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The Opportunity Cost of a PhD: Spending your Twenties

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Abstract

This paper examines the opportunity cost of pursuing a PhD by tracing the earnings trajectories of graduate students from undergraduate study through doctoral training and into the labour market. Using linked Canadian administrative and census data, we compare PhD graduates to those who complete a master's degree, to professional degree holders, and to individuals who enter but do not complete a PhD. We find that PhD graduates earn significantly less than their peers early in their careers due to delayed labour market entry. Over time, their earnings recover and eventually surpass those of master's graduates—but primarily among those who obtain academic positions and remain employed later in life. This "double premium" reflects both higher earnings conditional on full-time academic employment and longer labour force attachment. By contrast, the most substantial penalties accrue to non-completers who withdraw late from PhD programs. Finally, we document worsening outcomes for recent PhD graduates, driven largely by declining rates of academic employment. These findings highlight the central role of career timing, labour force attachment, and access to academic positions in shaping the economic returns to doctoral education.

Keywords: PhD education; Returns to education; Human capital; Labour market outcomes; Lifecycle earnings; Administrative data
JEL Codes: I26, J24, I23

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1 Introduction

Consider a star undergraduate planning her future. Her favourite professor has inspired a deep love of Chaucer and encouraged her to consider graduate school. This would mean completing a master's degree and then a PhD — a long academic journey, but one that promises immersion in scholarly joy and, perhaps, a career in teaching and research. All of her professors have followed this path; it feels like a natural next step. But she also wonders what other paths might bring. What would she be giving up? If she were to enter columns of counterfactual earnings into a spreadsheet, comparing one trajectory with a PhD and another without, what would the data suggest?

Her question is not merely personal. Across many fields, especially in the humanities and some social sciences, but increasingly in the sciences as well, there is growing concern that the PhD is a poor and worsening investment. Oversupply, long time-to-degree, high attrition rates, and limited academic job openings have raised questions about whether the current scale of PhD training aligns with labour market fundamentals (Council of Canadian Academies,, 2021).[1] Recent critiques (e.g., Cassuto (2015), Rosenberg (2023), Dirks (2023)) suggest that doctoral education may now serve institutional interests (supplying research and teaching labour) more than student outcomes. And while some graduates eventually secure rewarding careers, the path is uncertain and the opportunity costs substantial.

This paper attempts to fill those counterfactual earnings columns. Using rich Canadian administrative and survey data, we trace the earnings trajectories of individuals who pursue graduate training: those who earn PhDs, those who leave before completion, and those who stop at the master's level, compared to the majority of students who stop at a bachelor's. Whether the motivation is a love of Chaucer, a passion for climate change, or a commitment to reducing inequality, we aim to document the economic consequences of choosing the PhD path. In light of concerns about worsening outcomes for PhD students, and in response

[1] The first author served on the expert panel for the Council of Canadian Academies (CCA) report on the Labour Market Transition of PhD Graduates, and both the first and second authors contributed to the empirical analysis presented in that report. This study draws on the empirical questions and evidence identified there, significantly extends the analysis, and addresses policy questions raised in that study and elsewhere.

to Cassuto's characterization that "Thousands of professors are currently in the business of preparing thousands of graduate students for jobs that don't exist," we track the changing fortunes of PhD graduates from 1991 through to 2021.

From an individual perspective, the primary opportunity cost of the PhD lies in the foregone earnings from alternative education and career paths.[2] More precisely, it is a cost of time: the delayed accumulation of labour market experience, retirement contributions, career advancement, and financial independence during what are often prime working years. Unlike professional or shorter master's programs that may yield immediate labour market returns, doctoral study often defers substantive income gains until the late thirties or beyond. This cost of deferral compounds (both financially and personally) and is central to understanding the economic trade-offs faced by prospective doctoral students. Nevertheless, in keeping with convention, when discussing comparative earnings trajectories, we adopt the standard language of "returns" to the PhD, defined as the expected difference in log earnings (conditional on observables), since these returns represent the compensation required to justify the substantial opportunity costs.

Our paper provides new evidence on the labour market returns to doctoral education, using novel administrative data covering the universe of postsecondary students linked to yearly tax records and census data from Canada. Our analysis tracks individuals from their undergraduate studies through graduate education and into their subsequent labour market outcomes, allowing for credible estimation of the economic returns to earning a PhD relative to alternative educational pathways. We explicitly address the challenges associated with selecting appropriate counterfactuals by comparing PhD graduates to multiple alternative educational pathways: those who completed only a Bachelor's degree, Master's degree holders (all in the same fields), individuals with professional degrees (MBAs, JDs, MDs), and notably, those who enrolled but exited PhD programs at various stages without completion. This counterfactual framework, facilitated by detailed adminis-

[2]Converging evidence also points to a substantial mental-health cost among doctoral trainees. International meta-analyses find that roughly one-quarter of PhD students screen positive for depressive disorders and 17% for anxiety—rates several times higher than age-matched population norms (Satinsky et al., 2021). Although our empirical focus is on labour-market returns, these prevalence figures underscore that financial outcomes are only one dimension on which the costs and benefits of doctoral education must be weighed.

trative data, allows us to precisely quantify the short- and long-term consequences of doctoral education, accounting for and documenting selection through explicit controls for undergraduate characteristics and dropout timing. In addition to the administrative data, we draw on Canadian census data from 1991 through 2021 to explore lifecycle earnings of PhD graduates (beyond what is feasible with the administrative data), as well as documenting trends in returns to the different graduate degree paths.

Our main results confirm the general validity of concerns about PhD labour market outcomes while highlighting important distinctions across counterfactual groups and time horizons. First, the impression that PhD outcomes are deteriorating is broadly accurate for newly minted graduates: earnings dispersion has increased, with a larger share of PhDs falling into the lower tail of the earnings distribution.

Second, there remains a pronounced earnings premium for PhD graduates who secure academic appointments, yet the probability of becoming a university professor has declined notably over time. Lifecycle dynamics are also central, particularly for those employed in academia. For much of their careers, PhD graduates earn less than comparable master's graduates, with the financial payoff typically occurring later in life. This delayed payoff reflects both stronger labour force attachment beyond typical retirement ages and higher earnings for professors, conditional on full-time employment.

Third, returns to the PhD have diverged over time, declining for recent graduates while rising for older PhD holders, largely due to changes in the occupational composition of those working in academia. Gender patterns are striking as well: women experience higher returns than men, in the sense that their earnings premium over bachelor's and master's degrees is larger, while recent declines in returns have been more pronounced for men.

Non-completion also carries significant labour market penalties, particularly for those who withdraw late in their programs. Extended enrolment without completion reduces labour market experience and precludes access to higher-earning academic roles, effectively resulting in a "double penalty." Finally, neither field of study nor type of institution materially alters these broad patterns. This reflects our focus on within-field counterfactuals, comparing PhD graduates to bachelor's

and master's graduates in the same field (e.g., economics PhDs to economics master's graduates) and similarly conditioning on institutional background. While absolute earnings differ across fields, the relevant comparison is the incremental effect of the PhD relative to plausible alternatives.

Our paper contributes a lifecycle-based perspective on the returns to doctoral education, recognizing the stark contrast between substantial upfront costs and late-career benefits that hinge on securing academic employment. This builds upon and contributes to several strands of previous literature.

First, we extend existing research on selection into doctoral education and attrition from PhD programs (Stock et al., 2009; Stock and Siegfried, 2014; Ábrahám et al., 2022; Stansbury and Schultz, 2023; Denning and Turner, 2024). Using population-level administrative data, we build on Stock and Siegfried (2014) by examining PhD completion and attrition patterns across a broader range of disciplines beyond economics, and complement the detailed timing analyses of dropout explored by Denning and Turner (2024).

Second, we contribute to the literature on the short-term labour market returns to advanced degrees, including master's, professional, and PhD qualifications (Britton et al., 2020; Altonji and Zhong, 2021; Altonji et al., 2023; Altonji and Zhu, 2025; Minaya et al., 2024). Building on Altonji and Zhong (2021) and Britton et al. (2020), we incorporate PhD graduates into comparative analyses with master's and professional degree holders, thereby deepening understanding of the economic trade-offs associated with the duration and specialization of graduate education. Our work also complements Canadian evidence on the overall evolution of postgraduate returns (Boudarbat et al., 2010) and gender-based differences in returns to education (Jehn et al., 2021), while providing more granular estimates by field and lifecycle stage. Finally, we build directly on the Council of Canadian Academies (2021) report by extending its preliminary census-based estimates with linked administrative data that allow for richer counterfactual comparisons and lifecycle perspectives.

Third, we highlight the central role of academic employment in shaping the economic value of doctoral education. Our findings show that access to academic jobs is both the primary motivation for doctoral study and the main driver of long-run earnings differentials. This "tournament" structure means the value of

a PhD depends on securing a limited set of academic positions, with substantial variation across fields. We extend Canadian evidence on these dynamics using administrative and census data to show lifecycle earnings differences tied to academic employment. Our results complement prior analyses using survey and tax-linkage data that document mismatch between PhD training and employment outside academia (Jiang et al., 2023; Etmanski et al., 2017; Walters et al., 2021), as well as broader evidence on the role of occupational match in shaping education returns (Lemieux, 2014).

Fourth, our analysis documents heterogeneity in PhD returns by gender, immigration status, field of study, and institutional rank. We provide new evidence on how these patterns vary across fields and career pathways, building on prior research on gender gaps and immigrant outcomes in higher education (Buffington et al., 2016; Boustan and Langan, 2019; Delaney and Devereux, 2025; Tani, 2022).

Finally, our findings have direct policy relevance by grounding critiques of PhD overproduction and the disconnect between training scale and labour market demand in new empirical evidence. We inform debates about oversupply and misalignment between doctoral training and employment outcomes (Council of Canadian Academies,, 2021; Cassuto, 2015; Rosenberg, 2023; Dirks, 2023), as well as foundational supply-demand analyses (Bowen and Sosa, 1989).

By leveraging rich administrative data and building methodologically on prior influential work, our analysis offers robust evidence on the lifecycle implications of pursuing a PhD. This perspective underscores the importance of evaluating PhD training as a highly selective, career-stage-sensitive investment with significant implications for PhD enrolment management, program design, advising, and funding.

The remainder of the paper proceeds as follows. Section 2 provides background on the Canadian university landscape and the structure of doctoral study. Section 3 describes the data, presents stylized facts about graduate education, and introduces our methodology. Section 4 documents selection into PhD programs and estimates the short- and long-term labour market returns to PhD completion. Section 5 reflects on the broader implications for doctoral education policy and program design, emphasizing the need for more transparent, student-centered approaches in light of evolving labour market realities.

2 Post-Secondary Institutions in Canada

The economic returns to a PhD are closely tied to the structure and evolution of the academic job market. Most PhD students begin their programs with the intention of pursuing university-based research or teaching careers, and doctoral training is typically designed with this trajectory in mind. In their influential study, Bowen and Sosa (1989) emphasized that the long-run viability of this pathway depends on the alignment between the supply of new PhD graduates and the demand for academic labour, which in turn is shaped by undergraduate enrolments, faculty retirements, and institutional hiring. While their central concern in the late 1980s was the possibility of a future shortage of PhDs, the underlying framework they proposed, connecting program admissions to labour market forecasts, remains highly relevant. Today, the dominant concern is no longer undersupply but persistent and structural oversupply, as doctoral production has continued to grow while tenure-track academic employment opportunities have stagnated.

While not a fully closed labour market, the Canadian system of PhD education and academic employment shares important structural features with the United States. The vast majority of Canadian universities are public and operate under provincial regulation, especially with respect to enrolment and tuition policy. Research-intensive universities, particularly those in the U15 group, and even more so the U5 (Toronto, UBC, McGill, Alberta, and Montréal), play dominant roles on both the supply and demand sides of the academic labour market.[3] These institutions account for a disproportionate share of PhD enrolments and federally funded research, and they also train the majority of faculty who are later employed across the rest of the university system (Science and Research, 2024). In this sense, the U15 act as upstream producers of doctoral labour, while smaller and less research-intensive universities function as downstream employers. Over the period of our study, however, the distribution of doctoral students across institutional tiers has shifted. In particular, the share of PhD graduates coming from U5 and U15 institutions has declined, driven by increased doctoral enrolment at non-U15 universities. While this trend does not drive our results (since we control

[3] A more in-depth discussion on the nuanced governance and funding structures of universities can be found in Council of Canadian Academies, (2021).

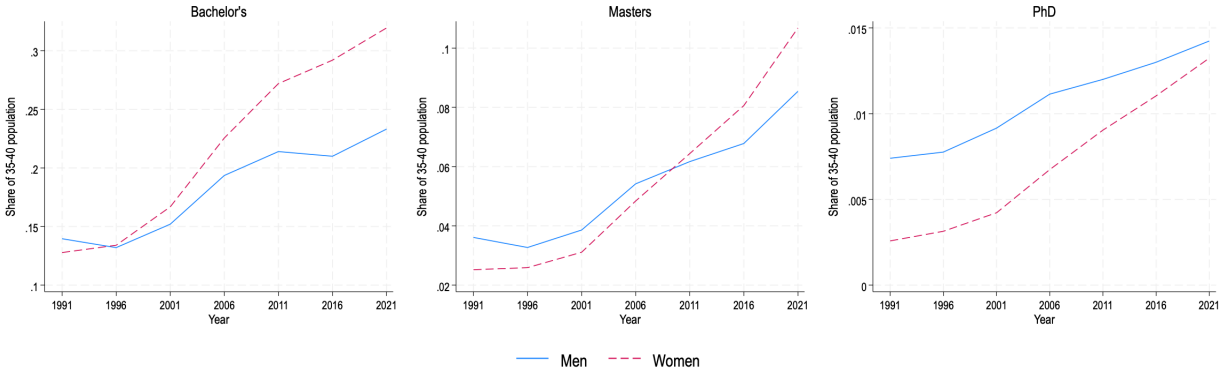
for institution fixed effects in all regressions) it reflects a notable change in the structure of doctoral training in Canada. These shifts may also affect access to academic employment and funding environments, and are relevant for understanding evolving student experiences and long-term outcomes. Canadian immigration policy further reinforces this semi-closed system: while universities may hire international faculty, permanent residents and citizens are typically given preference in hiring decisions, particularly at public institutions.

PhD enrolment decisions in Canada, as elsewhere, are shaped primarily by institutional incentives rather than by aggregate labour market demand. Program size and admissions are governed at the provincial level through operating grants and tuition structures, with some variation in how international student funding is treated. At the federal level, the main research councils - SSHRC, NSERC, and CIHR - provide both competitive fellowships for PhD students and research grants to faculty, which can be used to support graduate students as research assistants. The net result is a system in which doctoral study is heavily subsidized, particularly in fields aligned with national research priorities, and with an overall emphasis on building research capacity.

Within institutions, enrolment decisions are decentralized and driven by a combination of faculty supervisory capacity, the availability of qualified applicants (helped by funding subsidies), and historical program sizes that evolve only slowly over time. In many disciplines, students enter doctoral programs after completing a master's degree, which functions as a lower-stakes filtering mechanism offering students the chance to gauge research fit and providing a structured off-ramp to the labour market. More generally, the size and scale of undergraduate enrolment indirectly reinforce PhD enrolments: undergraduate tuition revenue supports institutional operations, undergraduates serve as the primary teaching population for PhD student assistantships, and they form the base from which many graduate programs draw applicants. Despite this complex web of institutional incentives, there is no direct mechanism linking national or sectoral labour market conditions to PhD admissions. As a result, the number of doctoral students trained often bears little relationship to the number of research or academic positions available.

We now provide an overview of the key enrolment and academic labour market trends. Over the past two decades, Canada has experienced a steady rise in

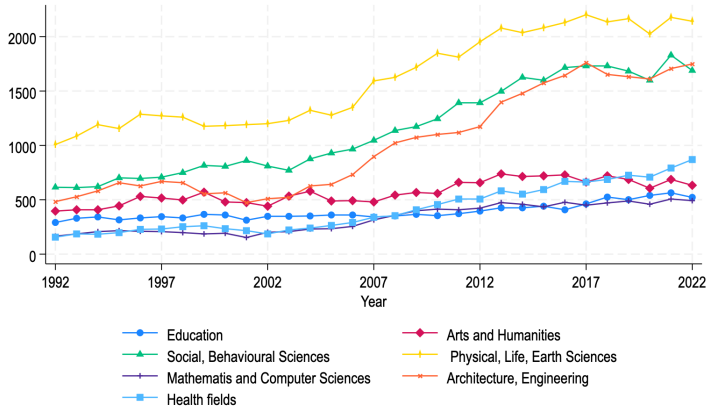
Figure 1: Share of 35-40 population by highest degree



Note: The figure shows the share of the population aged 35-40 years old by highest degree, separately for men and women.
Data source: Census 1991-2016.

educational attainment levels (Figure 1). The proportion of individuals holding postsecondary degrees has increased significantly, with a corresponding rise in the number of PhD graduates. This growth has been particularly pronounced in fields such as Physical, Life, and Earth Sciences, Social and Behavioural Sciences, and Architecture and Engineering (Figure 2).

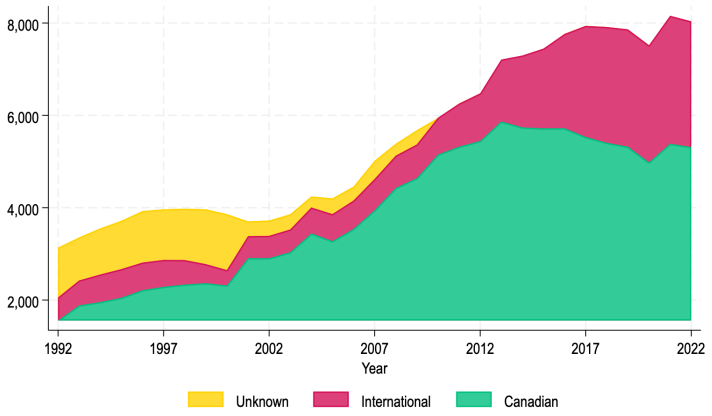
Figure 2: PhD Graduates by Field



Data source: Statistics Canada. Table 37-10-0012-01 Postsecondary graduates, by field of study, program type, credential type, and gender. DOI: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710001201.

Figure 3 highlights one key international dimension of the PhD labour market: The enrolment of international PhD students in Canadian universities. Since the 2010s, the expansion of PhD enrolment has been largely driven by international students, on a foundation of slowly declining domestic PhD enrolments.

Figure 3: PhD Graduates by Immigrant Status

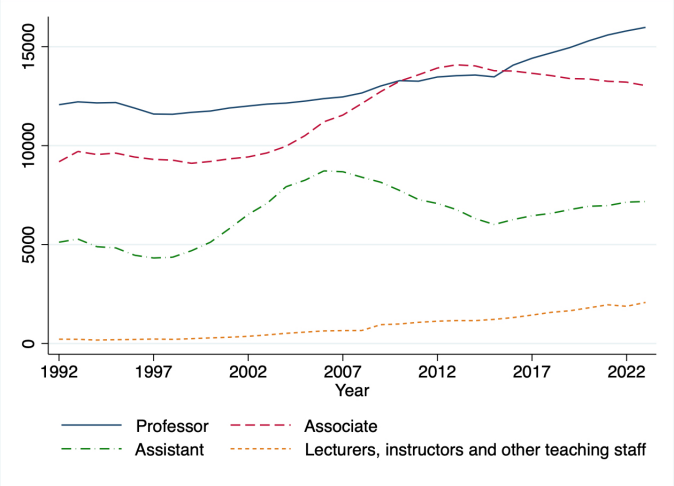


Data source: Statistics Canada. Table 37-10-0020-01 Postsecondary graduates, by institution type, status of student in Canada and gender. DOI: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710002001.

Despite this increase in PhD graduates, the demand for tenure-track faculty positions in Canada has remained stagnant or declined. While the total number of faculty members has grown modestly, this growth has been much slower since 2000, with the number of Assistant Professors declining since 2008 (Figure 4). The largest category of employed faculty is now Full Professors, reflecting an aging professoriate, facilitated in large part by the end of mandatory retirement. Simultaneously, undergraduate enrolments have increased in several fields, including Law and Social Sciences, Business, Health Fields, Physical and Life Sciences, and Architecture and Engineering, while the Humanities have experienced the most pronounced decline (Appendix Figure A1). While we often describe an "academic market for PhDs," of course, there are many discipline-based submarkets with their own enrolment fundamentals.

As perceived by higher education commentators, then, it is clear that the underlying determinants of PhD employment opportunities in the academic sector point

FIGURE 4: FACULTY



Data source: Statistics Canada, Table 37-10-0077-01 Number and median age of full-time teaching staff at Canadian universities, by highest earned degree, staff functions, rank, gender. DOI: https://doi.org/10.25318/3710007701-eng. Based on a sample of faculty who hold PhDs; trends are substantively identical when including all faculty regardless of highest degree.

to likely worsening outcomes, depending on the extent to which non-academic jobs grow to offset any potential spillovers from the university sector.

3 Data & Methodology

In this section we describe our two primary data sources: Matched tax and education administrative records that permit a close examination of short term transitions and labour market outcomes, and a series of Canadian censuses that provide a longer term lifecycle perspective on these outcomes.

3.1 Short-term Analysis

The analysis uses a range of linked administrative and survey data. Our analysis of early career outcomes for graduates relies on the Postsecondary Student Information System (PSIS), administrative records on the universe of enroled students in public post-secondary institutions in Canada (2009-2020), matched to yearly tax records. The linked files comprise the Education and Labour Market Longi-

tudinal Platform (ELMLP). For each student, these records provide information on age, citizenship, educational program, educational qualification, entry cohort, field of study, gender, geographic location, graduate status, learning institution, and school attendance. The linkages to the T1 Family File of the Canadian tax records allows us to access yearly information such as total employment income from T4 slips, total income, and marital status.

Our estimation sample is specifically constructed to maximize our ability to credibly estimate economic returns and educational trajectories. To do so, we focus on individuals who completed their Bachelor's degrees in 2009, enabling us to use the maximum available duration within the administrative data to observe subsequent labour market and educational trajectories. Given the tax records coverage from 2009 through 2019, this approach allows us to track labour market outcomes for a maximum of 10 years following undergraduate graduation. For individuals pursuing graduate studies directly after their Bachelor's degree (assuming typical progression through a Master's degree of two years followed by a PhD duration of approximately four years) our data captures labour market outcomes for up to five years after PhD completion.[4] This detailed timeframe enables a robust analysis of both immediate and early career outcomes associated with different educational pathways. Second, for our analysis comparing individuals who enroled in PhD programs (including both graduates and non-completers), we specifically focus on the cohort of students who began their PhD studies between 2010 and 2012.[5] We investigate their labour market outcomes nine years after their initial enrolment, ensuring that our analysis captures only individuals who have either completed their PhD programs or dropped out, explicitly excluding those who remain enroled to avoid bias stemming from ongoing student status.

To estimate the returns to completing a PhD relative to alternative educational outcomes, we employ an Ordinary Least Squares (OLS) regression framework using administrative tax records to measure income. The dependent variable varies

[4]Of course, the actual trajectory and time to completion for a PhD graduate are, on average, longer than the typical official 4 year program-length. We discuss the role of time to completion and drop-out in Section 4.

[5]We are unable to use an earlier starting cohort, as Alberta and Quebec do not report program start dates. We impute a start date in 2010, if a student is recorded as currently enrolled in a program in 2010 but was not recorded as enrolled in such program during the first available year, 2009.

by specification, either the logarithm of total income or the logarithm of T4 employment income (our preferred outcome). The primary independent variable of interest is an indicator for PhD completion, with specifications varying in the choice of comparison group.

The estimating equation for the first analysis, which compares PhD graduates to individuals from the same 2009 bachelor's degree cohort who pursued alternative educational trajectories, is specified as follows:

$$\begin{aligned}\log(Y_i) = \beta_0 + \beta_1\, PhD_i + \beta_2\, Masters_i + \beta_3\, ProfessionalDegree_i \\ + \beta_4\, OtherIntermediateDegree_i + \gamma X_i + \delta F_i + \lambda I_i + \varepsilon_i \qquad (1)\end{aligned}$$

where $\log(Y_i)$ represents the logarithm of total or employment income for individual i in 2019. The variables PhD_i, $Masters_i$, $ProfessionalDegree_i$ and $OtherIntermediateDegree_i$ are indicators for the highest level of educational attainment, such that the omitted category consists of individuals who did not pursue further education after the initial Bachelor's degree.

The vector X_i includes individual-level controls such as gender and immigration status. The term F_i represents fixed effects for bachelor's field of study (categorized as Humanities, Social Sciences, Economics and Business, Life Sciences, and Physical Sciences), and I_i captures institution fixed effects based on the university of undergraduate enrolment.

In the second analysis, which focuses on individuals who enrolled in a PhD program between 2010 and 2012, we estimate the following slightly modified equation:

$$\log(Y_{i,t}) = \beta_0 + \beta_1 PhDGrad_i + \beta_2 Drop2{-}3_i + \beta_3 Drop4_i + \gamma X_i + \delta F_i + \lambda I_i + \theta_t + \varepsilon_i \quad (2)$$

where $\log(Y_{i,t})$ represents the logarithm of employment income for individual i nine years after initial PhD enrolment, in year t. The variable $PhDGrad_i$ is an indicator for whether the individual completed the PhD, while $Drop2-3_i$ and $Drop4_i$ are indicators for dropping out of the program in years 2–3 and years 4 or

later, respectively. The omitted category in these specifications consists of individuals who dropped out in the first year of the program. The term θ_t represents cohort fixed effects corresponding to the year of program entry, and the terms X_i, F_i, and I_i are defined as specified above.[6]

In this set of specifications, we first compare individuals who completed the PhD to those who enroled but did not graduate—that is, we do not include the terms $Drop2-3_i$ and $Drop4_i$. In subsequent specifications, we refine the comparison group by distinguishing between different dropout periods. This allows us to estimate the differential returns to varying durations of PhD enrolment relative to early dropout. Across all specifications, robust standard errors are reported in parentheses.

Our primary measure of labour market outcomes is T4 employment income as reported through annual tax filings. To provide a more comprehensive assessment of economic returns, we also analyze total income, which captures earnings from additional sources such as self-employment—particularly relevant for professional degree holders (e.g., MBAs, JDs, MDs)—as well as transfers. Importantly, our income measures rely on individuals filing taxes, which introduces the possibility of selection bias if tax-filing behaviour is systematically correlated with labour market outcomes.

Although tax filing is mandatory for Canadian residents and generally very high among postsecondary graduates, our data indicate that filing rates among PhD students and graduates are not universal. Following graduation, filing rates decline and this decline is especially pronounced among international students.

One plausible interpretation of this post-graduation filing decline is emigration, particularly among international students who may return to their country of origin or move elsewhere for work. While we cannot directly observe geographic mobility, unemployment is an unlikely explanation, given the high education level of this population and the financial incentives to file taxes. Instead, the magnitude and structure of non-filing patterns point toward selective out-migration. Using a standard proxy for emigration—non-filing for three consecutive years following

[6]In specifications where we focus on the sample of individuals who enroled in a PhD and the relevant counterfactual group is students who dropped out of the program, we define these field and institutional fixed effects for PhD enrolment.

graduation (following Blit et al., 2024)—we estimate that approximately 14% of PhD graduates meet this criterion. This attrition is highly non-random: international students are six times more likely to become non-filers than domestic students; early dropouts are more likely to stop filing than graduates; and filing attrition is higher in the physical sciences and among students from U15 and U5 institutions. These patterns are consistent with prior evidence from institutional-level data. For example, the University of Toronto's 10,000 PhDs Project found that 25% of its doctoral graduates were working outside Canada, underscoring the international nature of the PhD labour market and the likelihood that non-filing reflects genuine geographic mobility.[7] Together, these findings suggest that out-migration is both substantial and selective, and they underscore the importance of interpreting our estimated returns as conditional on remaining in Canada.

This limitation also affects our long-term analysis. We partially address this issue by separately estimating returns for immigrants to Canada, which provides insight into the economic value of a PhD for foreign-born individuals.[8]

3.2 Long-term Analysis

The analysis of long-term returns to advanced degrees is based on the restricted version of the 20% sample of the Canadian Population Census microdata from 1991 to 2021. From these data, we are able to observe age, employment income, highest certificate/diploma/degree, labour force status, major field of study of the highest degree, occupation, province of residence, sex, total income, type of dwelling, families, households and marital status, and language.[9]

Our primary regression specification estimates the returns to a PhD relative to a Bachelor's degree among native individuals aged 25–75 who hold at least

[7] University of Toronto School of Graduate Studies (2019). 10,000 PhDs Project Overview Report. https://www.sgs.utoronto.ca/wp-content/uploads/2019/06/SGS_Overview_10KPhDsProject.pdf

[8] We classify individuals as immigrants if they were born abroad and immigrated to Canada after age 20, as this increases the likelihood that their education was completed outside Canada. We note that this classification successfully captures the location where individuals obtained their highest credentials for the vast majority of natives–which we corroborate using the 2006 to 2021 Censuses, which report this information.

[9] Unlike the richness of the PSIS data, we are unable to observe more detailed information about the highest degree outside of the major field of study.

a Bachelor's degree and report full-time employment with positive employment income.[10] The regression model takes the form:

$$\begin{aligned}\log(Y_{i,t}) = \alpha_0 + \alpha_1 PhD_{i,t} + \alpha_2 Masters_{i,t} + \alpha_3 ProfDeg_{i,t} \\ + \gamma Age_{i,t} + \eta Age_{i,t}^2 + \delta P_{i,t} + \theta F_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{3}$$

where $\log(Y_{i,t})$ represents the logarithm of real employment income for individual i in Census year t. The key independent variables capture individual's highest educational attainment: $PhD_{i,t}$ is indicator for holding a PhD, $Masters_{i,t}$ is an indicator for holding a Master's degree, and $ProfDeg_{i,t}$ is an indicator for holding an intermediate or professional degree (which include MBA, JD, and MD). The omitted category is a Bachelor's degree. We control for age and age squared, province of residence $P_{i,t}$, and field of study $F_{i,t}$. The returns to a PhD are always estimated separately for men and women. All regressions use Census survey weights, and robust standard errors are estimated. To assess whether the returns to PhD and Master's degrees (relative to a Bachelors) are statistically different, we report the F-statistic and p-value for the test $H_0 : \alpha_1 = \alpha_2$.

Additional specifications include separate regressions where we exclude individuals currently working as University professors, and analyses by university rank (U5, U15, non-U15) and field of study. We also estimate models where we separately estimate the returns to a PhD for native and immigrants, using native Bachelor's degree holders as the omitted category in those cases.

The process of earning a PhD is characterized by an abundance of unobserved selection. Individuals who choose to pursue and complete a doctoral degree differ systematically from those who do not, both in observable and unobservable ways. While we cannot fully account for these selection dynamics, our formal regression models control for observable heterogeneity, allowing us to estimate returns conditional on key demographic and educational characteristics. Additionally, our

[10] A potential concern in our analysis is selection bias due to restricting the sample to full-time workers with positive employment income. However, this restriction follows the standard approach in the literature (Altonji and Zhong, 2021; Altonji et al., 2023).

approach sheds light on the selection process itself, as differences in returns across subgroups provide insight into how PhD holders sort into different labour market trajectories. A key strength of our analysis is that we lean on various counterfactual groups, including individuals with a Bachelor's or Master's degree, PhD non-completers, and subgroups stratified by gender, immigration status, and institutional rank, to provide a more comprehensive understanding of selection and returns.

4 Results

4.1 The PhD

We begin our analysis by characterizing the selection process into PhD programs in Canada. Using the longitudinal structure of the PSIS administrative data, we observe the full educational trajectories of the universe of individuals who completed their undergraduate degrees in 2009, tracking transitions into Master's and PhD programs. This allows us to identify the subset of students who pursue doctoral education and to examine how selection varies along key dimensions such as gender, field of study, and immigration status.

Among individuals who complete a bachelor's degree in Canada, a relatively small share go on to pursue graduate education, and an even smaller fraction ultimately enter a PhD program. In our data, approximately 14% of bachelor's graduates proceed to a master's degree within 9 years of graduation, while only 1% graduate from a PhD program over the same period.[11,12] This indicates that PhD entrants represent a highly selective subset of the post-secondary population. Notably, the likelihood of pursuing graduate studies varies systematically across observable characteristics: students from certain undergraduate fields (e.g., physical and life sciences) and U15 and U5 institutions are disproportionately represented among graduate degree holders. Women are approximately equally repre-

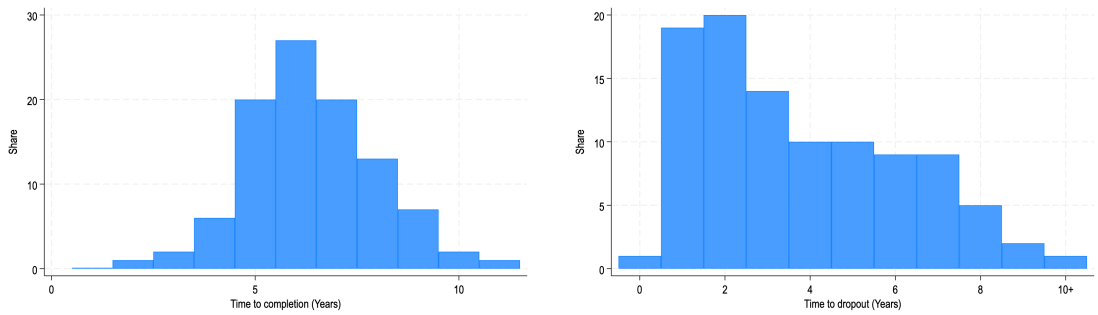
[11] We select the first available cohort to graduate from a Bachelor degree in the PSIS, in 2009, and follow their educational trajectories until 2018.

[12] Unlike in the United States, direct entry into PhD programs from a bachelor's degree is relatively uncommon in Canada. Most students enter doctoral programs after completing a master's degree, making graduate education a sequential process rather than a single-stage transition.

sented among PhD students overall, but this aggregate balance masks substantial variation in gender composition across fields of study. For example, women are significantly underrepresented in disciplines such as physical sciences, and overrepresented in fields like social and life sciences. International students also make up a substantial share of PhD enrolment. In our data, approximately 36% of PhD students are international, a figure that is notably higher than the share of international students at the undergraduate level (which stands at approximately 6%). This overrepresentation at the doctoral level likely reflects several dynamics, including targeted recruitment by graduate programs, the international portability of research-oriented training, and the use of PhD study as a pathway to longer-term immigration or academic employment in Canada.

PhD programs are long and uncertain undertakings, and not all students who begin a doctoral degree ultimately complete it. In 2020, the final year of observation in our data, 65% of 2009 PhD entrants had graduated, 28% had exited without a degree, 5% were still enrolled, and 2% held other statuses (e.g., administrative withdrawal or transfer).[13] Attrition tends to be concentrated in the early years of the program, with many students exiting within the first two to three years. These outcomes are illustrated in Figure 5. This pattern suggests that both academic fit and evolving career aspirations play a role in shaping persistence, alongside structural factors such as funding availability or supervisor relationships.

FIGURE 5: THE PHD EXPERIENCE: GRADUATION AND ATTRITION



Data source: PSIS. This figure is referenced in Section 4.1.

For those who do complete their degrees, PhD programs represent a significant

[13] See Liu (2025) for a rich analysis of time to completion of PhD in Canada.

investment of time. The median time to completion in our sample is 6 years (Figure 5), with variation across fields of study and institutions. During this period, students are typically outside the full-time labour market, foregoing several years of potential earnings they might otherwise have earned with a master's degree. This opportunity cost is non-trivial, particularly given that PhD entrants are often on average 30 years old, and that the cumulative foregone income can rival the early-career wage premium associated with doctoral education. The protracted timeline to completion highlights the long-run nature of the human capital investment involved in pursuing a PhD.

PhD students occupy a dual role within the university system: they are both advanced trainees and essential inputs into the university's core functions of teaching and research. Unlike other forms of postsecondary education that are primarily consumption- or instruction-based, the doctoral experience involves substantial work contributions by students. As teaching assistants, they support undergraduate instruction through leading tutorials, grading, and managing lab or discussion sections. As research assistants, they contribute directly to faculty-led research and, through their own scholarship, to the university's broader research output. In exchange, students typically receive funding packages that combine fellowships with compensation for their labour.

Appendix Table B1 presents the mean T4 income and total income received by PhD students during their doctoral studies, disaggregated by sex, immigration status, institutional rank, and field of study. A somewhat counterintuitive pattern emerges: students enrolled at lower-ranked (non-U15) institutions report higher average taxable income during the PhD than those at top-ranked U15 universities. While we cannot directly observe the composition of funding packages in our data, which is limited to taxable income, one plausible explanation for this pattern is institutional variation in the structure of graduate support. Higher-ranked institutions may offer a larger share of support in the form of non-taxable stipends or internal fellowships, which would not be reflected in T4 income. In contrast, students at lower-ranked institutions may receive a greater proportion of their support through employment-based funding, such as teaching or research assistantships, which are taxable and therefore captured in our data. These differences in funding structure may help explain the observed income patterns, though

we cannot directly test this mechanism with the available data.

Importantly, regardless of institutional differences, the overall level of income during the PhD is low. The average annual employment income reported by PhD students, approximately $22,000[14] , is substantially below the average earnings of individuals with a master's degree working full time. This gap underscores the significant opportunity cost associated with pursuing a PhD, particularly given that many entrants already hold master's degrees and could otherwise command relatively high wages in the labour market. These figures reflect the considerable tradeoffs that students must make to pursue doctoral training, not only in terms of delayed entry into full-time employment, but also in accepting lower earnings during what are often prime working years. This financial sacrifice is a central component of the doctoral experience.

4.2 The early-career returns to an earned PhD

Our analysis of the economic returns[15] to an earned PhD begins with a focus on the early years after graduation. For this, we use the PSIS data, which provides detailed records of attendance and graduation for higher education degrees. Each student recorded in the PSIS data is linked to their tax records, both during their studies and for all subsequent years up to 2020.[16]

When estimating the returns to the PhD, selecting an appropriate counterfactual is a particularly important yet challenging task, in light of the selection into the PhD documented above. While our analysis remains descriptive, we conduct a series of analyses to shed light on this matter.

We first focus on students who were admitted and enrolled in a PhD program and estimate the returns to completing the degree, relative to dropping out at dif-

[14]We note that there is substantial variation in earnings during the PhD across disciplines, as seen in Table B1.

[15]As previously noted, we define economic returns as log differences in earnings. For ease of interpretation, we refer to these differences as percentage changes throughout the paper. Strictly speaking, the correct percentage change requires applying the transformation $100 \times (e^{\beta} - 1)$, but for small coefficients the log approximation is sufficiently accurate.

[16]This analysis is restricted to individuals who were no longer enrolled in a PhD program at the time of observation—either because they had graduated or had dropped out. Those still enrolled are excluded from the analysis to ensure comparability in post-enrolment income outcomes.

ferent stages. Specifically, we examine a cohort of students who began their PhD between 2010 and 2012 and measure their labour market outcomes—specifically, T4 earnings—nine years after program entry. Among this cohort, 70% had graduated with a PhD by 2020, while 6% dropped out in the first year, 10.2% exited during years 2 and 3, and 13.8% withdrew after four or more years.

Table 1 presents estimates of early-career returns to PhD completion, measured as log T4 income nine years after initial program enrolment. The first two columns compare graduates to all non-completers, separately for men (column 1) and women (column 2). In column 1, we see that for men, PhD completion is not associated with a significant short-run earnings premium relative to non-completion. By contrast, column 2 shows that for women, completing a PhD is associated with a statistically significant increase in T4 income—roughly 10.9% higher than for women who did not complete. This suggests that the early-career labour market returns to a completed PhD are meaningfully positive for women, but not for men.

Table 1: Early-career returns as compared to dropping out: T4 income

	Dependent variable: Log T4 income 9 years after PhD start			
	Men	*Women*	*Men*	*Women*
	(1)	(2)	(3)	(4)
Graduated	-0.00756	0.109***	-0.123**	0.0881
	(0.0269)	(0.0326)	(0.0505)	(0.0648)
Dropped out in years 2-3			-0.0647	0.0384
			(0.0596)	(0.0806)
Dropped out in years 4+			-0.196***	-0.0676
			(0.0587)	(0.0739)
Year	Yes	Yes	Yes	Yes
Sex	No	No	No	No
Immigrant	Yes	Yes	Yes	Yes
Institution of PhD	Yes	Yes	Yes	Yes
Field of study of PhD	Yes	Yes	Yes	Yes
Omitted category	Did not graduate	Did not graduate	Dropped out in first year	Dropped out in first year

Note: The table reports our estimates of the returns to an earned PhD as compared to dropping out of the program for the PSIS cohort who enrolled in a PhD in 2010-2012. We estimate the returns separately for women and men. First, we report the returns to graduating as opposed to dropping out of the program (columns 1 and 2). Then, we classify students who did not finish the program based on the year in which they dropped out (columns 3 and 4). In columns 1 and 2, We estimate returns with regressions of log T4 income 9 years after the start of the program on an indicator for whether the student graduated from the PhD, controlling for field of study, institution, year in which they started the program, and immigration status. In columns 3 and 4, we add an indicator for dropping out of the program in years 2-3 of the program, and in years 4 and above. The resulting estimates correspond to the returns as compared to dropping out in the first year, the omitted education category. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS

Columns 3 and 4 then refine the comparison group by disaggregating non-completers based on when they dropped out of the program. Here, the omitted

category is students who exited in their first year—a group likely to have spent little time in the program and to have entered the labour market relatively quickly. For men (column 3), the results indicate that graduates earn significantly less than this early-dropout group. Further, men who dropped out in years 4 or later earn nearly 20% less than early dropouts, pointing to a substantial short-term penalty for late-stage attrition. For women (column 4), the differences across groups are not statistically significant, but the same general ranking holds: later dropouts earn less than early leavers, and graduates earn slightly more, although not significantly so.

When we compare these findings to estimates using total income—which includes non-T4 income sources such as self-employment, rental income, and investment earnings—the overall patterns are largely consistent (Appendix Table B2). In both T4 and total income measures, the timing of dropout emerges as a key determinant of post-PhD earnings: students who leave early tend to perform better than those who exit later, regardless of whether they ultimately complete the program. This pattern holds for both men and women.

However, one notable discrepancy arises in the comparison between male graduates and male non-completers. While the T4 estimates (column 1) show no earnings premium (and even suggest a slight disadvantage) for male PhD graduates relative to non-completers, the total income estimates show that male graduates earn modestly more than non-completers on average. This divergence likely reflects the presence of income sources not captured in T4 slips—for example, income from self-employment, consulting, investments, or other taxable but non-payroll earnings. While this distinction does not alter the core finding that late-stage dropout is associated with the largest income penalties, it highlights the importance of considering multiple dimensions of income when assessing the returns to doctoral education. For some subgroups (particularly men) the structure of post-PhD earnings may differ in ways not fully captured by employment income alone.

We next turn to differences in early-career income returns to PhD completion across fields of study (Table 2). Columns 1 through 5 present estimates comparing individuals who completed their PhD to those who did not, regardless of when they exited. These results suggest substantial heterogeneity in the earnings effects

of PhD completion across disciplines. In particular, PhD completion in economics and business is associated with the largest positive return, with graduates earning approximately 33% more in T4 income nine years after starting the program (column 5). A smaller but still significant return is observed in the social sciences (8.3%, column 2), while the estimates for the life sciences, physical sciences, and humanities are positive but not statistically significant.

However, when we disaggregate the non-completion group by timing of dropout (columns 6 through 10), the apparent short-term premiums to PhD completion are attenuated or disappear entirely in most fields. For example, in economics and business (column 10), the positive effect of completing the PhD becomes statistically insignificant when compared specifically to students who dropped out in the first year. Similarly, in the life sciences and social sciences, the graduate premium shrinks, and in physical sciences, the estimates indicate large and statistically significant penalties for dropping out later in the program—rather than clear gains from completion itself. This shift in interpretation underscores the importance of considering dropout timing when assessing returns to doctoral training. Taken at face value, these results suggest that the optimal strategy for a PhD enrollee (in the short-run) is to drop out in their first year.

One potential explanation is that early dropouts may possess strong labour market prospects independent of credential completion, and benefit from earlier entry into the workforce. In contrast, students who leave later in the program may suffer from a combination of lost time, delayed experience accumulation, and the absence of a terminal degree. The large penalties associated with dropping out in years 4+ (especially in the physical sciences) highlight the substantial opportunity costs of time spent in doctoral study without obtaining the degree. More broadly, these findings suggest that what appears to be a return to PhD completion may in fact reflect the high cost of late-stage non-completion, rather than the degree itself delivering large short-run income gains across all fields.

Appendix Table B3 presents the corresponding results using total income as the outcome, and they reinforce the general structure of findings from the T4-based analysis.

Table 2: Early-career returns as compared to dropping out, by field: T4 income

	Dependent variable: Log T4 income 9 years after PhD start									
	Humanities	*Social Sciences*	*Physical Sciences*	*Life Sciences*	*Economics and Business*	*Humanities*	*Social Sciences*	*Physical Sciences*	*Life Sciences*	*Economics and Business*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Graduated	-0.0782	0.0827**	-0.0173	0.116	0.329***	-0.0958	0.0509	-0.205***	0.0561	0.216
	(0.0601)	(0.0377)	(0.0332)	(0.0720)	(0.0803)	(0.131)	(0.0754)	(0.0531)	(0.146)	(0.151)
Dropped out in years 2-3						0.228	0.0398	-0.220***	-0.0455	-0.0321
						(0.146)	(0.0910)	(0.0717)	(0.176)	(0.167)
Dropped out in years 4+						-0.129	-0.0814	-0.250***	-0.101	-0.216
						(0.138)	(0.0835)	(0.0670)	(0.179)	(0.176)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sex	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institution of PhD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Field of study of PhD	No	No	No	No	No	No	No	No	No	No
Omitted category	Did not graduate	Did not graduate	Did not graduate	Did not graduate	Did not graduate	Dropped out in first year	Dropped out in first year	Dropped out in first year	Dropped out in first year	Dropped out in first year

Note: The table reports our estimates of the returns to an earned PhD as compared to dropping out of the program for the PSIS cohort who enrolled in a PhD in 2010-2012. We estimate the returns separately for women and men, and by field of study of the PhD. First, we report the returns to graduating as opposed to dropping out of the program (columns 1 and 2). Then, we classify students who did not finish the program based on the year in which they dropped out (columns 3 and 4). In columns 1 and 2, We estimate returns with regressions of log T4 income 9 years after the start of the program on an indicators for whether the student graduated from the PhD, controlling for institution, year in which they started the program, and immigration status. In columns 3 and 4, we add an indicator for dropping out of the program in years 2-3 of the program, and in years 4 and above. The resulting estimates correspond to the returns as compared to a dropping out in the first year, the omitted education category. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS

Graduates in economics and business, social sciences, life sciences, and physical sciences all experience statistically significant income gains relative to non-completers, with point estimates ranging from approximately 16% to nearly 29%. Interestingly, even humanities graduates, who showed no T4 income premium, exhibit a modest but statistically significant advantage in total income (8.5%, column 1). When we account for timing of dropout (columns 6–10), the overall pattern remains: students who leave the program in years 4+ consistently earn less than both early dropouts and graduates, and in many cases these penalties are statistically significant. In economics and business, for instance, late-stage dropouts earn nearly 40% less than those who exited early (column 10), a gap that is even larger than in the T4 income analysis.

Taken together, these findings suggest that while the size of the earnings differentials varies somewhat across income measures, the underlying story is robust: the short-run returns to doctoral education are shaped more by when a student exits than by whether they finish.

Table 3: Early-career returns as compared to dropping out, by institution: T4 income

	Dependent variable: Log T4 income 9 years after PhD start					
	Non-U15	*U15, not U5*	*U5*	*Non-U15*	*U15, not U5*	*U5*
	(1)	(2)	(3)	(4)	(5)	(6)
Graduated	0.0553	0.118***	-0.0193	0.0126	0.0367	-0.165**
	(0.0345)	(0.0385)	(0.0361)	(0.0658)	(0.0760)	(0.0691)
Dropped out in years 2-3				0.0342	-0.0192	-0.123
				(0.0799)	(0.0922)	(0.0854)
Dropped out in years 4+				-0.108	-0.167*	-0.206**
				(0.0750)	(0.0880)	(0.0809)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Sex	Yes	Yes	Yes	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes	Yes	Yes	Yes
Institution of PhD	Yes	Yes	Yes	Yes	Yes	Yes
Field of study of PhD	Yes	Yes	Yes	Yes	Yes	Yes
Omitted category	Did not graduate	Did not graduate	Did not graduate	Dropped out in first year	Dropped out in first year	Dropped out in first year

Note: The table reports our estimates of the returns to an earned PhD as compared to dropping out of the program for the PSIS cohort who enrolled in a PhD in 2010-2012. We estimate the returns separately for women and men, and by type of institution. Specifically, we classify institutions as U5, U15 excluding U5, and other institutions. First, we report the returns to graduating as opposed to dropping out of the program (columns 1 and 2). Then, we classify students who did not finish the program based on the year in which they dropped out (columns 3 and 4). In columns 1 and 2, We estimate returns with regressions of log T4 income 9 years after the start of the program on an indicators for whether the student graduated from the PhD, controlling for field of study, institution, year in which they started the program, and immigration status. In columns 3 and 4, we add an indicator for dropping out of the program in years 2-3 of the program, and in years 4 and above. The resulting estimates correspond to the returns as compared to a dropping out in the first year, the omitted education category. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS

Returns to PhD completion also vary by institutional context. Students from

U15 institutions outside the U5 show significantly positive earnings returns to graduation, whereas those from U5 universities earn significantly less than their early-dropout peers (Table 3). One possible explanation is that graduates from top-ranked institutions may be more likely to pursue academic career paths or postdoctoral positions, which often involve prolonged earnings delays relative to private-sector employment. Another possibility is that the admissions processes at the most prestigious institutions are particularly effective at selecting high-ability individuals. In this case, even those who leave the program early may have strong labour market potential. For U5 students, early exit from a PhD may still translate into favourable short-run outcomes if their underlying ability (screened in at the time of admission) is recognized and rewarded by employers. From this perspective, the lack of observed earnings gains for U5 graduates may reflect high counterfactual earnings for early dropouts, rather than an absence of returns to completing the degree.

These patterns are broadly consistent when using total income as the outcome (Appendix Table B4), suggesting that the differences in observed returns across institutional ranks are not driven by variation in the composition of income sources (e.g., self-employment, investment income, or other non-T4 income). This reinforces the conclusion that institutional rank is closely tied to both labour market trajectories and selection dynamics, but does not appear to fundamentally alter the structure of post-PhD income streams.

Our findings align with those of Stevenson (2016), who documents that earnings premiums associated with U.S. graduate program quality are concentrated in professional programs, such as MBAs.[17] In contrast, he finds limited or no returns to institutional quality in other graduate program types once cognitive ability and selection are accounted for. Consistent with this, our results suggest that for PhD programs (particularly at the most prestigious institutions) selection into the program may be a stronger predictor of short-run labour market outcomes than degree completion itself.

Overall, these results underscore the importance of accounting for timing and context when assessing the returns to doctoral education. The T4 earnings data

[17]These findings are consistent with Grove and Hussey (2014), who similarly document premiums to school quality for MBA programs.

reveal that while PhD completion can be associated with substantial labour market rewards, particularly for women and in certain fields, these returns are far from universal. In many cases, the opportunity costs of delayed labour market entry or prolonged time in academia—particularly without a credential—can lead to long-term earnings penalties.

We now turn to a broader comparison of PhD graduates to individuals who pursued alternative educational pathways, including those who stopped at a Bachelor's degree, completed a Master's degree, or obtained a professional credential such as an MD, JD, or MBA. We track the cohort of students who graduated with a Bachelor's degree in 2009 and follow their career trajectories through 2019. We classify students based on the highest degree obtained by 2018: while the majority did not pursue further education, 1% earned a PhD, 14% completed a Master's degree, 4% obtained an MBA, MD or JD, and 3% earned another intermediate or professional degree. We measure their labour market outcomes in 2019, conditional on not being enrolled in postsecondary education that year, and estimate differences in T4 earnings relative to students who earned only a Bachelor's degree. To account for academic background, we control for the institution and field of study of the original Bachelor's degree, along with sex and immigrant status.

Table 4 reports these early-career returns. Across nearly all subgroups in this short-run analysis, individuals with Master's degrees or professional degrees (MD, JD, MBA) earn significantly more than Bachelor's-only graduates. For example, women with professional degrees (column 2) earn approximately 33% more than those who stopped at a Bachelor's, and Canadian master's graduates earn 4.3% more (column 3). The one notable exception is men with Master's degrees, whose earnings are not statistically different from Bachelor's-only graduates. In contrast, PhD graduates face a short-run earnings penalty in nearly all subgroups: men with PhDs (column 1) earn 23% less than bachelor's graduates, while Canadian PhD holders earn 15% less. While the earnings gap for women and international students is smaller and not statistically significant, the point estimates are consistently negative.

These patterns closely align with our earlier analysis comparing PhD graduates to non-completers. In both cases, short-run earnings for PhD holders lag behind their counterparts, whether those are individuals who exited the PhD early or

Table 4: Early-career returns as compared to bachelors: T4 income

	Dependent variable: Log T4 income in 2019			
	Men	*Women*	*Canadian*	*International*
	(1)	(2)	(3)	(4)
PhD	-0.233***	-0.0628	-0.151***	-0.0639
	(0.0407)	(0.0417)	(0.0295)	(0.225)
Masters	-0.00605	0.0791***	0.0431***	0.153***
	(0.0123)	(0.0102)	(0.00801)	(0.0554)
Other intermediate degrees	-0.0133	-0.0158	-0.0225	0.0717
	(0.0229)	(0.0212)	(0.0169)	(0.228)
MD, JD, MBA	0.200***	0.328***	0.260***	0.296***
	(0.0211)	(0.0228)	(0.0157)	(0.107)
Sex	No	No	Yes	Yes
Immigrant	Yes	Yes	No	No
Institution of Bachelor	Yes	Yes	Yes	Yes
Field of Bachelor	Yes	Yes	Yes	Yes
Test of PhD = Masters				
F statistic	29.413	11.218	41.315	0.898
p-value	0.000	0.001	0.000	0.343
Omitted category	Bachelor only	Bachelor only	Bachelor only	Bachelor only

Note: The table reports our estimates of the returns to a PhD as compared to a Bachelors for the PSIS cohort who graduated from a Bachelors in 2009. We estimate the returns separately for women and men. We estimate the returns with regressions of log T4 income on a set of indicators for highest degree, which include PhD, Masters, Intermediate and Professional degrees (MBA, MD and JD), and other Intermediate and professional degrees, and control for field of study and institution of the bachelors degree, and immigration status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS

those who pursued alternative graduate degrees. This consistency reinforces a central theme in our short-run findings: the early-career returns to a PhD are negative, driven by prolonged educational investment and delayed entry into the labour market. Importantly, PhD training is distinct from other advanced degrees in that it imposes significant upfront opportunity costs, which are not offset in the short run by immediate labour market rewards.

That said, these early earnings penalties are not uniform across subgroups. As with our earlier comparison to non-completers, we find smaller penalties for women and international students. This likely reflects differences in counterfactual earnings: women, facing larger gender pay gaps at baseline, and international students, who may face limited domestic labour market options pre-PhD, both forgo less income by remaining in school. These differences highlight the importance of accounting for pre-existing disparities and the structure of outside options when interpreting the returns to doctoral education.

It is worth noting that while T4 income provides a clean measure of salaried employment, it may not fully capture the income of PhD graduates, particularly those in non-academic, or consulting roles that may involve contract or self-employment

income. In parallel estimates in Appendix Table B5 using total income (which includes self-employment earnings and other taxable income) we find broadly similar conclusions: PhD graduates do not experience a significant short-run earnings advantage relative to Bachelor's or Master's degree holders. Although the point estimates are generally smaller in magnitude (i.e., less negative), the overall message is consistent across both measures. The one exception is for women, where the sign of the PhD estimate flips—from a small, statistically insignificant penalty in T4 income to a modest and statistically significant premium in total income.

Building on the patterns observed by gender and immigration status, we next examine how early-career returns to graduate education vary across fields of study. This analysis compares individuals who pursued different types of graduate degrees to those who stopped at a Bachelor's. Unlike our earlier PhD-only analysis, which benchmarked field of study based on the doctoral program, here we classify field using the individual's undergraduate major. This allows us to evaluate the full counterfactual pathway: what individuals with a given undergraduate background earned if they pursued a PhD, a Master's, a professional degree, or no further education at all.

As shown in Table 5, we continue to observe meaningful differences in returns across fields. Professional degrees (MD, JD, MBA) yield large and consistent earnings premiums in every field, often exceeding 30% to 60%, reaffirming their strong short-run labour market value. Master's degrees generate more modest but still positive returns across most disciplines.

In contrast, the returns to PhD degrees are more heterogeneous: while economics and business stands out as the only field where PhD holders earn a large and statistically significant premium relative to Bachelor's graduates, other fields—such as the humanities, physical sciences, and life sciences—show either no premium or a statistically significant earnings penalty.

This pattern is broadly consistent with our earlier finding that, in the short run, apparent PhD premiums are often driven by particularly poor outcomes among late-stage dropouts rather than by large absolute gains to degree completion. In the context of field comparisons across degrees, we see that PhD holders tend to underperform relative to peers with alternative graduate credentials, particularly in applied or professional fields. These differences likely reflect both the structure

Table 5: Early-career returns as compared to bachelors by field: T4 income

	Dependent variable: Log T4 income in 2019				
	Humanities	*Social Sciences*	*Physical Sciences*	*Life Sciences*	*Economics and Business*
	(1)	(2)	(3)	(4)	(5)
PhD	-0.451***	-0.114*	-0.117***	-0.111**	0.214**
	(0.141)	(0.0607)	(0.0414)	(0.0494)	(0.107)
Masters	0.0804***	0.0987***	-0.0151	0.0378**	0.0523**
	(0.0228)	(0.0137)	(0.0169)	(0.0174)	(0.0231)
Other intermediate degrees	0.129***	-0.0442	-0.263***	-0.104***	-0.287***
	(0.0262)	(0.0316)	(0.0679)	(0.0402)	(0.0778)
MD, JD, MBA	0.562***	0.454***	0.148***	-0.0439	0.244***
	(0.0423)	(0.0249)	(0.0368)	(0.0474)	(0.0261)
Sex	Yes	Yes	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes	Yes	Yes
Institution of Bachelor	Yes	Yes	Yes	Yes	Yes
Field of Bachelor	No	No	No	No	No
Test of PhD = Masters					
F statistic	13.920	11.844	5.618	8.570	2.208
p-value	0.000	0.001	0.018	0.003	0.137
Omitted category	Bachelor only	Bachelor only	Bachelor only	Bachelor only	Bachelor only

Note: The table reports our estimates of the returns to a PhD as compared to a Bachelors for the PSIS cohort who graduated from a Bachelors in 2009. We estimate the returns separately for women and men, and by field of study of the Bachelors degree. We estimate the returns with regressions of log T4 income on a set of indicators for highest degree, which include PhD, Masters, Intermediate and Professional degrees (MBA, MD and JD), and other Intermediate and professional degrees, and control for institution of the bachelors degree, and immigration status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS

of post-PhD employment (where many begin in lower-paying academic or post-doctoral roles) and the timing of labour market re-entry. Once again, the evidence underscores that the short-run value of a PhD is highly dependent on the specific educational and disciplinary context, and that early labour market outcomes may reflect a combination of delayed entry, earnings deferral, and the foregone opportunity to pursue other high-return graduate pathways.

Some estimates become more or less favorable when total income (Appendix Table B6) is used in place of T4 income, particularly for PhD recipients. However, these differences are generally not large enough to overturn the qualitative conclusions, nor are they typically statistically distinguishable from corresponding estimates for other degrees. Thus, while total income captures a broader set of earnings streams and may slightly shift point estimates, our central findings on the limited short-run financial returns to PhD training (especially in comparison to professional and Master's degrees) remain robust across income definitions.

We next explore how early-career returns to graduate education vary by the rank of the institution at which the PhD was earned. Table 6 reports estimated T4

earnings premiums relative to Bachelor's-only graduates, separately for graduates from non-U15, U15, and U5 institutions. Across all three institutional tiers, we continue to observe the same general hierarchy in returns: professional degrees yield the largest short-run premiums, followed by Master's degrees, while PhDs trail behind. PhD graduates earn significantly less than Bachelor's-only graduates in all tiers, with the largest earnings penalties concentrated among graduates from U15 and U5 institutions (17% and 16.5%, respectively). These findings echo earlier patterns from the PhD dropout analysis (in Table 3), where we find that students from top-ranked institutions, particularly the U5, did not appear to benefit from completing a PhD in terms of short-run earnings. As before, this may reflect a combination of longer postdoctoral transitions, stronger screening at admission, or sectoral sorting into lower-paid academic tracks. Master's degree holders, by contrast, experience modest positive returns across all institutional tiers, and these returns are statistically significantly higher than those for PhDs, as confirmed by F-tests. Overall, these findings reinforce the interpretation that, in the short run, the opportunity costs of doctoral study—especially at higher-ranked institutions—are not offset by immediate labour market advantages, and that alternative graduate pathways offer more consistent financial returns across the institutional spectrum.[18]

4.3 The long-term returns to an earned PhD

While the PSIS-tax data are excellent for tracking enrolment and early labour market outcomes, the available span permits analysis of only a single cohort over a relatively short period, in our case, individuals who entered graduate programs between 2010 and 2012, followed through to 2020. To gain a more complete picture, particularly given that the returns to PhD education often take time to materialize, we turn next to an analysis of longer-term labour market outcomes. Using census data, we examine how earnings and employment patterns evolve over the lifecycle for PhD graduates.

We begin with a set of descriptive figures that trace age-earnings and employ-

[18]These institutional patterns are robust to the use of total income as the outcome measure; results are reported in Appendix Table B7.

Table 6: Early-career returns as compared to bachelors by institution: T4 income

Dependent variable: Log T4 income in 2019			
	Non-U15	*U15*	*U5*
	(1)	(2)	(3)
PhD	-0.120***	-0.169***	-0.165***
	(0.0453)	(0.0505)	(0.0584)
Masters	0.0842***	0.00303	0.0234
	(0.0111)	(0.0141)	(0.0183)
Other intermediate degrees	-0.00780	-0.0666**	-0.000883
	(0.0229)	(0.0300)	(0.0429)
MD, JD, MBA	0.262***	0.240***	0.285***
	(0.0242)	(0.0278)	(0.0296)
Sex	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes
Institution of Bachelor	Yes	Yes	Yes
Field of Bachelor	Yes	Yes	Yes
Test of PhD = Masters			
F statistic	19.628	11.097	9.856
p-value	0.000	0.001	0.002
Omitted category	Bachelor only	Bachelor only	Bachelor only

Note: The table reports our estimates of the returns to a PhD as compared to a Bachelors for the PSIS cohort who graduated from a Bachelors in 2009. We estimate the returns separately for women and men, and by type of institution where the individual completed their Bachelors degree. Specifically, we classify institutions as U5, U15 excluding U5, and other institutions. We estimate the returns with regressions of log T4 income on a set of indicators for highest degree, which include PhD, Masters, Intermediate and Professional degrees (MBA, MD and JD), and other Intermediate and professional degrees, and control for field of study of the bachelors degree, and immigration status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS

ment profiles by highest degree attained, separately for men and women. We restrict the sample to native-born individuals who earned at least a Bachelor's degree and classify them into four mutually exclusive categories based on their highest observed credential: (i) Bachelor's only, (ii) intermediate or professional degrees (including MBAs, JDs, and MDs), (iii) Master's degrees, and (iv) PhDs. For each group, we calculate outcomes for each 5-year age group from 25 to 75 using the 2016 Census and apply survey weights to ensure population representativeness.[19]

We focus on four key outcomes. First, we examine the share of individuals employed at each age. Second, we compute the share employed full time, conditional on being employed. This becomes our preferred measure of employment intensity, as it more closely aligns with labour force attachment and is standard in much of the academic literature studying life-cycle labour market dynamics.[20] Third, we examine average employment income, conditional on full-time employ-

[19]The figures are remarkably similar when we use different Census years. We focus on the 2016 Census because it is the most recent wave unaffected by COVID-19-related labour market disruptions.

[20]See, for example, Altonji and Zhong (2021) or Arcidiacono et al. (2008).

ment. This allows us to trace how earnings capacity evolves for individuals on different educational trajectories.

Finally, we narrow our focus to PhD holders and disaggregate them by occupation, comparing those employed as university professors to those working in non-academic roles. This decomposition allows us to understand the extent to which observed lifetime earnings gains for PhDs are concentrated within the academic sector, and to assess the broader economic value of doctoral training outside of traditional tenure-track pathways. This distinction is important for several reasons, but perhaps most notably because the likelihood of securing a university professorship has been declining over time, as shown in Figure A2.

Turning first, in Figure 6, to employment patterns over the life cycle, we find that both men and women exhibit high rates of labour market participation across all educational groups. Overall employment rates documented in Figure 6A are remarkably similar across sexes, with minimal divergence at the aggregate level. However, when we shift focus to full-time employment in Figure 6B (our preferred measure of labour force attachment) we observe a modest but consistent gap in early-career years (ages 25–40), with women slightly less likely to work full time than men. This pattern likely reflects differential caregiving responsibilities, particularly around childbirth and early child-rearing years, consistent with well-documented life-cycle gender differences in labour supply.

Perhaps most strikingly, while full-time and overall employment rates are nearly indistinguishable across education levels in the first half of the career, clear differences emerge later in the life course. In particular, PhD holders exhibit a substantially longer duration of labour market participation, with delayed retirement and higher employment rates at older ages (60+). This extended labour force attachment among PhDs is consistent with later entry into the workforce (due to prolonged education) as well as longer careers, potentially driven by the structure of academic employment or stronger attachment to professional identities. Importantly, this divergence is especially evident among women: from around age 45, PhD-holding women begin to show markedly higher rates of full-time employment compared to their non-PhD-holding counterparts. This gap not only emerges earlier for women but also persists more dramatically throughout the later stages of their careers, pointing to a distinct pattern of labour market engagement shaped

by education and gender.

Figure 7 examines how earnings evolve over the life cycle, focusing on real employment income conditional on full-time employment.

For men, PhD holders have the lowest earnings relative to all other degree types (including those with only a Bachelor's degree) until around age 35, when PhD and Bachelor's graduates' earnings cross over. It is not until about age 55 that PhD holders surpass Master's graduates in earnings, and they only catch up to those with intermediate/professional degrees by approximately age 65. Notably, the earnings profiles of PhD and professional degree holders deviate from the typical inverted-U shape observed for other groups, suggesting stronger and more sustained labour force attachment even later in life, despite this analysis being restricted to full-time workers.

For women, the trajectory is quite different. PhD holders earn roughly the same as their Master's degree counterparts from the outset of their careers, though they earn less than women with professional degrees until about age 35. Around age 35, however, earnings for PhD-holding women begin to climb more steeply, and by age 40 they become the highest-earning group—a position they maintain for the remainder of the observed career span. As with men, earnings for female PhD holders begin to decline only after age 65, further underscoring a prolonged attachment to full-time work. Except for a brief period at age 25, however, PhD-holding women consistently earn less than their male PhD counterparts across the life cycle.

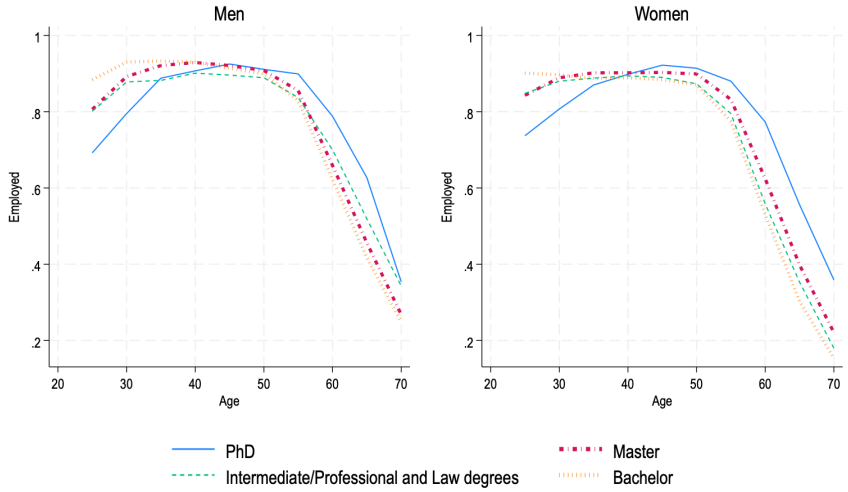
Another striking feature of the data is that women with Master's or professional degrees earn less, on average, than men with only a Bachelor's degree throughout most of the life cycle. However, this difference is less pronounced when we examine employment income unconditionally (i.e., not conditioning on full-time status) in Appendix Figure A3, suggesting that a meaningful share of the observed disparity reflects differences in labour supply rather than differences in wages or job quality.[21]

In the final part of our analysis, we focus specifically on PhD holders to better understand the role of academic employment in shaping long-run labour market

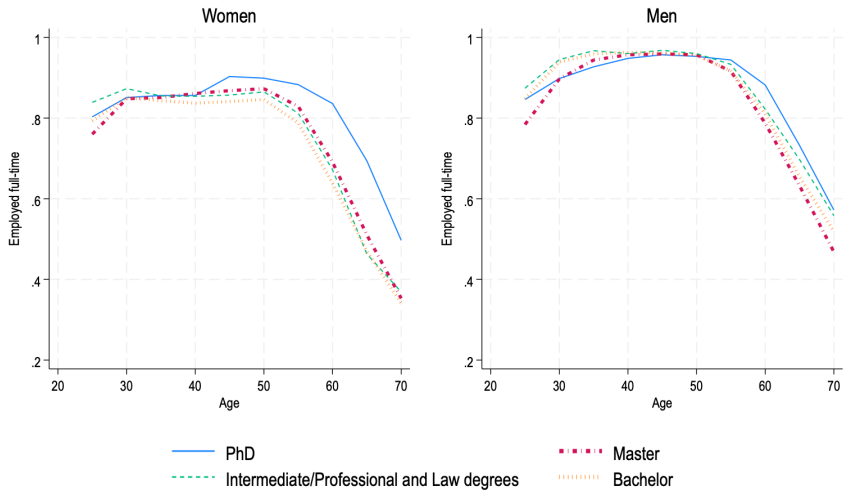
[21]These patterns are qualitatively similar when using total income, which includes non-employment income streams such as investment income, pensions, and self-employment earnings. See Appendix Figure A4.

FIGURE 6: EMPLOYMENT AND FULL-TIME EMPLOYMENT OVER THE LIFE CYCLE, BY HIGHEST DEGREE EARNED

A: EMPLOYMENT

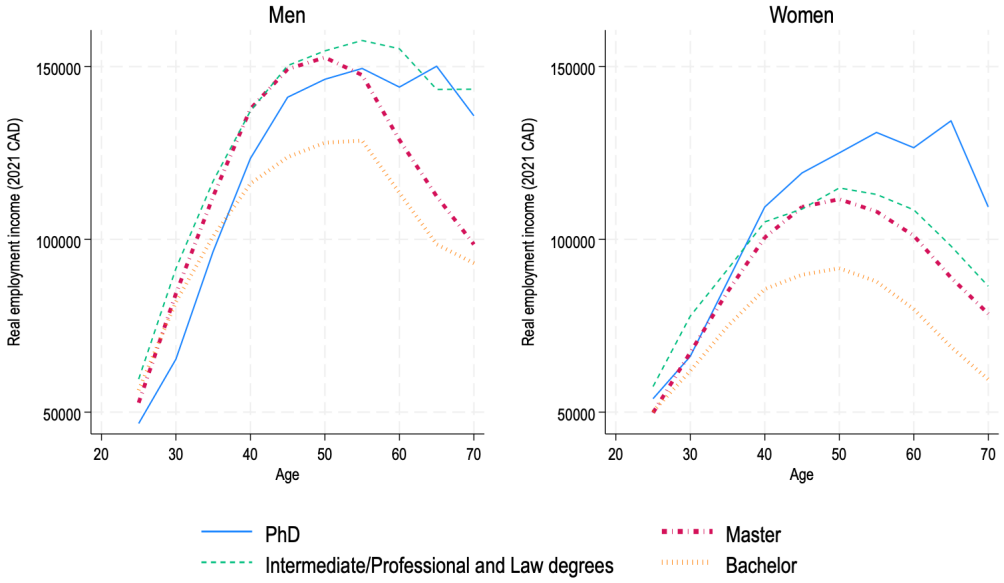


B: FULL-TIME EMPLOYMENT (CONDITIONAL ON EMPLOYMENT)



Note: The figure shows life-cycle profiles of employment (Panel A) and full-time employment (conditional on employment, Panel A) by highest degree, separately for men and women. Specifically, we select individuals who earned at least a bachelors degree and classify them into four groups, based on the highest degree earned: only bachelor, intermediate or professional degrees (which include JD, and MD), Masters and PhD. For each group, the employment share is calculated by 5-year age group in the interval 25 to 75 years old, using data from the 2016 Census. The average is computed using Census survey-weights. *Data source:* 2016 Census.

FIGURE 7: LIFECYCLE PROFILE: EMPLOYMENT INCOME, CONDITIONAL ON FULL-TIME EMPLOYMENT

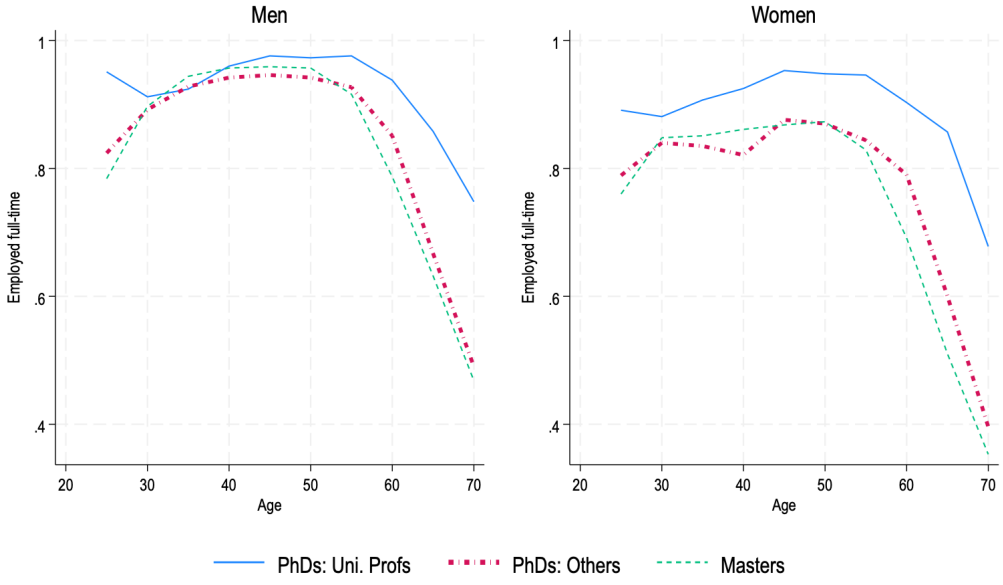


Note: The figure shows life-cycle real employment income profiles - conditional on full-time employment - by highest degree, separately for men and women. Specifically, we select individuals who earned at least a bachelors degree and classify them into four groups, based on the highest degree earned: only bachelor, intermediate or professional degrees (which include JD, and MD), Masters and PhD. For each group, the average income is calculated by 5-year age groups in the interval 25 to 75 years old, using data from the 2016 Census. Employment income is winsorized at the 1% level and the average is computed using survey-weights; we report real income in 2021 Canadian dollars. *Data source:* 2016 Census.

outcomes. Figure 8 plots life-cycle profiles of full-time employment (conditional on being employed) for PhD graduates, disaggregated by occupational category and shown separately for men and women. We classify individuals as university professors if they are employed in the post-secondary university education industry and report their occupation as university professor. As a benchmark, we also include Master's degree holders as a relevant non-PhD comparison group.

The results reveal stark differences in employment trajectories by occupation. The previously documented pattern of extended labour market attachment among PhD holders is driven almost entirely by those employed as university professors. Full-time employment rates remain high for this group well into their late 60s and early 70s, with only modest declines at retirement age. In contrast, PhDs working in non-academic sectors exhibit employment patterns that are far more similar to

Figure 8: Lifecycle profile: full-time employment among PhD graduates

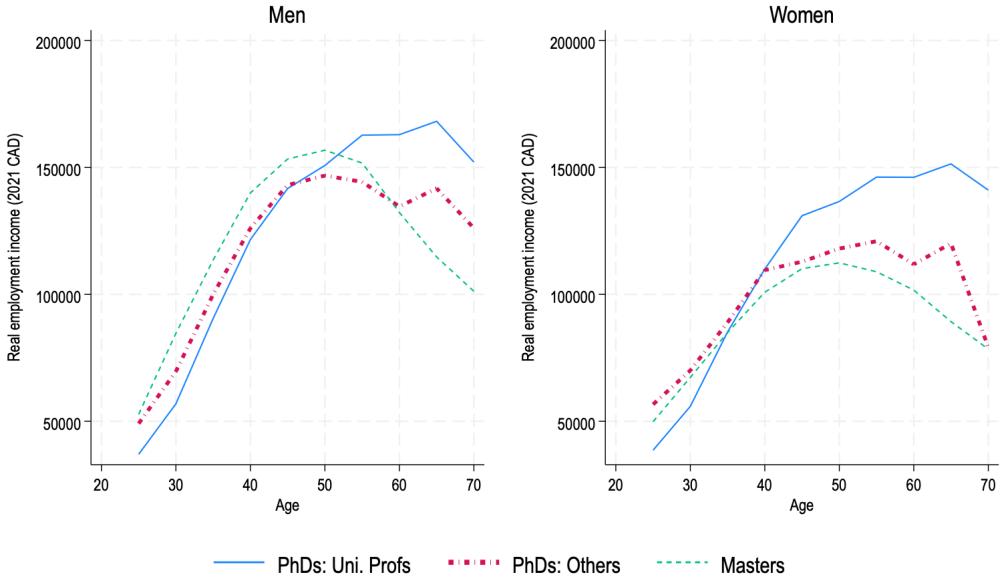


Note: The figure shows life-cycle profiles of full-time employment - conditional on employment - for PhD graduates by occupation, separately for men and women. We classify individuals as University Professors if they are employed in the post-secondary university education industry and their reported occupation is that of University Professor. For each group, the full-time employment share is calculated by 5-year age groups in the interval 25 to 75 years old, using data from the 2016 Census. The average full-time employment rates are computed using survey-weights. *Data source:* 2016 Census.

those of Master's graduates. While small differences emerge later in the career, they are dwarfed by the persistent and pronounced divergence between academic and non-academic PhDs. These findings suggest that the extended working lives of PhD holders are closely tied to the structure and incentives of academic employment, and that outside academia, PhD and Master's recipients exhibit broadly similar patterns of labour force attachment in the long run.

Figure 9 shows that these patterns are mirrored in employment income profiles. The thrust of the long-run gains to PhD education is driven almost entirely by those employed in academia. Among men, PhDs working outside the university sector earn incomes that are nearly indistinguishable from those of Master's graduates throughout most of the life cycle. Among women, non-academic PhDs experience somewhat higher earnings than Master's degree holders, but the gap is modest. These findings underscore the central role of academic employment in

Figure 9: Lifecycle profile: employment income among PhD graduates, conditional on full-time employment



Note: The figure shows life-cycle real employment income profiles - conditional on full-time employment - for PhD graduates by occupation, separately for men and women. We classify individuals as University Professors if they are employed in the post-secondary university education industry and and their reported occupation is that of University Professor. For each group, the average income is calculated by 5-year age groups in the interval 25 to 75 years old, using data from the 2016 Census. Employment income is winsorized at the 1% level and the average is computed using survey-weights; we report real income in 2021 Canadian dollars. *Data source:* 2016 Census.

shaping the long-run returns to doctoral education—both in terms of extended labour force participation and cumulative earnings—and highlight the relatively limited payoff to a PhD outside the university sector. The patterns also raise questions regarding the interpretation of "returns". First, with the earnings payoffs happening so late in the lifecycle, any formal cost-benefit analysis of the earnings trajectories will be sensitive an individual's discount rate and any other considerations of early versus late lifecycle experience (e.g., housing and family formation). Second, much of the earnings advantage is driven not only by higher wages, but by longer careers and delayed retirement. Whether this constitutes a benefit depends in part on one's view of retirement itself — as either a desirable reward or as foregone income and purpose. A fuller understanding of these dynamics would require deeper analysis of retirement incentives and pension structures, which lies

beyond the scope of this paper but is important context for interpreting earnings trajectories as distinct from broader measures of wellbeing.

4.4 Returns to an earned PhD: Trends over time

We conclude our analysis by examining how the aggregate returns to a PhD have evolved over the past three decades. Using repeated cross-sections from the Canadian Census spanning 1991 to 2021, we estimate the returns to doctoral education relative to a Bachelor's degree, focusing on individuals aged 25 to 75 who are employed full time with positive employment income. For each Census year, we estimate the returns to an earned PhD as compared to a Bachelor's by running a linear regression of log earnings on the highest level of educational attainment (Eq. 2). We separately include Master's degrees, intermediate and professional degrees (such as MDs and JDs), along with PhDs and Bachelor's degrees. This allows us to trace long-run trends in the earnings premium associated with a PhD, accounting for changes in the broader labour market, higher education expansion, and occupational shifts. To isolate the role of academic employment, we report results both including and excluding university professors, separately for men and women.

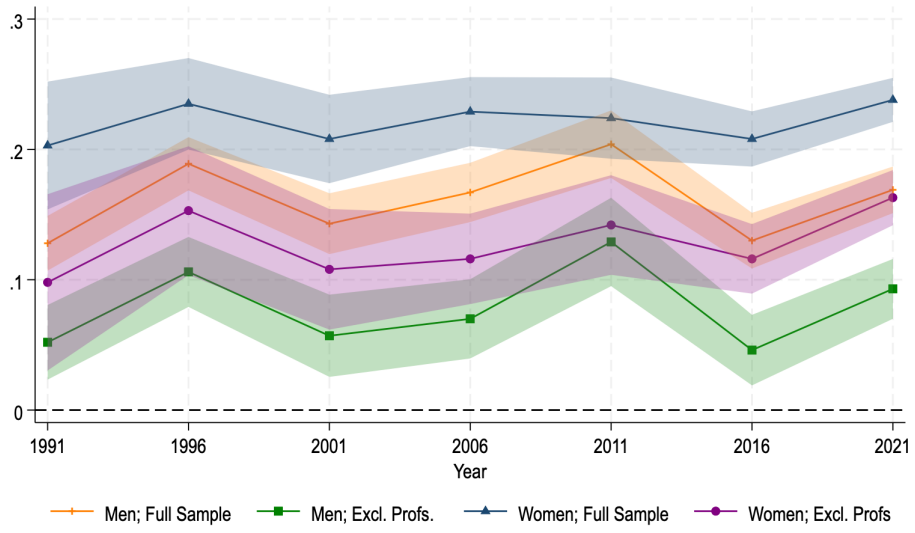
We then turn to exploring heterogeneity in these long-run returns. First, we assess differences between men and women to determine whether gender gaps in PhD pay have narrowed or persisted over time. Next, we investigate whether immigrant PhD holders experience similar returns to their Canadian-born counterparts, shedding light on how foreign-earned credentials or labour market integration shape outcomes. Finally, we disaggregate returns by field of study to understand which disciplines have seen stable or declining PhD premiums over time. Together, these results provide a comprehensive view of how the labour market value of a PhD has changed, and for whom,over the past 30 years.

We find that earning a PhD is associated with significantly higher earnings relative to holding only a Bachelor's degree (Figure 10). Across Census years from 1991 to 2021, the estimated earnings premium for PhD holders is approximately 30% for both men and women when considering all full-time workers. However, once we exclude individuals employed as university professors (who, as we showed

above, tend to earn more and remain employed later into the lifecycle) the estimated return falls to around 20%. This 10 percentage point difference underscores the central role of academic employment in driving the average financial return to doctoral education.

What is perhaps more surprising is that these returns appear to have remained remarkably stable over the past three decades. Across both men and women, and whether or not professors are included, the estimated premium associated with a PhD has remained relatively flat from 1991 to 2021, with only modest fluctuations. This apparent consistency would seem to indicate that the labour market value of a PhD has held steady, even amid considerable change in the broader economy and higher education landscape. However, as the next sections will show, this aggregate view masks substantial heterogeneity.

FIGURE 10: RETURNS TO A PHD OVER TIME: EMPLOYMENT INCOME



Note: The figure shows our estimates for the returns to a PhD as compared to a Bachelors, in terms of employment income. We estimate the returns to a PhD among the 25-75 years old population who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. In each sample, we estimate the returns with a regression of log real employment income on a set of indicators for highest degree, which include PhD, Masters, and intermediate or professional degrees, and we control for age and age squared, province of residence and field of study. The resulting estimates correspond to the returns as compared to a Bachelors, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census.

To explore this further, we move beyond regression-based estimates of average returns and examine the full distribution of earnings over time. Figure 11 presents

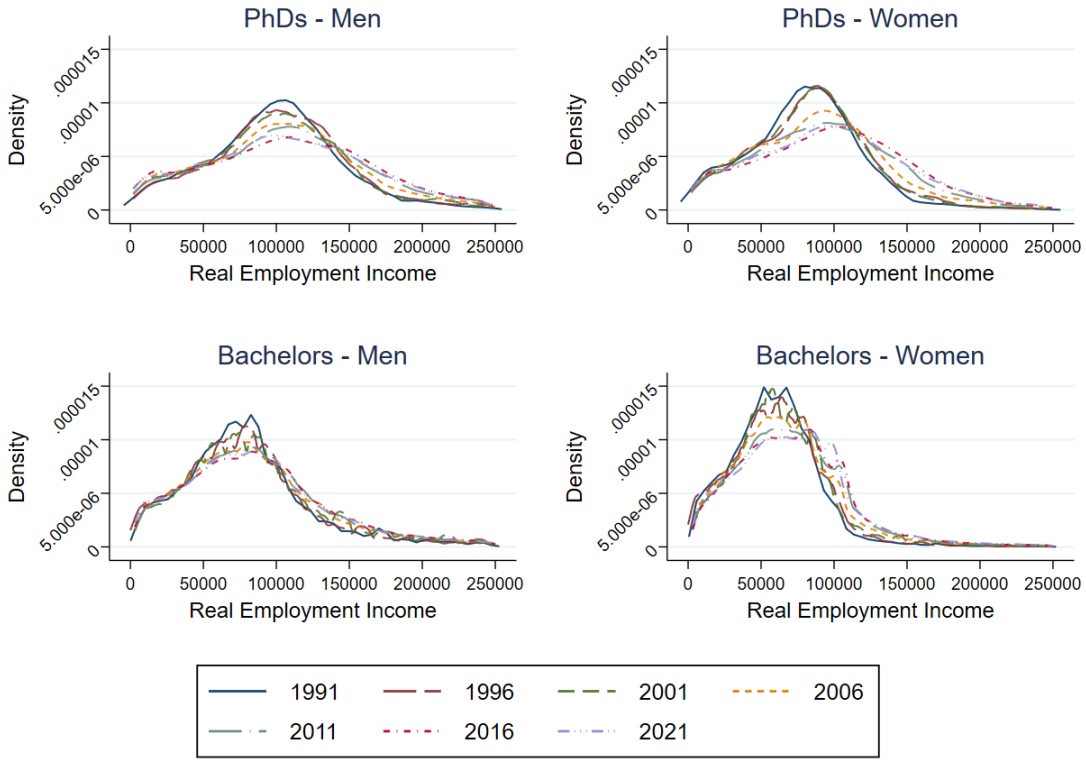
kernel density plots of real employment income for men and women with either a PhD or a Bachelor's degree, across Census years from 1991 to 2021. Unlike Figure 10, which estimate average premiums relative to a Bachelor's degree using regression models, this figure offers a descriptive view of the underlying income distributions, allowing us to assess how the dispersion of earnings has evolved for the average full-time worker in each group.

While the average PhD premium in Figure 10 appears stable, the underlying distributions tell a more nuanced story. Among men with Bachelor's degrees, the earnings distribution remains strikingly stable across census years, with little evidence of substantial upward or downward movement. For women with Bachelor's degrees, there is modest compression at the lower end and a slight rightward shift over time, suggesting gradual but limited earnings gains.

In contrast, the distribution of earnings for PhD holders appears to flatten over time for both men and women, though the implications differ by gender. For PhD-holding women, the broadening of the distribution reflects real gains, with an upward shift in mass toward higher incomes and a declining concentration around at the bottom of the distribution. This suggests expanding opportunities and increased returns among a subset of women with doctoral training. Among men with PhDs, the distribution also flattens over time, but with a distinct pattern: there is a growing concentration of individuals at both the lower and upper ends of the distribution. This bi-modal tendency suggests increasing divergence within the group. While a subset of male PhD holders continues to earn high incomes, an increasing share appears to be clustered in lower earning brackets.

These findings highlight the challenge of focusing solely on average effects when assessing the economic returns of a PhD. While the regression-based estimates suggest a stable premium over time, the underlying earnings profiles tell a more complex story, particularly for PhD men, where we observe growing concentration at both the top and bottom of the income distribution. Given the life-cycle patterns documented earlier (especially the delayed labour market entry and earnings penalties that often characterize the early stages of a PhD holder's career) it is also important to consider how these income patterns vary across different points in the career.

Figure 11: Employment Income Distributions for PhD and Bachelor's Holders (1991–2021)



Note: The figure displays kernel density estimates of real employment income distributions for full-time employed native-born workers with PhD and Bachelor's degrees, separately by gender and Census year. Each panel shows the smoothed distribution of annual employment income for a given degree-gender group, covering Census years from 1991 to 2021. Income is winsorized at the 1% level to reduce the influence of outliers, and all values are reported in 2021 Canadian dollars. Estimates are weighted using person-level survey weights. *Data source:* Canadian Census, 1991–2021.

Figure 12 plots these same income distributions for PhD holders, this time grouped by career stage—early to mid-career (ages 25–46) and late career (ages 47–75)—to document additional heterogeneity that helps to reconcile the apparent stability in average PhD earnings premiums over time. Two important patterns emerge.

First, among those in the later stages of their careers, both men and women have experienced substantial income gains over the past three decades. The density curves shift noticeably to the right across Census years, indicating broad-based improvements in earnings for older PhD holders, regardless of gender.

Figure 12: Employment Income Distributions by Age Group (1991–2021)

The figure displays kernel density estimates of real employment income for full-time employed, native PhD holders, separately by gender and career stage. Individuals are grouped into two broad age categories: early to mid-career (ages 25–46) and late career (ages 47–75). Each panel shows the smoothed distribution of annual employment income for men and women within each age group. Income is winsorized at the 1% level to reduce the influence of outliers, and all values are reported in 2021 Canadian dollars. Estimates are weighted using person-level survey weights. *Data source:* Canadian Census, 1991–2021.

In contrast, the story is notably different for the younger cohort. Among early to mid-career PhD holders, the distributions show little upward movement, and in the case of men, there is clear evidence of growing mass at the lower end of the income distribution. This suggests that the flattening and lower-tail concentration observed earlier for male PhD earners is driven almost entirely by this younger group, pointing to increasingly weaker labour market outcomes and a more uncertain return to doctoral education in the early career phase. For women, the younger cohort's distribution is more stable, but shows far less of the upward mobility observed among their older counterparts.

These patterns are not only visible in the raw income distributions, but are also reflected in regression-based estimates of the PhD earnings premium. Figure 13 presents estimated returns to holding a PhD relative to a Bachelor's degree, separately by gender and career stage. We further divide the sample into two broad age groups—25–46 and 47–75—to align with the earlier density plots.

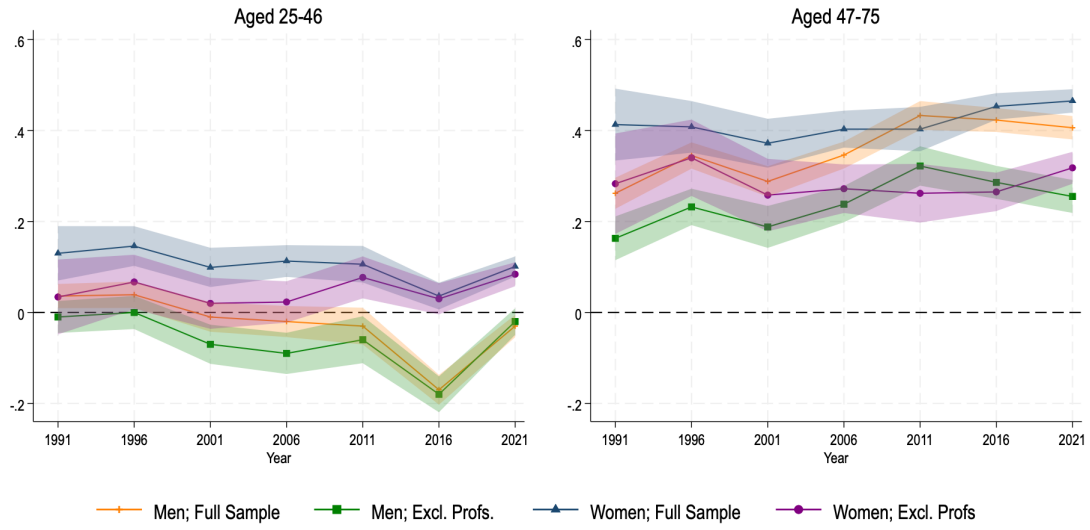
The regression results closely mirror the patterns observed in the distributional analysis. Among older workers (right panel), PhD holders experience large and rising returns over time. These returns remain substantial but are noticeably lower when university professors are excluded from the sample—indicating a clear premium to working in academia for this group.

In contrast, the results for the younger cohort (left panel) are more concerning. For both men and women, estimated returns to a PhD are not only modest but appear to decline over time. This downward trend is especially pronounced for men. However, unlike the older group, excluding professors has little impact on the estimated returns among younger workers—suggesting that academic employment does not confer the same relative earnings advantage early in the career. These findings reinforce the evidence from the density plots: the increasing mass in the lower tail of the income distribution for younger male PhD holders corresponds to a measurable erosion in the relative earnings advantage of doctoral education in the early career phase.

One notable exception to this pattern occurs in 2021, when estimated returns rise across all subgroups in the younger cohort. While it is unclear whether this reflects a structural shift or a temporary deviation, the reversal of the previous downward trend during this period is striking. It suggests that PhD holders may have been relatively insulated from the broader labour market disruptions associated with the COVID-19 pandemic, perhaps due to occupational positioning, sectoral stability, or other protective factors.

These contrasting patterns between younger and older cohorts, and between academic and non-academic PhD holders, motivate a closer examination of the role of occupation in shaping earnings outcomes. In particular, the fact that excluding university professors significantly lowers estimated returns for older workers (but not for younger ones) raises the question of how much of the observed variation in PhD earnings is driven by this relatively small segment of the PhD workforce.

FIGURE 13: RETURNS TO A PHD OVER TIME BY AGE: EMPLOYMENT INCOME

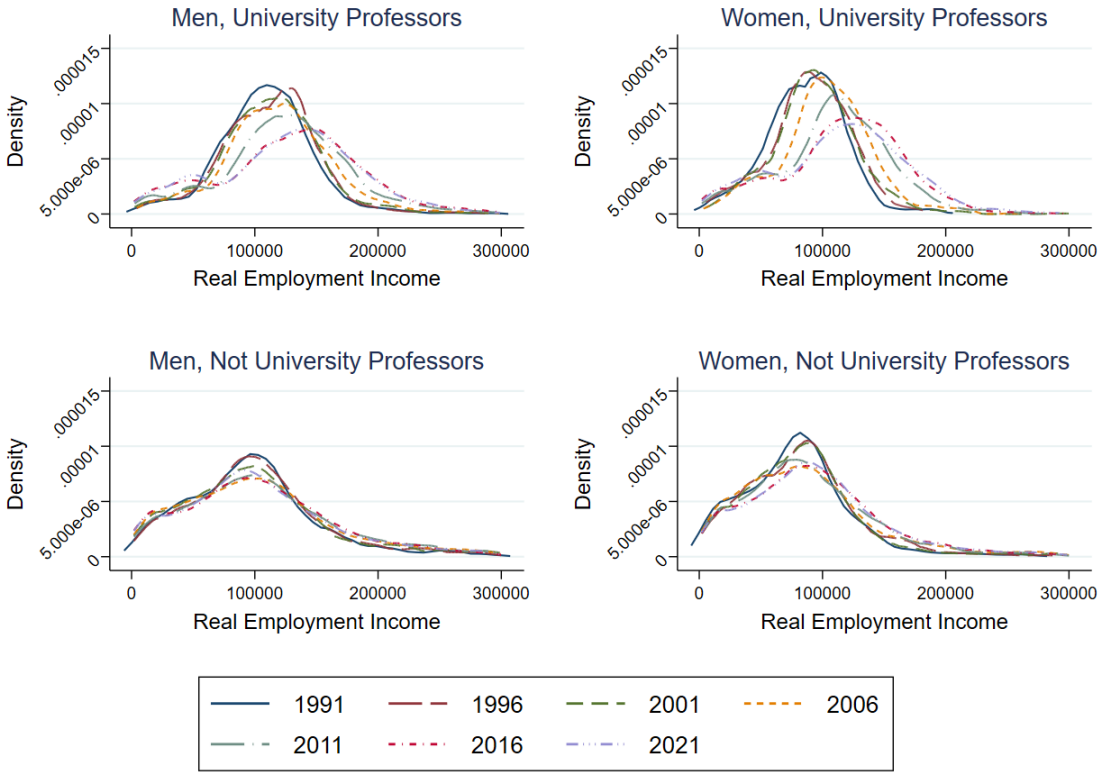


Note: The figure shows our estimates for the returns to a PhD as compared to a Bachelors, in terms of employment income. We estimate the returns to a PhD among the who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. We split each sample into two groups, based on the age of respondents: 25-46 years old and 47-75 years old. In each sample, we estimate the returns with a regression of log real employment income on a set of indicators for highest degree, which include PhD, Masters, and intermediate or professional degrees, and we control for age and age squared, province of residence and field of study. The resulting estimates correspond to the returns as compared to a Bachelors, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census.

Figure 14 addresses this by plotting the full distribution of real employment income for PhD holders, separately for those employed as university professors and those working in other occupations. These figures reveal a striking pattern: for both men and women, the majority of the income dynamics observed earlier (including the rightward shift in earnings for women and the growing mass at the lower end of the distribution for men) are concentrated almost entirely among university professors. In contrast, the income distributions for non-academic PhD holders show far less movement over time, suggesting much greater stability (and stagnation) in earnings outside of academia.

This finding is particularly notable given that university professors represent a smaller share of PhD holders overall. That such a relatively small group drives much of the observed variation in earnings highlights the outsized influence of academic employment on the labour market outcomes of PhD graduates.

Figure 14: Employment Income Distributions: University Professors vs. Other Occupations (1991–2021)



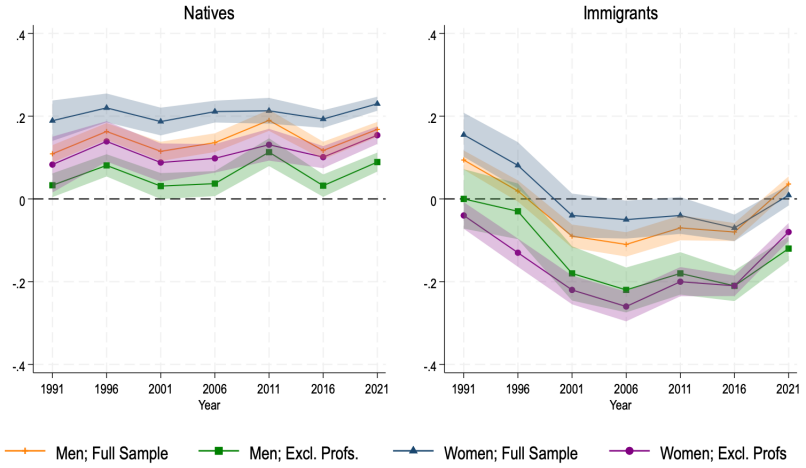
Note: The figure displays kernel density estimates of real employment income for full-time employed, native PhD holders separately by gender and occupation. We classify individuals as University Professors if they are employed in the post-secondary university education industry and and their reported occupation is that of University Professor. Income is winsorized at the 1% level to reduce the influence of outliers. All values are reported in 2021 Canadian dollars. Estimates are weighted using person-level survey weights. *Data source:* Canadian Census, 1991–2021.

Taken together, these results underscore that a small subset of PhD holders—those employed as university professors—account for a disproportionate share of the earnings variation observed in earlier figures. The fact that such a relatively small group drives many of the aggregate trends reinforces the need to disaggregate by additional characteristics to better understand who benefits most from doctoral education.

We next return to regression-based estimates to examine how average PhD returns vary across other key dimensions of heterogeneity. In particular, we the estimate the returns to a PhD separately for natives and immigrants as compared

to native Bachelors[22] to examine whether the economic returns to a PhD differ based on immigrant status (Figure 15). This distinction is important for both conceptual and empirical reasons. First, our data do not include information on where individuals completed their education, making it impossible to distinguish between foreign- and Canadian-trained PhD holders. As a result, occupational downgrading (working in jobs that do not fully utilize one's credentials) may be disproportionately common among immigrant PhD holders, especially if their degrees were obtained abroad and are not fully recognized in the Canadian labour market. This phenomenon is likely more pronounced at higher levels of education, where credential recognition plays a more critical role, and may lead to lower observed returns for immigrant PhDs compared to their native-born counterparts.

FIGURE 15: RETURNS TO A PHD OVER TIME BY IMMIGRATION STATUS: EMPLOYMENT INCOME



Note: The figure shows our estimates for the returns to a PhD for immigrants and natives as compared to a Bachelors for natives, in terms of employment income. We estimate the returns to a PhD among the 25-75 years old population who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. In each sample, we estimate the returns with a regression of log real employment income on a set of indicators for highest degree, which include PhD - separately for immigrants and natives -, Masters, intermediate or professional degrees, and Bachelors for natives, and we control for age and age squared, province of residence and field of study. The resulting estimates correspond to the returns as compared to a Bachelors for natives, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census.

Second, from an identification perspective, the inclusion of immigrants in the

[22]We classify individuals as immigrants if they were born abroad and immigrated to Canada after the age of 20.

pooled analysis could affect the estimated returns for native-born individuals. Immigrants in our sample tend to have lower average earnings and education levels, which could inflate estimated returns for PhDs if those returns are measured relative to weaker counterfactual earnings among comparison groups.

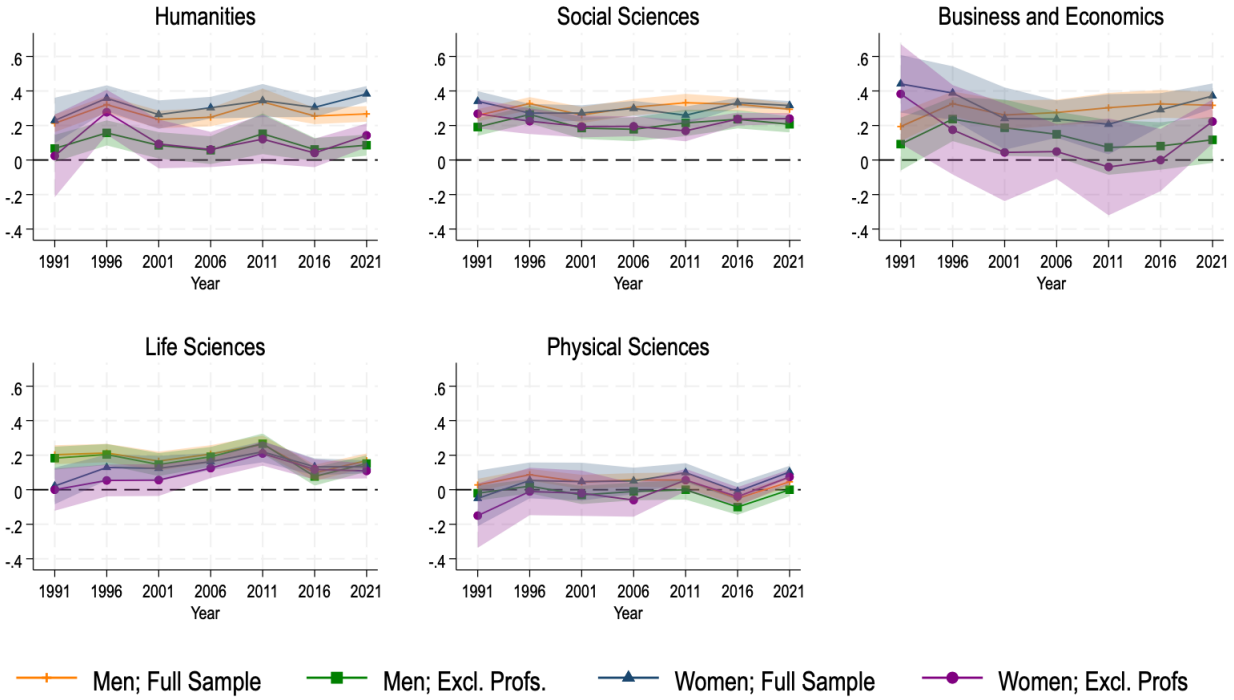
To address these concerns, we estimate PhD returns separately for immigrants and natives using repeated cross-sections of the Canadian Census from 1991 to 2021. We focus on individuals aged 25 to 75 who have earned at least a Bachelor's degree, are employed full time, and report strictly positive employment income. In each Census year, we run regressions of log real employment income on a set of indicators for highest degree attained—separately identifying PhD, Master's, and professional or intermediate degrees—with Bachelor's degree for native-born individuals as the omitted category.

The results for native-born individuals show a continuation of the gender-specific patterns identified earlier, with female PhD holders consistently earning higher returns than their male counterparts across the 1991–2021 period. This difference is particularly pronounced in the later years.[23] Over time, returns for native-born women remain relatively stable, and those for men are consistently lower throughout the period. Notably, when university professors are excluded from the sample, estimated returns to a PhD fall substantially (particularly for men, dropping to just above zero) in most census years.

Among immigrants, estimated returns to a PhD are consistently lower than for native-born individuals, and are negative in all census years except 1991. When restricting to individuals employed full time and excluding university professors, both immigrant men and women see little to no financial return to doctoral education relative to a Bachelor's degree. However, when considering the full sample(including university professors) the estimates improve modestly, particularly for immigrant women. In several years, the estimated returns for immigrant women approach zero and are consistently higher than those for immigrant men, suggesting that academic employment may play a disproportionately important role in shaping the financial outcomes of immigrant PhD holders—especially women—even as overall returns remain limited.

[23]Similar patterns are observed when looking at total income (Appendix Figure A7).

Figure 16: Returns to a PhD over time by field of study: Employment income



Note: The figure shows our estimates for the returns to a PhD as compared to a Bachelors, in terms of employment income. We estimate the returns to a PhD among the 25-75 years old population who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and by field of study, and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. We classify the field of study of an individual's highest degree in the following categories: Humanities, Social Sciences, Economics and Business, Life Sciences, and Physical Sciences. In each sample, we estimate the returns with a regression of log real employment income on a set of indicators for highest degree, which include PhD, Masters, and intermediate or professional degrees, and we control for age and age squared and province of residence. The resulting estimates correspond to the returns as compared to a Bachelors, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census.

Figure 16 shows the estimated returns to a PhD relative to a Bachelor's degree over time, disaggregated by field of study and separately for men and women, both including and excluding university professors.[24] Several important patterns emerge. First, returns vary substantially across disciplines. PhDs in Economics and Business consistently yield the highest earnings premiums, and importantly, these returns remain sizeable even outside academia. By contrast, in fields like the Humanities and Social Sciences, observed returns are much more dependent on academic employment; excluding professors reduces estimated returns substantially, especially for women. In the Life and Physical Sciences, returns are generally modest across the board and are often close to zero when professors are excluded, suggesting weaker non-academic labour market opportunities for PhDs in these fields.

Finally, we observe little evidence of a secular decline in returns over the 1991-2021 period. Although there are slight dips in some years (particularly in the early 2000s) returns remain relatively stable or even increase slightly in more recent periods, especially in Economics and Business. Together, these results underscore the importance of both field of study and sectoral placement in shaping the financial value of a PhD.

5 Conclusion

This paper set out to fill in the spreadsheet our hypothetical undergraduate student might create when weighing a PhD against other life paths. Using linked Canadian administrative and census data, we traced the educational and labour market trajectories of graduate students over the past three decades. What emerges is a complex and, in many respects, cautionary picture.

In the short run, pursuing a PhD entails substantial opportunity costs. Early-career earnings for PhD graduates are significantly lower than those of individuals with master's or professional degrees, reflecting prolonged enrolment and delayed entry into the labour market. These costs are especially high for non-completers, particularly those who exit the program after several years without earning a

[24] Results when using total income are presented in Appendix Figure A8, and are in line with those for employment income.

credential.

Over the lifecycle, earnings do eventually recover (and surpass those of bachelor's and master's graduates) but only under specific conditions. The most favourable long-run outcomes are concentrated among those who secure academic employment and remain in full-time work late into life. This "double premium," combining higher earnings and longer careers, plays a central role in shaping the average return to a PhD. Outside academia, PhD holders resemble master's graduates in both earnings and employment patterns.

However, the structure of this system increasingly resembles a tournament: the payoff remains high for those who reach the top, but the odds of doing so have declined, while the "consolation prizes" (non-academic labour market outcomes) have not improved significantly. Our analysis documents that the economic outcomes of recent PhD graduates, especially men, have worsened over time. The bottom of the earnings distribution has grown more populated, and early-career returns have declined even as aggregate statistics appear stable due to rising returns among older cohorts. This tournament dynamic not only raises the stakes for individual students but also has important implications for program design, admissions strategy, as well as for the evolving role of doctoral education within the academic labour market. It intensifies the information problem of identifying and supporting those most likely to succeed in academic roles, making admissions and progression decisions especially consequential for both students and institutions.

Historically, this reflects a shift from the medieval university, where doctoral training was tightly coupled to the demand for credentialed teachers and clerics, to the modern research university, which produces PhD graduates largely without regard to downstream labour market demand. The result is a persistent oversupply of doctoral degree holders relative to academic employment opportunities. While many institutions have responded by offering professional development and career preparation for non-academic paths, a laudable improvement, this should not be misinterpreted as evidence that the PhD has evolved into a broadly effective pathway to non-academic success. Outside a few specialized fields, private- and public-sector demand for PhD-trained labour remains limited.

Given the structure of doctoral education, there is value in fostering earlier resolution for students. When the payoff depends so heavily on reaching a narrow

career target, the ability to exit early, with some recognition of progress, may help mitigate the steep penalties associated with late-stage non-completion. While speculative, institutions might consider formalizing interim credentials (e.g., an all-but-dissertation, "ABD" degree) that confer some labour market value without requiring completion of the dissertation. At a minimum, graduate programs should invest in more transparent information about outcomes and risks — and in advising structures that foreground informed decision-making throughout the program.

Finally, these findings point to the need for student-centered thinking, and even Strategic Enrolment Management (SEM) principles, to extend beyond the undergraduate level. PhD students are often treated as apprentice academics, but they are also learners navigating complex trade-offs with limited information and high stakes. If universities are to remain credible stewards of doctoral education, they must design systems that recognize the entire arc and diversity of student trajectories, the narrowing of traditional outcomes, and the rising importance of well-structured alternatives.

After all, it's not just about what we learned — it's also about how we spent our twenties.

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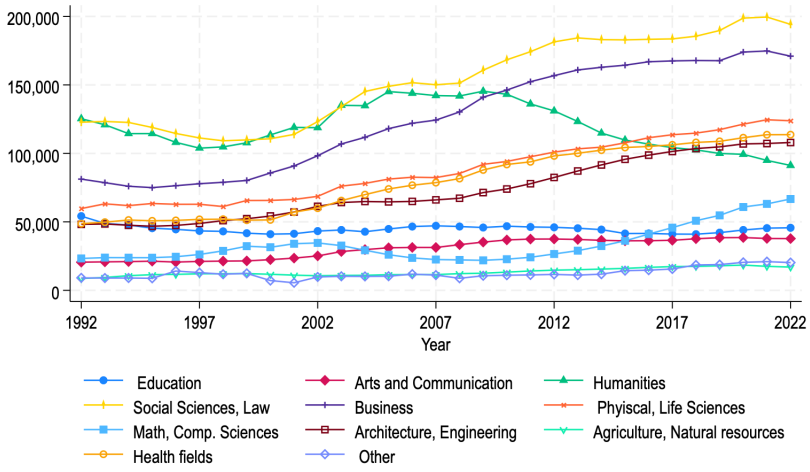
A Additional Figures

FIGURE A1: UNDERGRADUATE STUDENTS BY FIELD

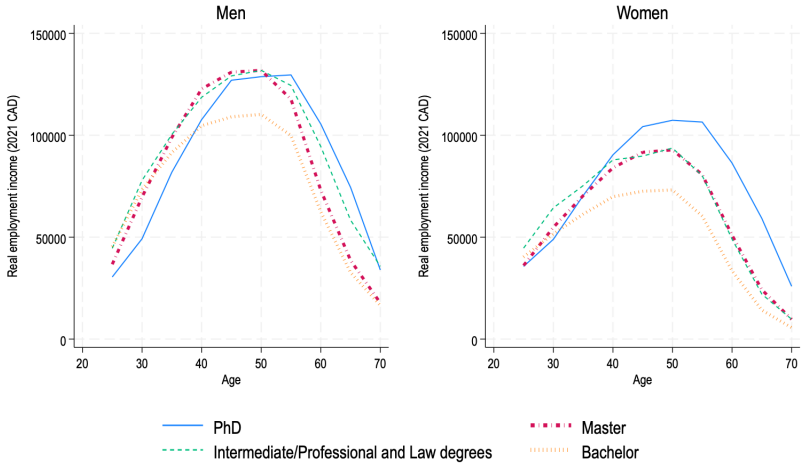


Data source: Statistics Canada, Table 37-10-0011-01 Postsecondary enrolments, by field of study, registration status, program type, credential type and gender. DOI: https://doi.org/10.25318/3710001101-eng. This figure is referenced in Section 2.

Figure A2: Share of PhDs working as Professors

Note: The figure shows the share of individuals working as professors among 25-75 year-old PhD holders, who are employed full-time. The shares are computed using survey-weights. *Data source:* 1991 to 2016 Census.

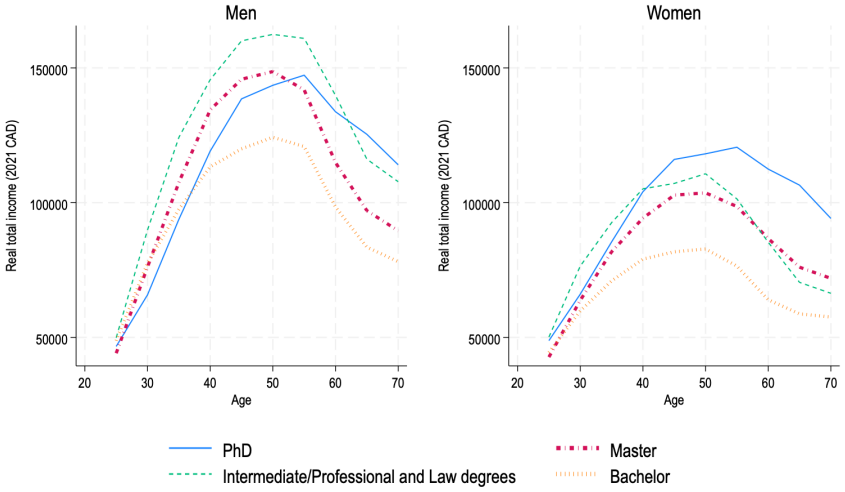
Figure A3: Lifecycle profile: employment income



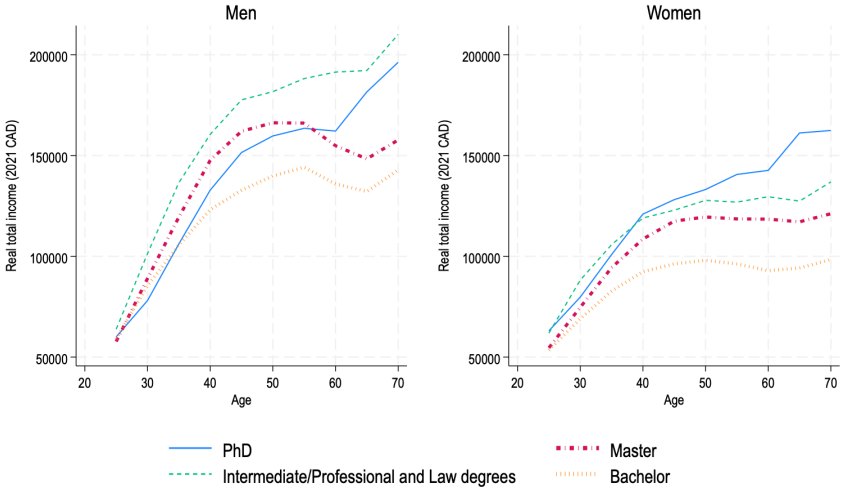
Note: The figure shows life-cycle real employment income profiles by highest degree, separately for men and women. Specifically, we select individuals who earned at least a bachelors degree and classify them into four groups, based on the highest degree earned: only bachelor, intermediate or professional degrees (which include JD, and MD), Masters and PhD. For each group, the average income is calculated by 5-year age groups in the interval 25 to 75 years old, using data from the 2016 Census. Employment income is winsorized at the 1% level and the average is computed using survey-weights; we report real income in 2021 Canadian dollars. *Data source:* 2016 Census. This figure is referenced in Section 4.3.

Figure A4: Total Income Over the Life Cycle, by Highest Degree Earned

A: Total Income

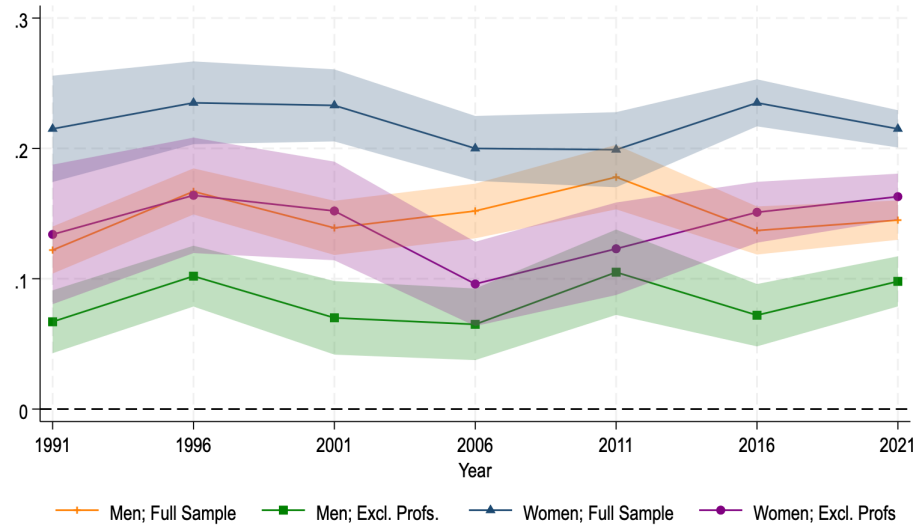


B: Total Income (Conditional on Employment)



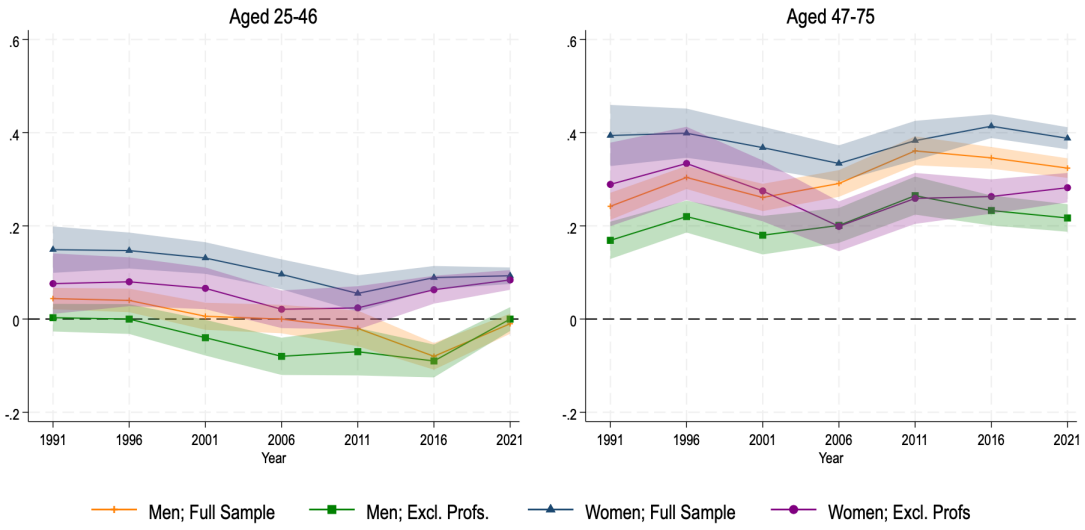
The figure shows life-cycle real income profiles by highest degree, separately for men and women. Specifically, we select individuals who earned at least a bachelors degree and classify them into four groups, based on the highest degree earned: only bachelor, intermediate or professional degrees (which include JD, and MD), Masters and PhD. For each group, the average income is calculated by 5-year age groups in the interval 25 to 75 years old, using data from the 2016 Census. Income is winsorized at the 1% level and the average is computed using survey-weights; we report real income in 2021 Canadian dollars. *Data source:* 2016 Census. This figure is referenced in Section 4.3.

Figure A5: Returns to a PhD over time: Total income



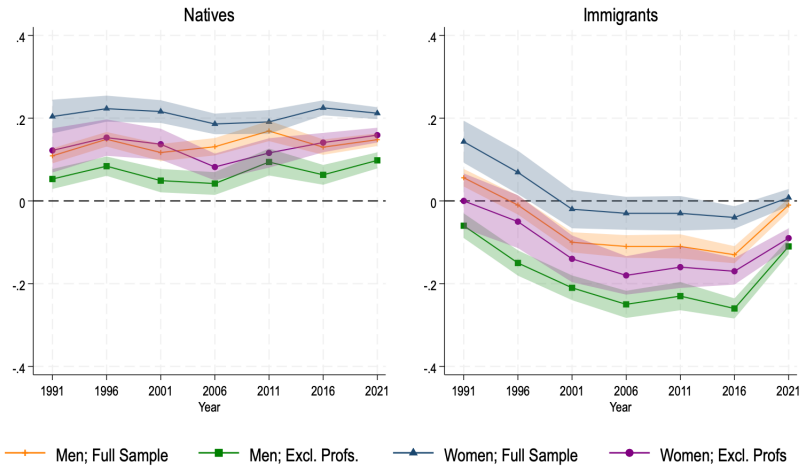
Note: The figure shows our estimates for the returns to a PhD as compared to a Bachelors, in terms of total income. We estimate the returns to a PhD among the 25-75 years old population who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. In each sample, we estimate the returns with a regression of log real total income on a set of indicators for highest degree, which include PhD, Masters, and intermediate or professional degrees, and we control for age and age squared, province of residence and field of study. The resulting estimates correspond to the returns as compared to a Bachelors, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census. This figure is referenced in Section 4.4.

Figure A6: Returns to a PhD over time by age: Total income



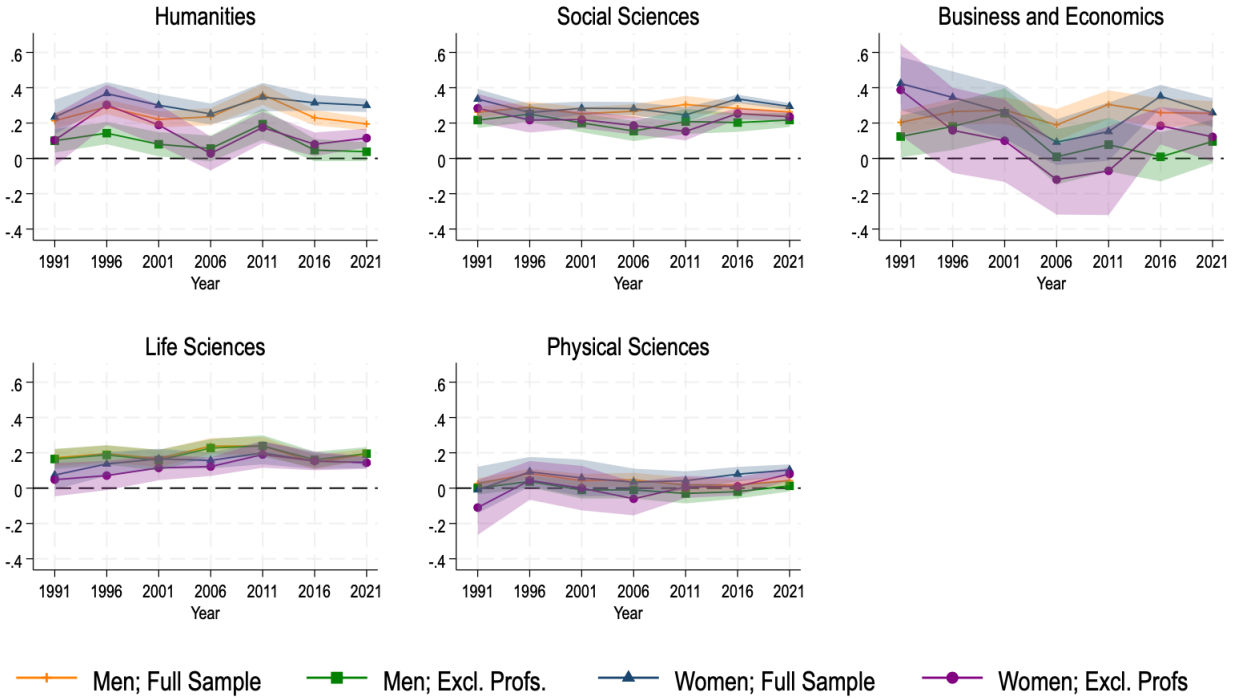
Note: The figure shows our estimates for the returns to a PhD as compared to a Bachelors, in terms of total income. We estimate the returns to a PhD among the who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. We split each sample into two groups, based on the age of respondents: 25-46 years old and 47-75 years old. In each sample, we estimate the returns with a regression of log real total income on a set of indicators for highest degree, which include PhD, Masters, and intermediate or professional degrees, and we control for age and age squared, province of residence and field of study. The resulting estimates correspond to the returns as compared to a Bachelors, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census. This figure is referenced in Section 4.4.

Figure A7: Returns to a PhD over time by immigration status: Total income



Note: The figure shows our estimates for the returns to a PhD for immigrants and natives as compared to a Bachelors for natives, in terms of total income. We estimate the returns to a PhD among the 25-75 years old population who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. In each sample, we estimate the returns with a regression of log real employment income on a set of indicators for highest degree, which include PhD - separately for immigrants and natives -, Masters, intermediate or professional degrees, and Bachelors for natives, and we control for age and age squared, province of residence and field of study. The resulting estimates correspond to the returns as compared to a Bachelors for natives, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census. This figure is referenced in Section 4.4.

Figure A8: Returns to a PhD over time by field of study: Total income



Note: The figure shows our estimates for the returns to a PhD as compared to a Bachelors, in terms of total income. We estimate the returns to a PhD among the 25-75 years old population who earned at least a Bachelors degree and reports being employed full time with strictly positive employment income, separately in each Census year and by field of study, and for the following subsamples: all women, all men, all women excluding professors, all men excluding professors. We classify the field of study of an individual's highest degree in the following categories: Humanities, Social Sciences, Economics and Business, Life Sciences, and Physical Sciences. In each sample, we estimate the returns with a regression of log real employment income on a set of indicators for highest degree, which include PhD, Masters, and intermediate or professional degrees, and we control for age and age squared, and province of residence. The resulting estimates correspond to the returns as compared to a Bachelors, the omitted education category. The regressions use survey weights and we estimate robust standard errors. *Data source:* 1991-2021 Census. This figure is referenced in Section 4.4.

B Additional Tables

Table B1: Descriptive statistics on PhD cohort: Earnings during the PhD

	T4 income	**Total income**
All	22,000	29,000
Men	21,000	28,000
Women	22,000	30,000
Canadian	26,000	34,000
International	9,000	13,000
Non-U15	25,000	32,000
U15	21,000	28,000
U5	19,000	26,000
Humanities	20,000	27,000
Social Sciences	31,000	40,000
Phyisical Sciences	16,000	22,000
Life Sciences	17,000	25,000
Economics and Business	32,000	40,000

Note: The table reports descriptive statistics on the earnings of students who enrolled in a PhD program in the years 2010-2012, during the PhD program. *Data source:* PSIS. This table is referenced in Section 4.1.

Table B2: Early-career returns as compared to dropping out: Total income

	Dependent variable: Log total income 9 years after PhD start			
	Men	*Women*	*Men*	*Women*
	(1)	(2)	(3)	(4)
Graduated	0.147***	0.220***	0.0305	0.0905*
	(0.0271)	(0.0256)	(0.0531)	(0.0474)
Dropped out in years 2-3			-0.0463	-0.0769
			(0.0630)	(0.0595)
Dropped out in years 4+			-0.209***	-0.210***
			(0.0610)	(0.0548)
Year	Yes	Yes	Yes	Yes
Sex	No	No	No	No
Immigrant	Yes	Yes	Yes	Yes
Institution of PhD	Yes	Yes	Yes	Yes
Field of study of PhD	Yes	Yes	Yes	Yes
Omitted category	Did not graduate	Did not graduate	Dropped out in first year	Dropped out in first year

Note: The table reports our estimates of the returns to an earned PhD as compared to dropping out of the program for the PSIS cohort who enrolled in a PhD in 2010-2012. We estimate the returns separately for women and men. First, we report the returns to graduating as opposed to dropping out of the program (columns 1 and 2). Then, we classify students who did not finish the program based on the year in which they dropped out (columns 3 and 4). In columns 1 and 2, we estimate returns with regressions of log total income 9 years after the start of the program on an indicators for whether the student graduated from the PhD, controlling for field of study, institution, year in which they started the program, and immigration status. In columns 3 and 4, we add an indicator for dropping out of the program in years 2-3 of the program, and in years 4 and above. The resulting estimates correspond to the returns as compared to a dropping out in the first year, the omitted education category. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS. This table is referenced in Section 4.2.

Table B3: Early-career returns as compared to dropping out, by field: Total income

	Dependent variable: Log total income 9 years after PhD start									
	Humanities	*Social Sciences*	*Physical Sciences*	*Life Sciences*	*Economics and Business*	*Humanities*	*Social Sciences*	*Physical Sciences*	*Life Sciences*	*Economics and Business*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Graduated	0.0849*	0.229***	0.169***	0.194***	0.289***	-0.0823	0.147***	0.0695	-0.0190	0.0666
	(0.0466)	(0.0297)	(0.0346)	(0.0627)	(0.0754)	(0.0893)	(0.0566)	(0.0724)	(0.100)	(0.124)
Dropped out in years 2-3						0.00207	0.00723	-0.0742	-0.302**	-0.0910
						(0.103)	(0.0707)	(0.0851)	(0.147)	(0.136)
Dropped out in years 4+						-0.279***	-0.154**	-0.172**	-0.252*	-0.397***
						(0.0952)	(0.0646)	(0.0854)	(0.134)	(0.151)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sex	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institution of PhD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Field of study of PhD	No	No	No	No	No	No	No	No	No	No
Omitted category	Did not graduate	Did not graduate	Did not graduate	Did not graduate	Did not graduate	Dropped out in first year	Dropped out in first year	Dropped out in first year	Dropped out in first year	Dropped out in first year

Note: The table reports our estimates of the returns to an earned PhD as compared to dropping out of the program for the PSIS cohort who enrolled in a PhD in 2010-2012. We estimate the returns separately for women and men, and by field of study of the PhD. First, we report the returns to graduating as opposed to dropping out of the program (columns 1 and 2). Then, we classify students who did not finish the program based on the year in which they dropped out (columns 3 and 4). In columns 1 and 2, we estimate returns with regressions of log total income 9 years after the start of the program on an indicators for whether the student graduated from the PhD, controlling for institution, year in which they started the program, and immigration status. In columns 3 and 4, we add an indicator for dropping out of the program in years 2-3 of the program, and in years 4 and above. The resulting estimates correspond to the returns as compared to a dropping out in the first year, the omitted education category. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS. This table is referenced in Section 4.2.

Table B4: Early-career returns as compared to dropping out, by institution: Total income

	Dependent variable: Log total income 9 years after PhD start					
	Non-U15	*U15, not U5*	*U5*	*Non-U15*	*U15, not U5*	*U5*
	(1)	(2)	(3)	(4)	(5)	(6)
Graduated	0.158***	0.208***	0.207***	0.0674	0.168**	-0.0761
	(0.0288)	(0.0343)	(0.0337)	(0.0533)	(0.0733)	(0.0597)
Dropped out in years 2-3				-0.0197	0.0431	-0.255***
				(0.0640)	(0.0879)	(0.0758)
Dropped out in years 4+				-0.169***	-0.123	-0.383***
				(0.0608)	(0.0830)	(0.0714)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Sex	Yes	Yes	Yes	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes	Yes	Yes	Yes
Institution of PhD	Yes	Yes	Yes	Yes	Yes	Yes
Field of study of PhD	Yes	Yes	Yes	Yes	Yes	Yes
Omitted category	Did not graduate	Did not graduate	Did not graduate	Dropped out in first year	Dropped out in first year	Dropped out in first year

Note: The table reports our estimates of the returns to an earned PhD as compared to dropping out of the program for the PSIS cohort who enrolled in a PhD in 2010-2012. We estimate the returns separately for women and men, and by type of institution. Specifically, we classify institutions as U5, U15 excluding U5, and other institutions. First, we report the returns to graduating as opposed to dropping out of the program (columns 1 and 2). Then, we classify students who did not finish the program based on the year in which they dropped out (columns 3 and 4). In columns 1 and 2, we estimate returns with regressions of log total income 9 years after the start of the program on an indicators for whether the student graduated from the PhD, controlling for field of study, institution, year in which they started the program, and immigration status. In columns 3 and 4, we add an indicator for dropping out of the program in years 2-3 of the program, and in years 4 and above. The resulting estimates correspond to the returns as compared to a dropping out in the first year, the omitted education category. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS. This table is referenced in Section 4.2.

Table B5: Early-career returns as compared to bachelors: Total income

	Dependent variable: Log total income in 2019			
	Men	*Women*	*Canadian*	*International*
	(1)	(2)	(3)	(4)
PhD	-0.139***	0.0798***	-0.0287	0.00183
	(0.0322)	(0.0274)	(0.0213)	(0.173)
Masters	0.00316	0.0922***	0.0549***	0.165***
	(0.0124)	(0.00843)	(0.00703)	(0.0518)
Other intermediate degrees	0.0230	0.0390**	0.0315**	-0.982
	(0.0241)	(0.0163)	(0.0136)	(0.648)
MD, JD, MBA	0.397***	0.521***	0.459***	0.449***
	(0.0164)	(0.0149)	(0.0111)	(0.0733)
Sex	No	No	Yes	Yes
Immigrant	Yes	Yes	No	No
Institution of Bachelor	Yes	Yes	Yes	Yes
Field of Bachelor	Yes	Yes	Yes	Yes
Test of PhD = Masters				
F statistic	17.735	0.196	14.507	0.847
p-value	0.000	0.658	0.000	0.357
Omitted category	Bachelor only	Bachelor only	Bachelor only	Bachelor only

Note: The table reports our estimates of the returns to a PhD as compared to a Bachelors for the PSIS cohort who graduated from a Bachelors in 2009. We estimate the returns separately for women and men. We estimate the returns with regressions of log total income on a set of indicators for highest degree, which include PhD, Masters, Intermediate and Professional degrees (MBA, MD and JD), and other Intermediate and professional degrees, and control for field of study and institution of the bachelors degree, and immigration status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS. This table is referenced in Section 4.2.

Table B6: Early-career returns as compared to bachelors by field: Total income

	Dependent variable: Log total income in 2019				
	Humanities	*Social Sciences*	*Physical Sciences*	*Life Sciences*	*Economics and Business*
	(1)	(2)	(3)	(4)	(5)
PhD	-0.0793	0.166***	-0.0924**	-0.113***	0.362***
	(0.0748)	(0.0342)	(0.0416)	(0.0402)	(0.0791)
Masters	0.0806***	0.111***	0.00244	0.0517***	0.0792***
	(0.0199)	(0.0118)	(0.0182)	(0.0135)	(0.0214)
Other intermediate degrees	0.169***	0.0123	-0.174***	-0.0747**	-0.193***
	(0.0229)	(0.0218)	(0.0634)	(0.0353)	(0.0719)
MD, JD, MBA	0.612***	0.445***	0.293***	0.663***	0.319***
	(0.0351)	(0.0230)	(0.0326)	(0.0216)	(0.0203)
Sex	Yes	Yes	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes	Yes	Yes
Institution of Bachelor	Yes	Yes	Yes	Yes	Yes
Field of Bachelor	No	No	No	No	No
Test of PhD = Masters					
F statistic	4.371	2.368	4.762	15.914	12.091
p-value	0.037	0.124	0.029	0.000	0.001
Omitted category	Bachelor only	Bachelor only	Bachelor only	Bachelor only	Bachelor only

Note: The table reports our estimates of the returns to a PhD as compared to a Bachelors for the PSIS cohort who graduated from a Bachelors in 2009. We estimate the returns separately for women and men, and by field of study of the Bachelors degree. We estimate the returns with regressions of log total income on a set of indicators for highest degree, which include PhD, Masters, Intermediate and Professional degrees (MBA, MD and JD), and other Intermediate and professional degrees, and control for institution of the bachelors degree, and immigration status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS. This table is referenced in Section 4.2.

Table B7: Early-career returns as compared to bachelors by institution: Total income

Dependent variable: Log total income in 2019			
	Non-U15	*U15*	*U5*
	(1)	(2)	(3)
PhD	0.000410	-0.0377	-0.0598
	(0.0343)	(0.0338)	(0.0433)
Masters	0.0877***	0.0138	0.0532***
	(0.00989)	(0.0128)	(0.0155)
Other intermediate degrees	0.0475***	-0.0278	0.0624*
	(0.0174)	(0.0268)	(0.0366)
MD, JD, MBA	0.386***	0.485***	0.531***
	(0.0175)	(0.0192)	(0.0212)
Sex	Yes	Yes	Yes
Immigrant	Yes	Yes	Yes
Institution of Bachelor	Yes	Yes	Yes
Field of Bachelor	Yes	Yes	Yes
Test of PhD = Masters			
F statistic	6.124	2.156	6.413
p-value	0.013	0.142	0.011
Omitted category	Bachelor only	Bachelor only	Bachelor only

Note: The table reports our estimates of the returns to a PhD as compared to a Bachelors for the PSIS cohort who graduated from a Bachelors in 2009. We estimate the returns separately for women and men, and by type of institution where the individual completed their Bachelors degree. Specifically, we classify institutions as U5, U15 excluding U5, and other institutions. We estimate the returns with regressions of log total income on a set of indicators for highest degree, which include PhD, Masters, Intermediate and Professional degrees (MBA, MD and JD), and other Intermediate and professional degrees, and control for field of study of the bachelors degree, and immigration status. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Data source:* PSIS. This table is referenced in Section 4.2.