment comprises information on students who attended Ph.D. programs in Brazilian universities between 2007 and 2016. The data sources are CAPES' (2017) graduate students' database and the 'Annual Social Information Report – RAIS' (MINISTRY OF LABOR

⁶ CAPES recently allowed students who receive a scholarship to have a job, subject to limitations and criteria defined by the university (Ordinance CAPES 133/2023).

⁷ Different areas used the duration of the CAPES and CNPq scholarships as benchmarks for such limits, thus defining a 4 years target for completion of a Ph.D. program (CAPES, 2016; CASADO *et al.*, 2016; SOARES *et al.*, 2016).

AND EMPLOYMENT, 2017). These sources were merged using the Individual Taxpayer Registry (C.P.F.), resulting in a novel dataset used in this investigation.

As the analysis focuses on the time of completion, only students who successfully earned the degree up to the seventh year of the Ph.D. are considered.⁸ As suggested by Ehrenberg and Mavros (1995), students who completed the program within the first two years are excluded, as these cases are likely reporting errors or suggest atypical trajectories. The dataset is also limited to students aged between 23 and 62 years, as those out of this age range indicate an unusual profile of doctorate students in the country. Cases of missing data are also excluded, using a 'complete case' approach (SEAMAN AND WHITE, 2013; HUGHES *et al.*, 2019).

Students' progress is assessed on a yearly basis. The year of first enrollment (as reported in the database) is considered the first year of the Ph.D.⁹ The subsequent years were defined exclusively based on the time elapsed from the first year. The variable 'year of completion of the Ph.D.' (the dependent variable of the model) is discrete and refers to an entire year, so the month in which the student earned the degree is not considered. Therefore, e.g., a student is classified as having completed the program in any given year of the Ph.D. regardless of whether he or she graduated in the first or the last month of such year.

Data on the employment contracts of students during the program are extracted from the RAIS database (MINISTRY OF LABOR AND EMPLOYMENT, 2017). An important limitation of this source is that it only comprises information on employment relationships acknowledged by Brazilian law, not considering other types of labor contracts. The implications of such limitations are discussed with the findings of the empirical analysis.

The final dataset comprises information on 62,590 students distributed in eight knowledge areas, according to the International Standard Classification of Education (UNESCO, 1997), as presented in Table 1. The table shows that the fifth year is crucial for the completion of the Ph.D., as more than half of the students in the sample completed the program during this year. The distribution also reveals

⁸ By that time, more than 99% of doctorate students of the initial database had either completed or withdrawn from the Ph.D. program.

⁹ If the year of the first enrollment is not reported, the first year in which the student appears in the dataset enrolled in a program was considered the first year of doctorate.

the differences in completion times between fields: a higher percentage of students earned the degree during the third and fourth years of the program in 'Agriculture' (43.20%) and 'Health and Welfare' (44.51%); on the other hand, a greater proportion of students in 'Science' and 'Engineering, Manufacturing and Construction' programs still had not completed the program at the end of the fifth year (21.32% for the former field and 26.34% for the latter). These differences are consistent with the argument that students' trajectories in different fields are likely to be different (BAIR AND HAWORTH, 2004; VAN DER HAERT *et al.*, 2014), thus highlighting the importance of controlling for such feature.

Knowledge Area		Total				
Knowledge Area	3	4	5	6	7	Total
Education	$272 \\ 5.2\%$	$1,251 \\ 24.0\%$	$3,309 \\ 63.5\%$	$362 \\ 6.9\%$	$21 \\ 0.4\%$	$5,215 \\ 100\%$
Humanities and Arts	$293 \\ 3.5\%$	$1,310 \\ 15.8\%$	$5,\!280 \\ 63.7\%$	$1,304 \\ 15.7\%$	$106 \\ 1.3\%$	8,293 100%
Social Sciences, Business and Law	$384 \\ 5.0\%$	$1,797 \\ 23.4\%$	$4,602 \\ 60.0\%$	$804 \\ 10.5\%$	$82 \\ 1.1\%$	7,669 100%
Science	$340 \\ 4.0\%$	$1,436 \\ 16.9\%$	$4,\!894 \\57.7\%$	$1,562 \\ 18.4\%$	$245 \\ 2.9\%$	8,477 100%
Engineering, Manufacturing and Construction	$471 \\ 5.9\%$	$1,445 \\ 18.0\%$	4,000 49.8%	$1,763 \\ 22.0\%$	$352 \\ 4.4\%$	8,031 100%
Agriculture	597 8.2%	$2,558 \\ 35.0\%$	$3,898 \\ 53.4\%$	$233 \\ 3.2\%$	$\begin{array}{c} 18 \\ 0.3\% \end{array}$	7,304 100%
Health and Welfare	$1,781 \\ 13.3\%$	$4,192 \\ 31.2\%$	$6,310 \\ 47.0\%$	$1,049 \\ 7.8\%$	88 0.7%	$13,420 \\ 100\%$
Services	$\begin{array}{c} 153\\ 3.7\%\end{array}$	$698 \\ 16.7\%$	2,785 66.6%	$469 \\ 11.2\%$	$76 \\ 1.8\%$	4,181 100%
Total	$4,291 \\ 6.9\%$	14,687 23.5%	35,078 56.0%	7,546 12.1%	$988 \\ 1.6\%$	62,590 100%

Table 1 – Number of students per knowledge area and year of graduation

^a According to the 'broad groups or fields of education' presented in the 1997 edition of the International Standard Classification of Education (UNESCO, 1997). Source: prepared by the authors, based on CAPES (2017).

Table 2 displays the number and share of students graduating each year, distinguishing them by whether they have been employed in the public or private sector¹⁰ at any time during the Ph.D. An interesting fact highlighted by these statistics is that the share of students completing the program in their third year

¹⁰ Private employment is considered herein as the cases in which the employer is a commercial firm, private nonprofit organization or any other operating under private law.

is smaller for those who did not have an employment contract. The same group is also the one with the highest share of students graduating in the fifth year. The numbers also show that the highest share of completion in the third and fourth years is found for students who were employed only in the public sector.

Table 2 – Number and percentage of students completing the Ph.D. each year (of all students who completed the program), per employment status and sector (in any year of the program).

Employment status and	Year of Completion of the Ph.D.					
sector ^a	3	4	5	6	7	Total
No employment	971	3,933	10,077	1,754	196	16,931
	(5.74%)	(23.23%)	(59.52%)	(10.36%)	(1.16%)	(100%)
Employment in the private sector only	974	3,034	7,321	1,745	266	13,340
	(7.30%)	(22.74%)	(54.88%)	(13.08%)	(1.99%)	(100%)
Employment in the public sector only	1,927	6,236	13,751	2,995	374	25,283
	(7.62%)	(24.66%)	(54.39%)	(11.85%)	(1.48%)	(100%)
Employment in the private	419	1,484	3,929	1,052	152	7,036
and public sector	(5.96%)	(21.09%)	(55.84%)	(14.95%)	(2.16%)	(100%)
Total	4,291	14,687 (23,47%)	35,078 (56.04%)	7,546 (12.06%)	988 (1.58%)	62,590 (100%)

Notes: percentage of students (per employment status and sector) in parentheses. ^a Employment and sector observed for any year of the program. Source: prepared by the authors, based on CAPES (2017) and RAIS (MINISTRY OF LABOR AND EMPLOYMENT, 2017).

The other variables used in the empirical analysis are those available in the CAPES (2017) and RAIS (MINISTRY OF LABOR AND EMPLOYMENT, 2017) databases that are acknowledged by or discussed in the literature as potential predictors of the Ph.D. time of completion. The gender of students is considered because previous studies concluded that female students may take longer to earn the degree (GROENVYNCK *et al.*, 2013; LIN AND CHIU, 2014), although this result is not unanimous (BAIR AND HAWORTH, 2004; POTVIN AND TAI, 2012).¹¹ Similarly, students' nationality may be important, since foreign students were found to take distinct trajectories with higher odds of completion (ZWICK, 1991; PARK, 2005). Following previous empirical analysis, students' age was also taken into consideration, although it is not clear whether it is a significant or meaningful predictor of students' progress and success (SPRONKEN-SMITH *et al.*, 2018).

University features and institutional factors can also affect the time students take to finish their doctoral activities (JIRANEK, 2010). The quality of the

¹¹ The reasons for a potential difference between men and women are also not clear, and it may be related to other variables, such as the children born during the Ph.D. (MASTEKAASA, 2007).

program (herein proxied by the score in the CAPES evaluation system) can suggest higher standards and require additional effort from students, but it also increases the value of the degree and satisfaction with the program, which are important features for persistence and progress (ATTIYEH, 1999; BAIR AND HAWORTH, 2004). The field of knowledge is another important factor to be considered, as different papers have found that the availability of funding, academic culture and other relevant features vary between fields (BAIR AND HAWORTH, 2004; GROENVYNCK *et al.*, 2013). Finally, a distinction between public and private universities was also included in the analysis (using a dummy for private institutions), because in Brazil only private universities are allowed to charge tuition fees (RAMALHO, 2017), which may create an incentive for students to conclude their program sooner (as suggested by BRENEMAN, 1976).

The descriptive statistics of the variables used in the empirical analysis are presented in Table 3 (apart from the state where the program is located, calendar year and knowledge area, which are taken from the CAPES, 2017 database of graduate students). Students who worked only in the public sector are the largest group of the sample and the one with the highest average age of students at completion. Students who did not have an employment contract attended programs with a higher average score in the CAPES (2018) evaluation system, and this group is also the one with the highest share of female students. Students who were employed in the private sector only attended programs with the lowest CAPES (2018) average score.

anaiysis.							
	Employment status and sector in any year of the						
		_	program				_
X7	Courses	Stat	Not	Only public	Only	Public and	Total
variable	Source	Stat	employed	employment	private	private	Total
					employmen	employment	
					ť	1 0	
X7 C 1	GADEG	Mean	4.78	4.75	4.80	4.86	4.78
Year of completion	CAPES	Std. dev.	(0.75)	(0.82)	(0.83)	(0.82)	(0.80)
Female (dummy)	CAPES	% of total	59%	54%	54%	51%	55%
Nationality	GADDO	% of total	96%	100%	100%	100%	99%
(dummy) ^a	CAPES						
	CADEC	Mean	34.81	39.94	37.75	39.04	37.99
Age (at completion)	CAFES	Std. dev.	(6.59)	(8.47)	(7.50)	(7.58)	(7.97)
CAPES score ^b	CADEC	Mean	5.38	5.02	5.15	4.97	5.14
	CAPES	Std. dev.	(1.06)	(0.99)	(1.01)	(0.97)	(1.02)
Private university	CADEC	0/ 6/ / 1	20/	20/	7 0/	40 /	20/
(dummy)	CAPES	% of total	2%	2%	1%	4%	3%
Average no. of		Mean	0.00	34.86	23.77	31.56	22.69
weekly working hours ^c	RAIS	Std. dev.	(0)	(11.13)	(15.94)	(10.40)	(18.01)
No of yoong with		Moon	0.00	2.86	0.00	9 90	1 99
nublic omployment	RAIS	Std dow	(0)	(1 51)	(0)	(1.10)	(2.00)
public employment		Stu. uev.	(0)	(1.01)	(0)	(1.13)	(2.03)
No. of years with	DATC	Mean	0.00	0.00	3.31	2.04	0.93
private employment	RAIS	Std. dev.	(0)	(0)	(1.67)	(1.11)	(1.63)
No. of obs.			16,931	25,283	13,340	7,036	62590

Γable 3 – Descriptive statistics (mean and standard deviation) of the variables used in the empirical	1
analysis.	

Notes: standard deviations presented in parentheses. ^a Dummy for Brazilian students. ^b Score observed at the year of completion of the program. The CAPES (2018) score uses a scale of one to seven points. ^c Average number of years with a positive number of weekly working hours, as presented in the RAIS database (MINISTRY OF LABOR AND EMPLOYMENT, 2017). Source: prepared by the authors, based on CAPES (2017) and RAIS (MINISTRY OF LABOR AND EMPLOYMENT, 2017).

5 EMPIRICAL STRATEGY

The data presented in the previous section suggest that employment might be associated with the time of completion of the Ph.D. and, therefore, with students' trajectories in the program. The empirical analysis described in this section tests such an association, controlling for other features of students and of the doctorate programs they attended.

For this analysis, a model with Ph.D. program fixed effects is used to account for heterogeneity between programs, following the 'school fixed effects' used in studies on primary education (WÖBMANN AND WEST, 2006; OST AND SCHIMAN, 2015) and the 'university fixed effects' of higher education studies (HORSTSCHRÄER, 2012; DI PIETRO, 2015). Such a strategy requires the inclusion of a set of dummies for all minus one Ph.D. programs in the sample, thus controlling for any unobservable features of programs that are constant across individuals and that might be associated with the dependent variable. The strategy eliminates any biases arising from unobservable between-program variation (OST AND SCHIMAN, 2015) and sorting between programs (WÖßMANN AND WEST, 2006).

A linear model is specified as presented in equation 1, where the year of completion of student *i* (*completion_year*_i) enrolled in Ph.D. program *j* is the dependent variable regressed on the variable '*employed*_i'(*employed*_i = 0, 1, 2,..., \mathcal{N} , which indicates the number of years of the Ph.D. in which the student had an employment contract at any time of the year¹², and on a vector X_i of explanatory variables (that includes the average number of working hours, student's sex, age at completion, nationality and dummies for calendar year). The set of dummies θ_j for all minus one *j* Ph.D. programs are the 'program fixed effects', which takes the value of one if the student attended such a program and zero otherwise. Finally, β_1 , β_2 and β_3 are column vectors of coefficients to be estimated, and ε is the error term.

$$completion_year_i = \beta'_1 employed_i + \beta'_2 X_i + \beta'_3 \theta_i + \varepsilon$$
(1)

A large body of literature has documented differences between employment in the public and private sectors (CREWSON, 1997; GINDLING *et al.*, 2020; SÁNCHEZ-SÁNCHEZ AND PUENTE, 2021). For this reason, we also assess whether the sector of employment matters for the time of completion. For this analysis, we replace *employed*_i in equation (1) with two variables that indicate the number of years in which the student was employed in the public (*employed*_i^{Public} = 0, 1, 2,..., 7) and private

(employed^{Private} = 0, 1, 2,..., 7) sectors during the Ph.D., as presented in equation (2).

 $completion_year_i = \beta'_1 employed_i^{Public} + \beta'_2 employed_i^{Private} + \beta'_3 X_i + \beta'_4 \theta_j + \varepsilon$ (2)

¹² For this variable, it is only considered whether the student was employed at any time in a specific calendar year, regardless of the duration of the employment relation in that year.

To check the robustness of the results, an alternative specification of the main models are presented in equations 3 and 4. In these regressions, instead of program fixed effects, a set of attributes of universities and programs are included as explanatory variables. The new vector W_j of regressors (where j indicates each program in the sample) includes the program's CAPES score valid at the time of completion, a dummy for private universities and dummies for the location (state) of the program and for each knowledge area.

$$completion_year_i = \beta'_1 employed_i + \beta'_2 X_i + \beta'_3 W_i + \varepsilon$$
(3)

$$completion_year_{i} = \beta'_{1}employed_{i}^{Public} + \beta'_{2}employed_{i}^{Private} + \beta'_{3}X_{i} + \beta'_{4}W_{i} + \varepsilon$$
(4)

6 **Results**

The results of the main model are presented in Table 4. A 95% confidence level is considered to assess the statistical significance of the estimated coefficient. The estimates presented in column 1 provide evidence of the positive association between employment and time of completion, in line with the suggested hypothesis. We find that each year of the Ph.D. in which the student is employed is associated with a 0.145 additional year necessary for the completion of the program. In practical terms, these estimates mean that if a student is employed for five years during the Ph.D., he or she is expected to earn the degree approximately 0.725 years (approximately nine months) later.

If private and public sectors are considered separately (column 2 of Table 4), both coefficients are positive and statistically significant, but employment in the public sector predicts a higher time of completion than employment in the private sector, although the difference is very small and not meaningful (approximately 0.004 of a year). This result does not confirm the initial hypothesis on the advantages of public employment for a faster graduation, and it suggests that employment sector may not be a relevant factor for the time of completion of the Ph.D.

Dependent variable year of completion	(1)	(2)
Variable	Sectors of employment considered jointly	Sectors of employment considered separately
	Coef.	Coef.
	(Std. err.)	(Std. err.)
Number of years with employment during the Ph.D.	0.145^{***} (68.00)	
Number of years with public employment during the Ph.D.		0.147*** (61.84)
Number of years with private employment during the Ph.D.		0.143*** (63.93)
Age (at completion)	0.00606^{***} (15.83)	0.00597^{***} (15.50)
Female	0.106*** (19.36)	0.106^{***} (19.32)
Nationality: Brazilian student (dummy)	0.0496^{*} (1.96)	0.0497^{*} (1.96)
Mean number of positive working hours	-0.0114*** (-47.73)	-0.0115*** (-46.50)
Constant	1.730^{***} (50.17)	1.737^{***} (50.09)
Program Fixed Effects (program dummies)	Yes	Yes
Calendar year dummies	Yes	Yes
Observations	62590	62590
\mathbb{R}^2	0.407	0.407

Table 4 –	Estimate	results for	r the mai	n model	(Ph.D.	program	fixed e	effects)
Depen	dent varia	ble: vear o	of comple	tion of th	ne Ph.	D.		

Robust standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1. Source: prepared by the authors, based on CAPES (2017) and RAIS (MINISTRY OF LABOR AND EMPLOYMENT, 2017).

Other relevant findings of the model refer to students' personal features. The estimated parameters suggest that older students are expected to earn the degree later, but the magnitude of the coefficients is very small, which is consistent with previous studies that concluded that age is a minor or negligible factor in explaining doctorate students' trajectories (BAIR AND HAWORTH, 2004; SPRONKEN-SMITH *et al.*, 2018). On the other hand, the coefficient for female students is positive and statistically significant, and it predicts that, *coeteris paribus*, women take approximately 0.1 years more than men to complete their Ph.D. This finding is in line with previous studies (GROENVYNCK *et al.*, 2013; LIN AND CHIU, 2014), and it contributes to the debate on the relevance of gender to students' trajectories. Finally, the estimates suggest that nationality is not a significant predictor of time

of completion in Brazil, a result that contrasts with previous studies in developed countries (ZWICK, 1991; PARK, 2005).

The results of this empirical analysis are consistent with previous studies in different countries that also found that employment during the Ph.D. predicts that students should take a longer time to complete the requirements to earn the degree (ABEDI AND BENKIN, 1987; WAO AND ONWUEGBUZIE, 2011; MATUTE, 2014). Following a rational choice approach, this can be explained by a higher cost function faced by employed students to progress in and complete the program. As these students have to cope with their professional duties (GIRVES AND WEMMERUS, 1988; GARDNER AND GOPAUL, 2012), they cannot focus solely on their studies (BEKOVA, 2019), so the opportunity cost of their time and effort to study and develop academic activities becomes higher than for non-employed students (EHRENBERG AND MAVROS, 1995). Consequently, when confronting such costs with the benefits of the Ph.D. over time in a cost-benefit analysis, employed students are more likely to dedicate less time and effort to the program, thus resulting in a longer time for completion (GITTINGS *et al.*, 2018).

The robustness tests' estimates are presented in Table 5, and they confirm the findings of the main model on the positive association between employment and time of completion, adding to the strength of the presented empirical evidence. The coefficients are similar to those reported in Table 4, both when sectors of employment are considered jointly (column 1) and when they are estimated separately (column 2).

Dependent variable year of completion	(1)	(9)
Variable	Sectors of employment considered jointly Coef. (Std. err.)	(2) Sectors of employment considered separately Coef. (Std. err.)
Number of years with employment during the Ph.D.	0.154^{***} (68.33)	
Number of years with public employment during the Ph.D.		0.156^{***} (62.04)
Number of years with private employment during the Ph.D.		0.151^{***} (64.32)
Age (at completion)	0.00469^{***} (11.90)	0.00458^{***} (11.57)
Female	0.0823^{***} (14.57)	0.0820^{***} (14.53)
Nationality: Brazilian student (dummy)	-0.0338 (-1.25)	-0.0333 (-1.23)
Mean number of positive working hours	-0.0131*** (-51.56)	-0.0133*** (-50.05)
Private institution	-0.133*** (-8.75)	-0.130*** (-8.51)
Program CAPES' evaluation score (at the end of the Ph.D.)	0.0791^{***} (26.19)	0.0789^{***} (26.13)
Area: Humanities and Arts (dummy)	0.217***	0.218***
-	(19.80)	(19.87)
Area: Social Sciences, Business and Law (dummy)	0.0891^{***} (7.84)	0.0921^{***} (8.05)
Area: Science (dummy)	0.343^{***} (28.53)	0.345^{***} (28.63)
Area: Engineering, Manufacturing and Construction (dummy)	0.314^{***} (25.84)	0.317^{***} (26.01)
Area: Agriculture (dummy)	-0.00618 (-0.53)	-0.00426 (-0.36)
Area: Health and Welfare (dummy)	-0.158*** (-14.96)	-0.155*** (-14.70)
Area: Services (dummy)	0.245^{***} (18.26)	0.246^{***} (18.37)
Constant	2.545^{***} (11.55)	2.551^{***} (11.58)
State dummies	Yes	Yes
Calendar year dummies	Yes	Yes
Observations ${ m R}^2$	$62,590 \\ 0.272$	$62590 \\ 0.272$

Table 5 – Estimate results for robustness tests (model with university and program attributes)
Dependent variable: year of completion of the Ph.D.	

Robust standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1. 'Education' was considered the baseline for the other knowledge areas, and therefore a respective dummy not included in the model. Source: prepared by the authors, based on CAPES (2017) and RAIS (MINISTRY OF LABOR AND EMPLOYMENT, 2017).

The test results also shed light on the relevance of university and program attributes, which were not included in the main model because they are ruled out by the program fixed effects specification. The estimates suggest that students attending private institutions are expected to finish their Ph.D. earlier, which might be explained by additional tuition fees students may pay to postpone graduation (BRENEMAN, 1976). On the other hand, the program's quality (proxied by the CAPES score) is positively associated with the time of completion, which may be explained by more rigorous evaluations and higher research standards that require more time and effort to be met. Finally, the 'Science' and 'Engineering, Manufacturing and Construction' areas present the highest positive and statistically significant association with the moment of earning the degree, while programs in 'Health and Welfare' are predicted to be the ones in which students graduate earlier. These estimates for knowledge areas are consistent with the distribution of students graduating per year presented in Table 1, and they confirm the argument that knowledge areas are relevant predictors of students' trajectories (VAN DER HAERT et al., 2014).

This research contributes to the literature by presenting the first quantitative model-based evidence on the relevance of employment as a predictor of the time of completion of the Ph.D. in Brazil. The findings point in the same direction as the international literature, therefore Brazil does not constitute an exception to the general argument that being employed during the Ph.D. hinders students' progress and accomplishments. This is important to a broader audience, as the literature on the subject is mostly comprised of studies in developed countries (EHRENBERG AND MAVROS, 1995; MASTEKAASA, 2007; MATUTE, 2014; VAN DER HAERT *et al.*, 2014), and evidence of the factors associated with students' trajectories in developing economies is scarce (BAO *et al.*, 2018; MALOSHONOK AND TERENTEV, 2019).

Employment during the Ph.D. constitutes an important challenge in many countries, and it has been noted as a main cause of long times of completion and low quality of research output (ABEDI AND BENKIN, 1987; WAO AND ONWUEGBUZIE, 2011). The problem is likely to persist in the foreseeable future, as different countries report low budget levels for graduate education (ANDRADE, 2019;

MALOSHONOK AND TERENTEV, 2019). In Brazil, the number of Ph.D. scholarships granted by the main federal and state agencies had a deficit of approximately 60% of the total number of students (CAPES, 2021). In this scenario, the findings of this paper present relevant inputs for the design of policies and regulations on doctorate programs, especially on the progress of students and the limit of time for earning the degree. As universities and programs fail to provide funding for their students and accept the enrollment of those who have to work during the program, it is relevant that they acknowledge the implications of such choice and the needs and incentives of such students, considering that they are likely to take more time to complete the program if the quality of the research is not to be compromised.

This analysis is based on the available data on students' graduation (CAPES, 2017) and their employment activities reported in the RAIS database (MINISTRY OF LABOR AND EMPLOYMENT, 2017). The main limitation of this database is that it does not contain information on professional activities and work contracts that do not constitute an employment relation under Brazilian law. Therefore, such activities are not considered or controlled for in this empirical investigation. Another point to bear in mind when interpreting the findings is that they only present the conditional correlation between explanatory and dependent variables, and therefore, no causal relation between employment and time of completion is argued or evidenced herein.

7 CONCLUDING REMARKS

The expansion of graduate education in Brazil over recent decades has shifted the focus toward other relevant topics related to the country's educational system, including the challenges faced by most Ph.D. students who do not have access to scholarships or who cannot rely solely on such an income source to finance their subsistence and studies. The expected consequences of employment during the Ph.D. have been discussed in the international literature, but to date, the topic has not been examined in detail by the academic community and policy-makers in Brazil. This paper contributes to this debate by investigating how employment is associated with the time Ph.D. students take to complete their program. Based on a sample of students who earned degrees in Brazilian universities, the association is assessed using a program fixed effects model, along with robustness tests that include features of universities and programs. The results indicate a positive and statistically significant correlation (conditional on the covariates) between the number of years in which the student was employed during the Ph.D. and the time of completion. The estimated conditional correlation for employment in the public sector is slightly higher than for the private sector, but the difference is small and not relevant. These findings provide relevant insights for the design and improvement of Ph.D. programs and evaluation systems programs that acknowledge and take into consideration the context in which these students develop their studies and research.

The analysis also suggests different paths to advance this research agenda and to improve our understanding of the implications of the type of financial support for doctorate students. An important extension of this work would be to use data on other types of work contracts (in addition to employment), both to confirm whether the results remain unchanged and to assess if the association of employment with the dependent differ from other types of work. Another promising topic that might provide relevant insights is the potential relation of employment with other dependent variables and indicators of students' trajectories and outcomes, such as the quality of generated research and the rate of attrition.

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