

PhD Pathways in Canada: Sociodemographic and Disciplinary Influences That Impact Pathway, Duration, and Outcomes

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Abstract

The growing number of doctoral degree holders in the labour market signals increases in individual achievement and produces broader social and economic benefits. However, systemic inequities continue to shape access to doctoral education and favours certain students and degree pathways over others. Students typically enter PhD programs through two main paths: directly from a bachelor's degree (two-degree pathway) or via a master's degree (three-degree pathway). Despite the prevalence of both pathways, empirical research examining their predictors and outcomes remains limited. Using Canada as a case study and drawing on data from the 2018 National Graduate Survey, we examine how degree pathways are influenced by sociodemographic and disciplinary factors and how they relate to academic and labour-market outcomes. Our findings highlight disparities in pathway prevalence and outcomes, revealing that the path to and from a PhD is not uniform. From a policy standpoint, our results suggest that broader adoption (beyond STEM fields) of the two-degree model (bachelor's to PhD) could improve the efficiency of doctoral training and align Canadian graduate education more closely with practices at leading U.S. institutions and among Canadian science and engineering fields.

Keywords: PhD, doctorate, master's, graduate education, education pathways, equity, labour market, time-to-completion, academic outcomes, graduate age

1. Introduction

Since 1980, the number of individuals enrolling in graduate programs across Canada has increased (Looker, 2018; Statistics Canada, 2021; The Association of Universities and Colleges of Canada (AUCC), 2011). Navigating the academic system from an undergraduate degree to a doctorate may seem straightforward, according to many government resources (e.g., EduCanada, 2019; The Canadian Information Centre for International Credentials, 2016), with the sequence of degrees typically progressing from bachelor's to master's to doctorate. However, educational institutions, programs, and departments/schools can adjust entrance requirements, leaving room for alternative pathways to doctoral programs.

We are aware of three pathways of access into a doctoral program. The first pathway is to enter directly after completing a bachelor's degree ("direct entry"). The second is by way of a transfer from a master's program ("transfer"). The third and most traditional sequence is to complete a bachelor's degree and a master's degree before entering a doctoral program ("3-degree pathway").

PhD studies are primarily influenced by rigorous, long-held academic standards that prioritize the pursuit of high-quality, novel knowledge. These standards are the foundation of a PhD's research program (Bøgelund, 2015). Additionally, PhDs supervised by research faculty are often trained for careers in the professoriate, despite declines in the hiring of tenure-track faculty (Council of Canadian Academies, 2021; Edge & Munro, 2015; Hawley, 2010; Lovitts, 2001).

Financial stability, PhD retention, and socialization throughout PhD programs remain the focus of ongoing research due to historical inequities. Financial support varies by funding and discipline, which affects completion and attrition (DeVos et al., 2017; Rigler et al., 2017). Funding for PhD studies, such as the Canadian Graduate Scholarship, the Vanier Canada Graduate Scholarship, and the Ontario Graduate Scholarship, have remained the same despite

increases in tuition and the cost of living, meaning students are receiving the same amount of money, but have less to meet their basic living costs (Council of Canadian Academies, 2021). Research on attrition in the United States has found attrition (dropout) rates of 50-70%, with dropout being higher for traditionally underrepresented groups (i.e., anyone other than young, White males) (Ames et al., 2018; Lovitts, 2001; Rigler et al., 2017). Socialization, positive academic experiences, and mentors with similar lived experiences have been shown to support completion rates (DeClou, 2017; Devos et al., 2017; Gardner, 2009). Conversely, student demographics and negative socialization experiences whereby students experience feelings of “differentness” from their peers (e.g., older adults, students with children, women, students of colour, part-time students) can affect overall satisfaction and integration into degree programs (Gardner, 2008; Greene, 2013; Offerman, 2011).

For PhD graduates, labour market outcomes in Canada differ by discipline (Council of Canadian Academies, 2021; Walters et al., 2020). Annual income is highest for PhDs in business, followed by engineering, education, and health, and finally social sciences and math and computer sciences. Humanities and science PhDs start with the lowest income of all PhD graduates (Council of Canadian Academies, 2021). Research also shows that PhD holders in Canada have higher employment rates and, on average, higher reported earnings than bachelor's and master's degree holders (Edge & Munro, 2015), as well as greater earnings parity for women (Jehn, Walters, and Howells, 2019).

Getting a doctorate delays an individual's entrance into the labour market compared to individuals who enter the workforce after a bachelor's or master's degree. Competition for doctorates in the labour market is increasing due to reductions in faculty positions and low uptake of doctoral graduates in the private sector in Canada (Desjardins & King, 2011; Edge & Munro, 2015; Walters et al., 2020). There is a general perception that a doctorate is a path to a successful career (e.g., higher income, more employment options, better working conditions, increased professional mobility), making doctorate degrees highly attractive to students (Litalien, Guay, and Morin, 2015). The result is more students getting degrees at the master's and doctorate levels, which is observed in the enrollment data (16% increase for master's enrollments and 13% for doctorate enrollments between 2009 and 2013) and the number of degrees awarded, which has also increased in recent years (Looker, 2018).

1.1 Rationale

As more students pursue graduate degrees, they navigate an increasingly complex academic system. Without clear knowledge of available pathways, students may struggle to determine the most appropriate route to achieve their goals. A review of English-language research on PhD programs in North America (Canada and the U.S.) and by the OECD has not addressed how prior degrees influence academic, personal, or labour-market success. Thus, key questions remain: Are specific characteristics (academic, demographic) associated with higher or lower chances of earning a master's before a doctorate? Do transfer or direct-entry pathways offer unexpected benefits or drawbacks compared to the three-degree route? This issue is crucial for policy, yet the optimal doctoral trajectory remains underexplored. There is limited empirical evidence, especially in Canada, comparing outcomes between direct bachelor's-to-PhD paths and those involving a master's degree. In Canada, the three-degree system is more common than in some leading U.S. universities, where bachelor-to-PhD transitions are more frequent. In Canada, the natural sciences and engineering typically follow a two-degree pathway, whereas the social sciences and humanities typically follow a three-degree pathway. Understanding how these pathways affect students' finances, career trajectories, and labour-market readiness is vital for informing individual decisions and shaping institutional and national graduate policies. Our research provides insight into whether the two-degree pathway offers tangible benefits without compromising career or financial success. Despite its significance, this topic remains under-studied, particularly in Canada, where research is currently non-existent. Our study addresses this critical gap, by providing research necessary for institutional officials and policy makers to engage in evidence-based decision making, and for students to make informed educational choices.

1.2 Research Questions

There are two ways of thinking about a pathway: upstream and downstream. A doctorate's educational pathway can be examined in response to factors present prior to program entry, such as parental education (upstream). Alternatively, pathways can be explored to explain differences in outcomes after program registration or completion, such as annual salary (downstream).

In this study we assess: Are there differences in who accesses a doctorate program based on pathway, and does pathway affect outcomes? This led to two sub-questions (Figure 1). Sub-question one (upstream) explores which variables related to an individual's personal attributes (e.g., parents' level of education, sex) and academic background (e.g., discipline). Sub-question two (downstream) captures measurable outcomes associated with

personal (e.g. age at time of graduation), academic (e.g. debt incurred by graduation), and early career outcomes (e.g. annual income).

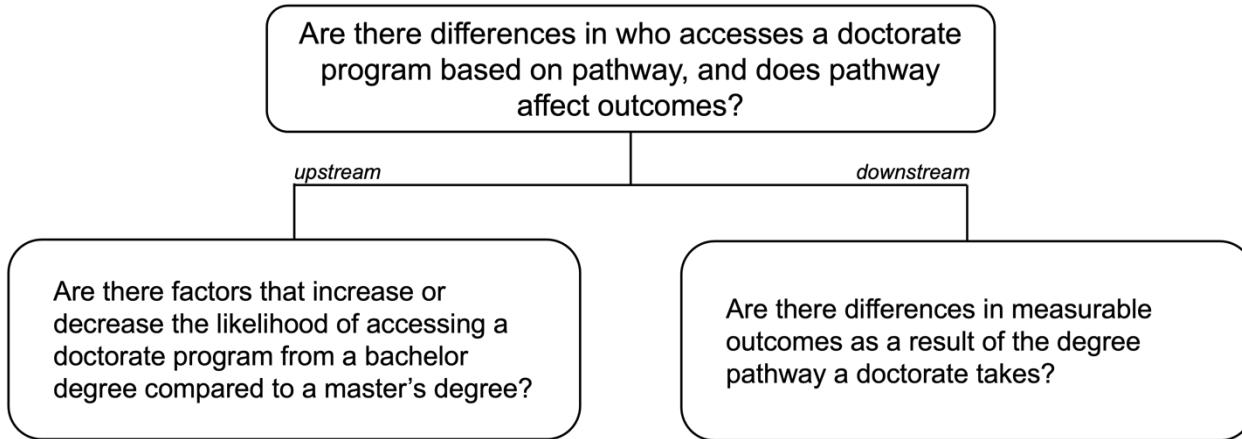


Figure 1. Research Questions

The research question was central to understanding the role of the degree pathway and was addressed by exploring two sub-questions. The first sub-question sought variables that influence the degree pathway (upstream), and the second sub-question examined differences in measurable outcomes related to personal, academic, and early-career outcomes (downstream).

2. Data and Methods

2.1 Data Source – The National Graduate Survey

The data source for this study was the 2018 National Graduate Survey (NGS). The NGS is a nationally representative survey of graduate students across Canada three years post-graduation. The NGS has been running since 1984. The 2018 NGS surveyed graduates from the 2015 cohort from across Canada at all levels of post-secondary education.

The NGS includes an extensive questionnaire covering educational experiences, pathways, labour market outcomes, and socioeconomic demographics. By surveying students three years post-graduation, the NGS provides valuable information on early-career outcomes and their relationship to education, as well as sources of funding, income, continued studies, and characteristics of educational programs (Statistics Canada, 2019).

The 2018 NGS was the first to move from an interviewer-administered computer-assisted telephone interviewing (CATI) survey to a respondent self-completed online survey and included substantial modifications to the survey content compared to the 2013 NGS, as indicated in the NGS Public Use Microdata File (PUMF) User Guide (Statistics Canada, 2019). All graduates of Canadian public postsecondary institutions who completed their degree requirements in 2015 were considered the target population for the 2018 NGS. The target population did not include graduates from private post-secondary institutions, graduates of continuing education programs (unless they led to a college/university degree or diploma), or graduates of apprenticeship programs (Statistics Canada, 2019).

The 2018 NGS used a stratified simple random sample design for data collection, with two strata: geographical location (13 strata—10 provinces and 3 northern territories) and level of certification (4 strata—college, undergraduate, master's, and doctorate). The total number of strata was 52, but some strata had no graduates; therefore, 45 were used. The sample selection of graduates within strata was done without replacement using a systematic method (Statistics Canada, 2019).

To represent the graduating population nationwide, the data were weighted to account for nonresponse and sampling bias. Data on the number of graduates in the population, compared with the number who participated in the survey, were used to develop the weight variable. Statistics Canada has a rigorous process for determining weights that considers various factors, including eligibility and non-response (Statistics Canada, 2019).

2.2 Selection Criteria

For this study, we focused on graduates who reported earning a doctoral degree. An earned doctorate, as defined by Statistics Canada, is “persons who have obtained a doctorate awarded by a university. This includes, for example, Doctor of Philosophy (PhD) and Doctor of Juridical Science (SJD). It does not include persons who have received an honorary doctorate unless they were also awarded a doctorate based on successful completion of a doctorate program

at a university" (Statistics Canada, 2016). This was the only selection criterion we used when subsetting the NGS dataset.

2.3 Pathway as a Variable

The pathway variable was constructed from a derived variable that asked respondents about their "highest level of education completed before the 2015 program," both in Canada and outside of Canada. With an interest specifically in how doctoral programs are accessed, we narrowed our focus to whether the respondent held a bachelor's or master's degree prior to starting their 2015 doctoral program (Figure 2). Given the options available on the 2018 NGS, there was no way to distinguish between those who entered their programs via direct entry and those who transferred from a master's because the highest degree awarded before their doctorate would be a bachelor's degree for both. As a result, we will refer to direct entry and transfer pathways as the "2-degree pathway" and to those with a master's and an assumed bachelor's as the "3-degree pathway".

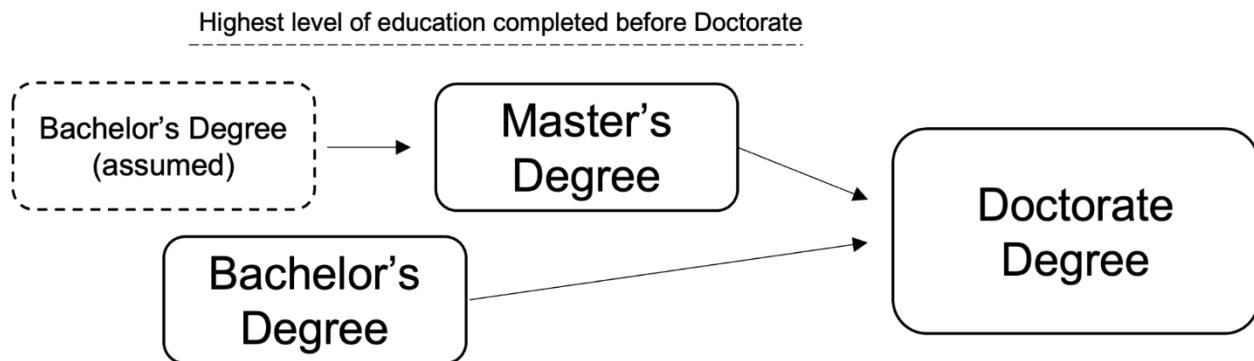


Figure 2. Creation of Pathway Variable

Completed using the 2018 National Graduate Survey.

2.4 Pathway as the Dependent Variable

We treated pathway as the dependent (i.e., response) variable and considered a range of variables that might influence selecting one pathway over the other (e.g., Bachelor's to PhD versus Master's to PhD). Variables were categorized as either academic or personal (Figure 3).

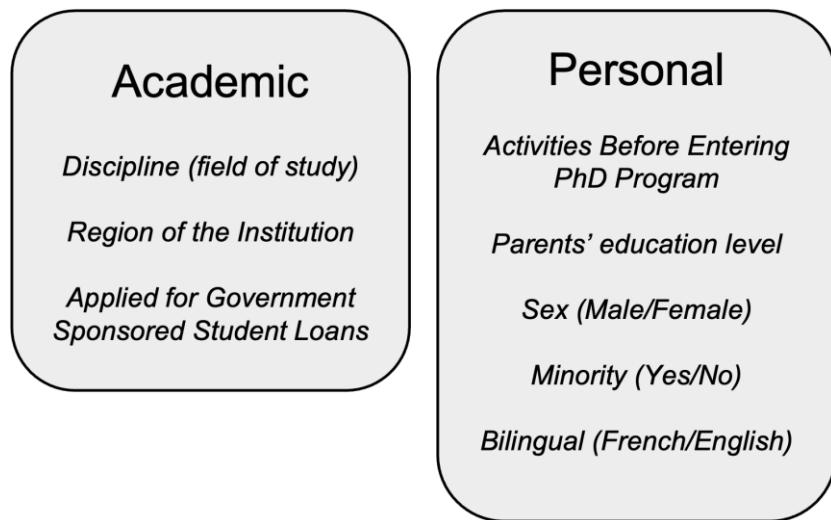


Figure 3. Academic and Personal Predictor Variables

The above variables were selected for investigation as possible influences of pathway.

Academic predictor variables were those that do not change because of pathway, such that pathway is the after-effect or would have occurred later in time. Discipline, the region in which the institution is located, and whether an

individual applied for government-sponsored student loans (an indicator of financial need; Frank & Walters, 2012) are variables that could have influenced whether an individual earned a bachelor's degree or a master's degree before their doctorate. Other variables, such as personal characteristics (e.g., sex, activities before entering their doctoral program) and sociodemographic characteristics (e.g., parents' education level, ethnic minority status), are examined.

2.5 Pathway as the Independent Variable

When pathway was used as an independent variable, we tested its influence on several variables related to academic outcomes (e.g. amount of money received as scholarships and awards, and program satisfaction), early career outcomes (e.g. annual salary, overall job satisfaction), and personal outcomes (e.g. age at time of graduation), focusing on those variables that would be most relevant to both students and academic institutions (Figure 4).

There were three outcome groupings: academic, early career, and personal (Figure 4). Academic outcomes support students in navigating the system (debt load, satisfaction with their program, the amount of scholarships and awards they receive, and the time required to complete their program). Early-career outcomes focus on the labour market and how their degrees and experiences support labour market satisfaction and integration three years after graduating. Personal outcomes were those that fell outside either academic or early career and considered age at the time of graduation (which corresponds to the amount of time an individual delays entering the labour market), and whether they report having any emotional, psychological, or mental health conditions, the latter being relevant to the conversation about PhDs experiencing reductions in the quality of their mental health during their studies (Ali & Kohun, 2007; Levecque et al., 2017; Lovitts, 2001).

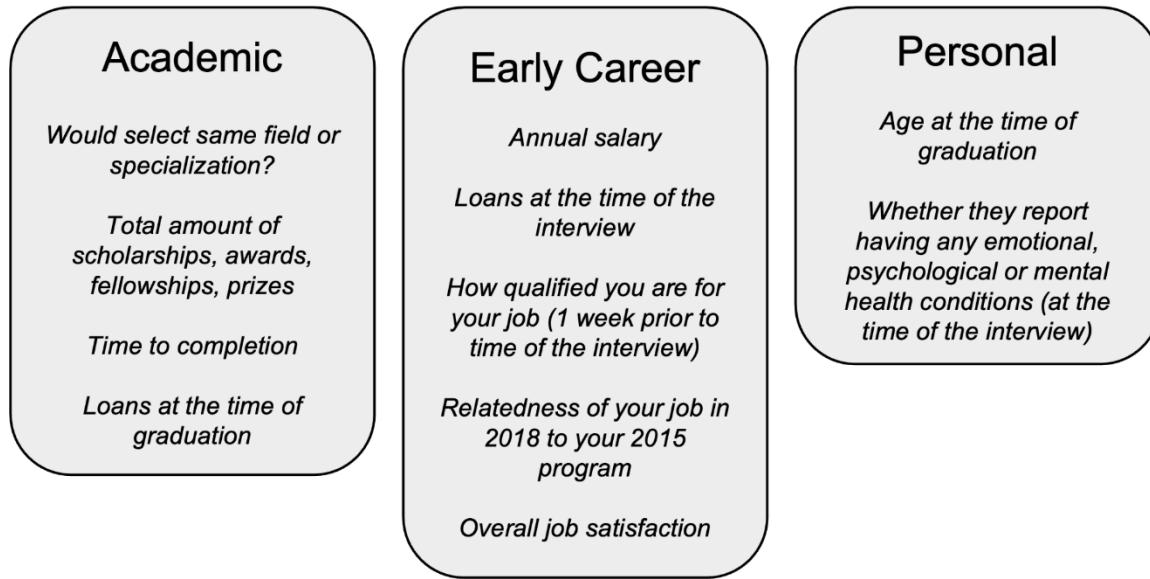


Figure 4. Academic, Early Career, and Personal Outcome Variables Explored

2.6 Control Variables

Control variables were included when building models in which pathway was the independent variable. They included many of the variables we tested as predictors of pathway and were either academic or sociodemographic (personal) in nature (Figure 5). We held these variables constant across all statistical analyses when testing the outcome variables (Figure 4) to obtain a more accurate sense of the relationship between the pathway and the dependent (response) variable under investigation.

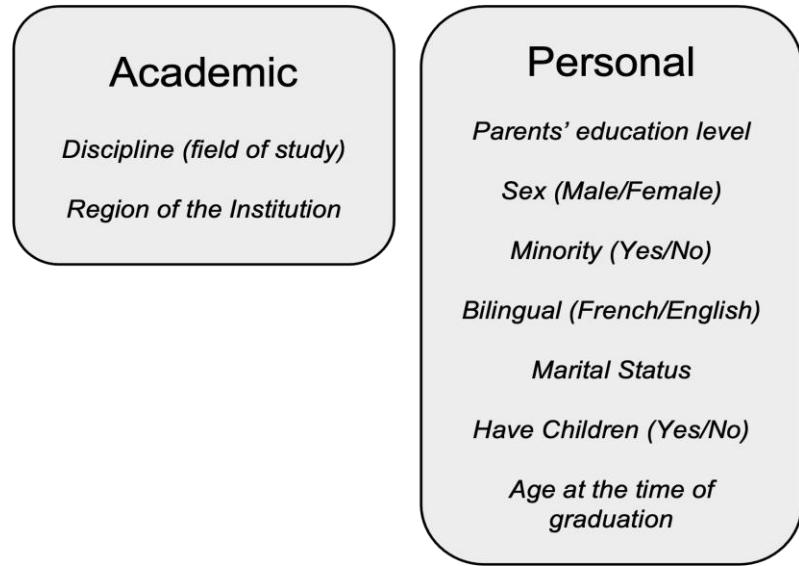


Figure 5. Control Variables Used in Models Exploring Pathway Outcomes

2.7 Connecting the Two Pieces

With the pathway having the versatility to serve as both a dependent and an independent variable, we can understand the broader picture of the factors influencing the pathway to a PhD and how these factors contribute to differences in outcomes. The upstream and downstream approach to answering the research question is beneficial because it examines both sides of the PhD experience, and adopts a systems perspective on what is occurring nationally.

2.8 Statistical Analyses

2.8.1 Regression Models

Three types of regression models were constructed based on the variables included in the model (Figure 6). We used logistic regression for binary response variables and ordinary least squares (OLS) for continuous outcome variables, such as time to completion and annual salary. Finally, we used an ordered logistic regression model when the dependent variable was ordinal in nature, such as overall job satisfaction and relatedness of job to field of study, both of which had ranking responses. Pathway was coded using a 0/1 dummy variable, with 0 indicating the 2-degree pathway and 1 indicating the 3-degree pathway. Pathway was coded this way when it was the explanatory variable and when it was the response variable. Variables with more than two categories were coded using a numerical numbering system that started at one.

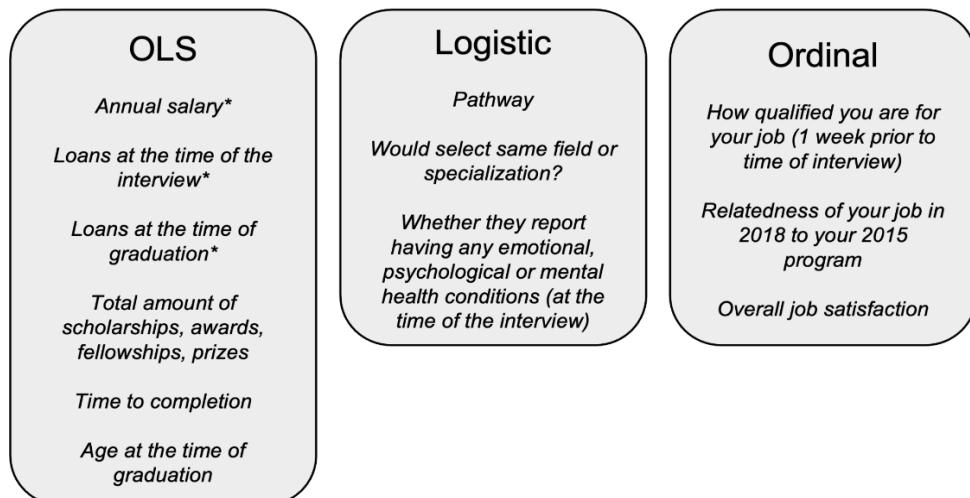


Figure 6. Types of Regression Models That Were Used for Exploring Dependent Variables

The * asterisks indicate the variable was log transformed so the data would be normally distributed.

2.9 Data Transformation

Preliminary analysis of the data for three variables: annual salary, loans at the time of graduation, and loans at the time of the interview, were found to have a right-skewed distribution, requiring them to undergo a log transformation to meet the assumptions of normal distribution required for running their respective models. No other variables required a transformation.

2.10 Statistical Software

All regression models (OLS, logistic, and ordinal) were run using Stata Statistical Software (version 16 and version 17) in a Statistics Canada Research Data Centre.

2.11 Research Ethics

Institutional Research ethics review was not required for this research as Statistics Canada has their own procedures to screen researchers, and all data are vetted (i.e., reviewed and assessed) to ensure that no participant could be identifiable based on the data that is released. Three co-authors were authorized to access the 2018 NGS in a Research Data Centre for this project.

3. Results

All descriptive statistics were weighted using the weight variable in the 2018 NGS dataset (Table S1: Descriptive Statistics). Among individuals with a doctorate, 80% followed the 3-degree pathway, and 20% followed the 2-degree pathway. The distribution of disciplines for doctorate graduates in the 2018 NGS (regardless of pathway) was composed largely of three discipline groups. The disciplines in the sciences (30%), engineering (19.8%), and social and behavioural sciences (18.2%) accounted for 68% of all doctorate graduates in 2015. The remaining 32% were from math and computer science, business, arts and humanities, legal professions, health care, education and teaching, and trades, services, natural resources and conservation.

The demographic distribution of graduates from PhD programs in the 2018 NGS was similar to that observed in 2019 (Statistics Canada, 2021). Ontario had the highest number of doctoral graduates (~40%), followed by Quebec (~30%), and the Western provinces (BC and AB) (~19%), together accounting for 90.6% of doctoral graduates in Canada. The remaining 9.6% were from the Atlantic Provinces (NL, NB, NS, and PEI) and the Prairie provinces (SK and MB). There were no PhD graduates from institutions in the Northern Territories in this NGS cohort.

The sociodemographic descriptive statistics revealed differences in who completes a doctorate in Canada. There were slightly more doctoral graduates with at least one parent who had a university degree (58%) than graduates with neither parent having a university degree (42%). There were slightly more males who completed a doctorate (52%) compared to females (48%). Non-minority individuals outnumbered those who identified as members of visible minority groups, 62% to 38%, respectively. There were 98% non-Indigenous graduates compared to 2% Indigenous graduates. There were also differences in the representation of bilingual doctoral students, with approximately 62% speaking only one language (either English or French) and 38% speaking both national languages.

Approximately 43% of doctoral students applied for government-sponsored student loans, and 57% did not. With respect to enrollment, the majority were enrolled full-time (~90%), followed by full-time/part-time (changing status during the degree) (8%), and finally, part-time (~2%).

At the time of data collection (2018), most doctorate graduates were either married (73%) or single (22%), with the remaining 5% being previously married (i.e. widowed or divorced). Approximately half of doctoral graduates (46%) had children at the time of the survey, whereas the remaining 54% reported having no dependent children. Most did not self-report having any emotional, psychological, or mental health conditions (90%), and most were employed (81%).

Before entering their doctorate program, the 2015 cohort were either in school (54%) or working (37%). The remaining 9% were looking for work, had family-related responsibilities, or were travelling, volunteering, had illness/disability circumstances, or indicated 'other'. Doctorates completed their studies in an average of 5.6 years, and they graduated at an average age of 34.8. Respondents in the sample received an average of \$ 72,181 CDN in scholarships, awards, fellowships, or prizes across their entire program and graduated with an average of \$ 26,828 CDN in debt. Three years post-graduation (2018), respondents had an average of \$8,147 less in debt than at the time of data collection, with an average total of \$18,681 CDN, and were earning an annual salary of \$76,251 CDN across all disciplines and demographics.

3.1 Regression Results

3.1.1 Pathway as the Dependent Variable

Five variables were statistically significantly associated with pathway (2-degree versus 3-degree). These were: discipline (field of study); main activity before the doctorate program; parents' education level; identification as a member of a visible minority; and whether an individual applied for a government-sponsored student loan (an indication of financial need). The results for these five variables are presented in Table 1.

Table 1. Logistic Regression Results for Predictors of Pathway

Variable	Odds Ratio	SE	p	Predicted (%) ¹	proportion
Constant	1.5				
Discipline Groups					
Science and Science Technology	-	-	-	62.7	
Engineering and Engineering Technology	2.9	0.4	***	82.4	
Mathematics and Computer Science	6.1	1.7	***	90.5	
Business and Administration	11.1	5.7	***	94.5	
Arts and Humanities	16.7	4.5	***	96.3	
Social and Behavioural Sciences	2.6	0.3	***	80.6	
Legal Professions and Studies	1.6	0.6	0.3	71.8	
Health Care	2.7	0.6	***	81.3	
Education and Teaching	26.9	12.4	***	97.6	
Trades, Services, Natural Resources and Conservation	13.5	7.1	***	95.4	
Region of Post-Secondary Institution					
Atlantic	-	-	-	76.3	
Quebec	1.3	0.3	0.3	80.2	
Ontario	1.3	0.3	0.3	80.0	
Prairie	1.4	0.4	0.3	80.9	
Western	1.0	0.2	0.9	76.7	
Main Activity Before Doctorate Program					
Working	-	-	-	82.8	
Looking for work	1.2	0.4	0.6	84.8	
School	0.7	0.1	***	77.0	
Family Responsibilities	1.5	0.8	0.4	87.6	
Parental Leave	0.8	0.5	0.7	80.1	
Illness/Disability			(empty)		
Travelling	0.4	0.2	***	67.7	

Volunteering	1.8	1.5	0.5	89.3
Other	0.9	0.3	0.7	80.9
Parents' Education Level				
No University Degree	-	-	-	82.5
University Degree	0.7	0.1	***	77.1
Sex				
Male	-	-	-	80.7
Female	0.8	0.1	0.1	78.0
Visible Minority Status				
Non-Minority	-	-	-	75.8
Minority	2.0	0.2	***	85.0
Bilingual (French/English)				
Not bilingual	-	-	-	79.5
Bilingual	1.0	0.1	0.8	79.1
Applied for Gov Sponsored Student Loans				
Yes	-	-	-	75.9
No	1.5	0.1	***	81.7

*** p < 0.001 ** p < 0.01 * p < 0.05

¹ Proportion of doctorate graduates expected to take the 3-degree based on the calculated marginal estimates of the models.

Base categories are denoted by “-”, and odds ratios and predicted proportions of doctorates taking the 3-degree pathway are included in the table. 2-degree pathway = 0 in the model and 3-degree pathway = 1.

When holding constant all other variables in the regression model, there were differences between science disciplines and legal disciplines compared to all other disciplines (Figure S1: Predicted Proportion of Doctorates by Pathway Across Disciplines). Science and science technology disciplines had the highest predicted proportion of students who took the 2-degree pathway (37.3%), and similarly, they also had a lower predicted proportion of students who took the 3-degree pathway (62.7%), compared to other disciplines and compared to the average across all disciplines. Notably, the fields of Science and Science Technology account for 30% of all doctorate graduates. Similarly, Legal Professions and Studies had a higher-than-average predicted proportion of students taking the 2-degree pathway (28.2%), with fewer students also taking the 3-degree pathway (71.8%) compared with the average and with other disciplines. However, this could be a result of the pathway used to get a SJD, which is a professional designation given to lawyers and does not require a master's degree for entrance (University of Toronto, 2022).

Some disciplines, such as education and teaching, arts and humanities, trades, services, natural resources and conservation, business and administration, and math and computer science, all had a vast majority of doctorates entering their programs with master's degrees beforehand (approx. 90-98%).

When all other variables in the regression model were held constant, there were pathway differences across three sociodemographic variables (Figure S2: Predicted Proportion of Doctorates by Pathway Across Three Sociodemographic Variables). Individuals who indicated they applied for government-sponsored student loans had a higher predicted proportion of individuals who entered a doctorate program taking the 2-degree pathway (24.1%), which is slightly higher than the average across all doctorates (20%) and significantly higher (p<0.001) than those who did not apply for government loans (18.3%).

Individuals who identified as members of a visible minority had a higher predicted proportion of individuals who entered a doctorate via the 3-degree pathway (85.0%) than the average (80%) and than individuals who did not identify as a minority (i.e., White). Individuals who indicated they were a non-minority had significantly fewer doctorates taking the 3-degree pathway (75.8%), a difference of 9.2% with minority-identifying individuals.

Individuals with at least one parent who had a university degree had a higher predicted proportion who entered a doctorate via the 2-degree pathway (22.9%) than those who indicated neither parent had a university degree (17.5%), who were significantly less likely to take the 2-degree pathway.

The main activity doctoral graduates engaged in before they started their doctorate program also influenced pathway. Doctorates who were in school before entering their program and those who were traveling were slightly more likely to take the 2-degree pathway (23.0% and 32.3%, respectively). At the same time, all other activities, including working, looking for work, family responsibilities, parental leave, volunteering, and other activities, varied between 10-20% who took the 2-degree pathway (Figure S3: Predicted Pathway Taken Based on Main Activity Before Doctorate Program).

Of the eight variables considered for their possible influence on pathway, three variables did not have any significant differences in the proportion of individuals taking one pathway over another. These three variables were: the region where the institution was located, sex, and whether an individual was French/English bilingual or not.

3.1.2 The Impact of Pathway on Outcomes

When investigating Research Question 2 (Figure 1), regarding the effect of pathway on outcomes, 11 models were run. Of the 11 models with pathway as the independent variable (e.g., annual salary, time to completion), three variables were statistically significant, whereas the remaining eight were not. The three variables with significant differences were scholarships, awards, and fellowships received over the duration of their program; time to completion; and age at the time of graduation (Table 2).

Table 2. Three of the OLS Regression models for Outcome Models

		Coefficient	SE	p	Predicted Values
Academic Outcomes	Scholarship				
	2-degree	-	-	-	\$68,237
	3-degree	6267.9	2993.7	*	\$74,505
	Time to Completion				
Personal Outcome	2-degree	-	-	-	6.1 yrs
	3-degree	-0.5	0.1	***	5.6 yrs
Personal Outcome	Age at the Time of Graduation				
	2-degree	-	-	-	32.0
	3-degree	3.5	0.3	***	35.6

The models showed differences across pathways, the amount of scholarship dollars received by the individual, the amount of time it took to complete the doctorate program, and the age at the time of graduation.

There were significant differences in the number of scholarships, awards, and fellowships received depending on whether a doctoral graduate pursued a 2-degree or 3-degree pathway. The model-estimated difference was -\$6,268 for individuals who took the 2-degree pathway (i.e., students on the 3-degree pathway received \$6,268 more). Graduates who took the 3-degree pathway completed their programs approximately half a year earlier than those who took the 2-degree pathway, a significant difference ($p<0.001$).

There were statistically significant differences in age at graduation between the two pathways. The model-estimated difference was approximately 3.5 years younger at the time of graduation (32 years old) for individuals who took the 2-degree pathway, compared with those who took the 3-degree pathway (35.6 years old at the time of graduation) (Table 2).

Figure 7 summarizes the results of how pathways influenced academic and personal outcomes.

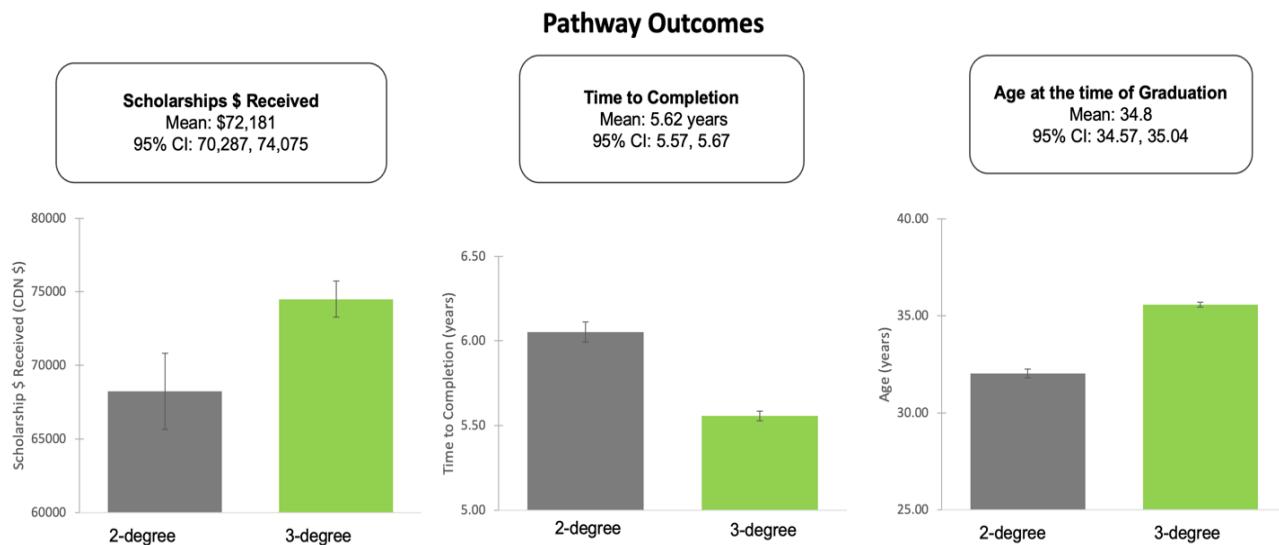


Figure 7. Outcome Differences Across Pathway

These three variables showed different outcomes across degree pathways (2-degree versus 3-degree). Scholarships received were the total amount awarded across an entire doctorate program. Time to completion was the number of years required to complete the doctoral program. Age at graduation was the age at which the individual completed their doctoral program.

4. Discussion

The evidence from this study indicates pathways to access a doctorate program are influenced by various factors and lead to differences in important outcomes for doctoral graduates. Specifically, we found that discipline, parents' education, identification as a member of a visible minority, financial need, and activities before a doctorate all influenced the likelihood that an individual would take the 2-degree or 3-degree pathway into their doctorate studies. We also found differences in outcomes based on the pathway a doctorate took, the number of scholarships, awards, and fellowships they received, the time taken to complete their degree, and their age at the time of graduation.

The higher likelihood of a student taking the 2-degree pathway in science disciplines is particularly noteworthy, as science doctorates are the largest group of doctorate graduates in the 2018 NGS (30%). What makes this finding interesting is that natural science departments are known to have a "teamwork research training structure in which students and supervisors collaborate on research projects...compared to social sciences students who participate primarily in individual research training structures" (Sverdlik et al., 2018; p.375). The advisor-student mentorship system has been shown to benefit doctoral learning, program completion, and overall satisfaction (Devos et al., 2017; Sverdlik et al., 2018; Young-Jones et al., 2013). Further to this, collaboration and teamwork are likely to provide the student with more regular access to their advisor, increasing socialization and opportunities to seek advice on other aspects of graduate studies, such as degree pathway. However, this has not been directly addressed in studies on student-advisor mentorship or socialization.

Academic advisors can have a significant impact on student experiences, success, and retention in a program, whether undergraduate or graduate, master's or doctorate (DeLaRosby, 2017; Drake, 2011; Lovitts, 2001; Young-Jones et al., 2013). The advisor-mentor relationship can also be supportive for the student, both in their career and psychosocially (Beres & Dixon, 2016). As a result of the relationship between students and advisors across undergraduate and graduate levels, an advisor can influence which degree pathway an individual takes, including whether the individual is encouraged or discouraged to enroll in a master's or doctoral program. However, we are not aware of any research directly connecting the two. A preliminary analysis of our survey data conducted as part of our ongoing research suggests that advisors play a role, among other social factors, including family members (Ablard, 1996; Hegna & Smette, 2017; Hortaçsu, 1995), peers (Noonan et al., 2007; Rosenqvist, 2018), and other mentors inside and outside academia (Brill et al., 2014; Noonan et al., 2007; Thomas et al., 2007). Future research exploring

the social networks and personal perceptions that contribute to degree pathway decisions is recommended to gain a broader understanding of who influences doctoral candidates and why.

According to a recent report, “Degrees of Success” by the Council of Canadian Academies (2021), doctorates in the sciences have the least favourable labour market outcomes, along with those in the humanities. Both disciplines have lower earnings in Canada than other disciplines, with graduates earning approximately \$45,000 upon graduation and \$68,000 five years later (Council of Canadian Academies, 2021). Notably, the report also shows, “PhD graduates from education, health, and engineering hav[ing] the second-highest earnings behind business graduates” (p.109) with starting salaries ranging from \$62,300 to \$79,300 and rising to approximately \$92,000 by year five (Council of Canadian Academies, 2021). In other disciplines, like social sciences and math and computer science, starting salaries were approximately \$60,000, with social science graduates increasing to \$77,900 five years later, and math and computer science graduates rising to \$98,700 five years later (the latter, which has the highest growth rate in earnings of all disciplines) (Council of Canadian Academies, 2021).

In this study, we observed no significant differences in reported annual earnings across the two pathways (2-degree and 3-degree) (Table S3: Results from Models with Continuous Numerical Outcomes). However, there are two factors to consider that could inform future research. First, we examined science disciplines as a single unit, and research exploring science subdisciplines (e.g., physics, chemistry), degree pathways, and labour market outcomes, including annual earnings, is necessary to determine whether trends within the sciences differ across pathways. Second, because graduates in the 2-degree pathway enter the labour market 3 years earlier than those in the 3-degree pathway, we must ask what the difference in earnings is when age is considered. More simply, someone entering the labour market with a PhD, having taken the 2-degree pathway, will be younger and will have the opportunity to hit salary milestones at a younger age compared to someone taking the 3-degree pathway who enters the labour market at an older age. The long-term impact on personal financial success cannot be understated.

Sociodemographic characteristics influenced the degree pathway, such that the following characteristics made a doctorate more likely to take the longer 3-degree to doctorate pathway (vs. 2):

- (1) Neither parent has a university degree (2x higher likelihood)
- (2) An individual identifies as being a member of a visible minority (2x higher likelihood), and
- (3) An individual is not experiencing financial need (i.e. they indicate “no” they did not apply for government-sponsored student loans) (1.5x higher likelihood).

There is evidence of parents’ education playing a role in a child’s experiences and perceptions of their academic abilities (Ablard, 1996; Hortaçsu, 1995) and the type of support they can offer their child (e.g. knowledge of the academic system, emotional support) (Ablard, 1996; Hegna & Smette, 2017). The influence parents have extends into decision-making, and often, youth are supported in making their decisions regardless of their socioeconomic status. However, there is some difficulty in making choices when parents have strong opinions about educational decisions (Hegna & Smette, 2017). A greater challenge arises when the individual is uncertain about themselves and experiences variable input from multiple sources (e.g., friends, counsellors, other family members) (Hegna & Smette, 2017).

Identification as part of a visible minority contributes to academic experiences and decision-making (Felder et al., 2014). Racial and ethnic minorities receive variable levels of input from their families, depending on whether family members have experience with the higher education system (Ball et al., 2002). If there is minimal knowledge of the academic system, support for collecting and accessing information resources, and for reaching decisions, is largely left to the student and supported by the parent (Ball et al., 2002). Finding an advisor or peer who can serve as a source of information on navigating academia is essential for first- or second-generation university students, regardless of race (Ball et al., 2002; Gardner, 2009; Young-Jones et al., 2013). Individuals from visible minorities may be encouraged to, or seek comfort in, pursuing the more traditional 3-degree pathway rather than opting for the 2-degree pathway, but we lack data to assess this hypothesis, which warrants further research.

We observed that doctoral students experiencing financial need were more likely to pursue the 2-degree pathway. One possible explanation is time. A doctoral degree program takes years to complete, does not provide consistent (good) income, and delays entrance into the labour market (Council of Canadian Academies, 2021; Edge & Munro, 2015; Hawley, 2010; Lovitts, 2001). According to the 2019 report by the Canadian Association for Graduate Students, financial pressures are both a minor and a major obstacle to academic progress for 37.2% and 37.1% of respondents, respectively, making them among the most significant obstacles faced by approximately 75% of the graduate student population. The perception of skipping a master’s degree could be seen as a means of spending less money and less

time working towards a doctorate, especially if a doctorate is the end goal or the individual believes a doctorate will yield better outcomes in the labour market, the latter which has been widely reported in the literature (Council of Canadian Academies, 2021; Edge & Munro, 2015; Liu et al., 2012; Walters, 2004). In this way, taking the accelerated 2-degree pathway could be more appealing. While we found that doctoral studies took a significantly shorter time for those taking the 3-degree pathway, we also found that those who took the 2-degree pathway entered the labour market with their doctorate at an average of 3.5 years younger than those who took the 3-degree pathway and earned a master's degree. Thus, the time between graduation from a bachelor's program and getting the doctorate is, overall, shorter. As noted earlier, entering the labour market at a younger age can be advantageous for reaching career milestones, but this warrants further investigation into the effects of pathway on longer-term career outcomes for PhD graduates.

5. Key Findings

The most impactful finding is the difference in age at graduation for students taking the 2-degree pathway. Despite the three-degree pathway being half a year shorter in total duration, the requirement of a master's degree delays professional entry by roughly 3.5 years compared to the undergraduate-to-doctorate route. Ultimately, the two-degree pathway facilitates a faster transition into the labor market, allowing individuals to capitalize on full-time employment and pension contributions sooner (Etmanski et al., 2017).

Moreover, we did not find significant differences in debt accrued during the studies or 3 years post-graduation, or in annual income, across the two pathways. This further suggests that obtaining a doctorate without a master's degree does not affect an individual's ability to succeed in the labour market.

As this study investigates a previously unexplored area of the PhD experience and uses data from a pre-COVID-19 labour market (2018 NGS), this study can be used as baseline research to assess the impacts of disruption in national and global education systems. With the 2023 NGS now available, research comparing our data with data collected from graduates who completed their programs and entered a highly disrupted labour market during the COVID-19 pandemic is made possible.

6. Limitations

One limitation of the study was the inability to capture influences and outcomes related to pathways beyond the 2- or 3-degree pathways. For instance, the 2-degree pathway includes both direct-entry doctorates and doctorates that transfer into a doctorate program from a master's program. When an individual takes the transfer pathway, they start in a master's program and transfer into a doctoral program, often within the first year, without completing their master's degree. This pathway is becoming more popular, particularly in the sciences (Kent, 2022; Study Portals, 2018), as reflected in the higher proportion of individuals taking the 2-degree pathway. Though we could not differentiate the transfer pathway from the direct entry pathway in our findings, the transfer pathway is more common than the direct entry pathway, at least at for PhD programs (the same is not true for professional doctorates, like a Juris doctor or medical doctor which can be accessed from a bachelor's degree (University of Toronto, 2022) and is designed to train students for the workplace, rather than produce dissertations of original research) (Fink, 2006).

Overall, the NGS is robust and provides researchers and policymakers with nationally representative, weighted data. Hence, the findings here provide a Canadian lens on the influences and outcomes of degree pathways for doctoral graduates, such that we can make recommendations that are applicable nationwide. That said, this study provided a sense of what is happening, on average, for graduates. Further research that includes doctorate candidates who did not complete their studies (i.e. all-but-dissertation or lost to attrition) and the pathways they take is necessary to get a more complete understanding of whether pathway is a contributing factor to completion. Statistics Canada's Post-Secondary Information System (PSIS) could be useful for research on completion, including variables such as discipline and sociodemographic characteristics. Additionally, data capturing lived experiences using a combination of quantitative and qualitative approaches is warranted. First-person accounts can help identify which elements of academic pathways are unclear to students, which circumstances prevent or support students' choices of degree pathways, and the roles of faculty, disciplinary norms, educational policy, parental influence, and other social factors in shaping these pathways.

7. Conclusions

Our findings provide evidence of differences in who accesses doctoral programs and in outcomes for graduates. Factors influencing whether an individual is more likely to take the 2-degree or 3-degree pathway highlight continued social inequities within the academic system. Who is more likely to fast-track hinges on parental education and financial need, both of which are closely linked to socioeconomic status. Who takes the 3-degree pathway is related to whether an individual identifies as a visible minority and whether they are working or in school before entering their doctorate program. The doctorate education system was traditionally designed to train academics and was an exclusive club for the intellectually elite (Greene, 2013; Hawley, 2010; Offerman, 2011). A changing labour market and a changing student body have put pressure on academic institutions to make changes (Canadian Association for Graduate Students, 2019; Cheung, 2012; Etmansi et al., 2017; Offerman, 2011). Pathways of accessing a doctorate are shifting in Canada, with some flexibility as to the prerequisites required for entry, likely, in part influenced by our American neighbours, where the 2-degree pathway is more common (Study Portals, 2018). However, doctorates in Canada do not experience the same labour market outcomes as they do in the U.S., in part, because Canada lacks in the uptake of doctorates into the private sector (Desjardins & King, 2011).

Our findings suggest that the pathway is shaped by discipline, socioeconomic status, demographic characteristics, and family background. Furthermore, those who take the 2-degree accelerated pathway enter the labour market 3.5 years earlier than those who take the more traditional 3-degree pathway. From a policy perspective, we consider this the most significant finding of the study.

Given the comparable income and debt outcomes of students on the two- and three-degree pathways, our findings support a policy shift to normalize and expand direct-entry PhD programs from the bachelor's level, particularly within Canadian institutions. By enabling earlier entry into the labour market, which we found to be approximately 3.5 years sooner, students following the BA-to-PhD path gain additional years of work experience following their final degree, potentially creating more financial stability, and pension contributions without compromising the quality or value of their education. Hence, many institutions and academic fields may therefore reconsider the requirement or strong preference for a master's degree prior to doctoral studies, especially when it offers limited return on investment in terms of labour market outcomes.

Still, we must emphasize that while receiving a master's degree does not appear to provide a meaningful advantage in terms of income or debt for those who subsequently pursue PhDs, it may offer other benefits, such as helping students build academic skills, clarify research interests, or improve readiness for doctoral work, which could, in turn, support PhD completion. Likewise, a master's degree may serve as a valuable stepping stone for students who wish to gain more knowledge or skills before committing to a PhD, or for those seeking an earlier transition to the labour market. Thus, we are not suggesting the elimination of the master's degree altogether, as it offers clear advantages for many students, particularly those who may benefit from additional academic training before pursuing doctoral studies. However, since our data are drawn from a survey of graduates, we are unable to assess the impact of master's training on persistence or completion within doctoral programs. As such, this remains an important area for future research.

Nevertheless, encouraging broader adoption of the two-degree model could enhance the efficiency of doctoral training, reduce time-to-degree, and better align Canadian graduate education not only with leading U.S. institutions but also with existing practices in many Canadian science and engineering programs.

8. Abbreviations

The following abbreviations are used in this manuscript:

PhD	Doctor of Philosophy
OECD	Organization for Economic Cooperation and Development
U.S.	United States of America
NGS	National Graduate Survey
CATI	Computer Assisted Telephone Interviewing
PUMF	Public Use Microdata File
SJD	Doctor of Juridical Science
OLS	Ordinary Least Squares
BC	British Columbia, Canada
AB	Alberta, Canada
NL	Newfoundland and Labrador, Canada
NB	New Brunswick, Canada
NS	Nova Scotia, Canada
PEI	Prince Edward Island, Canada
SK	Saskatchewan, Canada
MB	Manitoba, Canada
CDN	Canadian Currency

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