Lessons learned while searching for meaning in doctoral completion metrics: An intra-institution case study

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For institutions intent on improving their research student outcomes, it is important to identify the variables most strongly associated with timely or tardy completions, which the university has the potential to influence or amend. For this to occur the analyses of doctoral completion times need to be conducted at an institution or discipline level. However, conducting meaningful analyses of doctoral completion data is a complex undertaking fraught with potential problems. This paper uses an intra-institution case study to reflect on and illustrate how different meanings can emerge from data analysis, depending on the statistical approach used to analyse the data. The paper outlines the lessons learned during data analysis, and the implications for doctoral education. The findings also point to potential marketing opportunities for research institutions.

Introduction

The importance of doctoral completion metrics

Doctoral completion time is one of the metrics used to rank research performance across universities and disciplines (European Science Foundation, 2017; Kyvik & Olsen, 2014; McGagh et al., 2016) at international (Cloete, Bunting & van Schalkwyk, 2018) and national levels (Palmer, 2016). Completion metrics are also used by governments throughout much of Europe (van de Schoot, Yerkes, Mouw & Sonneveld, 2013; Visser, Luwel & Moed, 2007), Scandinavia (Hansen, Aarrevaara, Geschwind & Stensaker, 2019), and Australia (Department of Education, Skills & Employment, 2021) when calculating the amount of funding to allocate to universities for higher degree by research (HDR) student training, and thus a timely completion of a doctoral candidature may be considered a financial asset by an institution. Timely completions are also a reflection on the quality of researcher training (Palmer, 2016), thus, for researcher educators who are intent on improving doctoral student training, identifying the factors influencing timely completions is worthwhile.

To improve doctoral student training and outcomes, research which provides insights into the factors affecting performance at the home institution is arguably more valuable when conducted at an intra-institution level, where the findings are based on and the learnings applicable to the local context and demographics (Ehrenberg et al., 2007). The supposition is strengthened by the comments of McGagh et al. (2016, p. xv), made at the culmination of a comprehensive review of HDR training in Australia, that "The absence

of performance data at the institutional and disciplinary level makes it difficult to identify where the system is performing well and where it can be improved". Given this context, the researchers embarked on a study aimed at identifying the predictors of doctoral completion times at an Australian institution, in order to provide insights into how HDR outcomes could be improved. While searching for meaning in the data analyses, it became apparent to the researchers that the "message" implied by the results varied depending on the method being utilised. This outcome led to the purpose of the paper, which is to use an intra-institution case study to illustrate how different statistical approaches used to analyse completion data can provide clearer distinction in the end results, thereby potentially increasing the value of the findings for the institution. The following section outlines current understanding of the predictors of completion times, the importance of analysing data at an institutional level, and some of the issues in analysing doctoral completion data.

Literature review

What have prior doctoral completion analyses revealed?

Notwithstanding the complexities in data analysis, given the value in identifying the factors influencing timely doctoral completions, much research has been done. The early literature shows a diversity of findings across institutional and student variables (see Booth & Satchell, 1995), but much has changed in the higher education sector since the 1980s and 1990s (Skopek, Triventi & Blossfeld, 2020). Studies conducted in the last two decades show greater consensus on the factors associated with shorter time-to-degree, namely: adequate funding (Horta, Cattaneo & Meoli, 2019; Spronken-Smith, Cameron & Quigg, 2018); discipline (Churchill et al., 2021; Torka, 2020); prior research experience (Spronken-Smith et al., 2018); and international student status (Geven, Skopek & Triventi, 2018; Spronken-Smith et al., 2018; Zhou & Okahana, 2019). The association between age, gender, marital status, and time-to-degree remains inconsistent across studies, as they are largely influenced by the demographics and cultural context of the institution.

Why analyse doctoral completion data at an intra-institution level?

Given the substantial body of evidence on the predictors of time-to-degree, it could be argued that further studies—especially if conducted at the single institution level—add little to the body of scholarly literature. Meta-analyses of multi-institutional or national data have the potential advantage of providing insights relevant to policy (Groenvynck, Vandevelde & Van Rossem, 2013), or a national higher education sector, but tend to provide less value for guiding change at an individual institutional level due to the diversity across doctoral training programs (see Zhou & Okahana, 2019). Commenting on the design of an education program aimed at improving the time-to-degree in doctoral students in the United States of America (USA), Ehrenberg et al. (2007, p. 135) state: "the designers … concluded that what went on in departments was the key to improving doctoral programs"; the evidence-based recommendations emanating from an analysis of doctoral time-to-degree in 43 departments in a single institution in the USA substantiates such claims (see de Valero, 2001). In Australia, McGagh et al. (2016) recommended that

HDR performance be reported by discipline. With reference to prior studies, and at the conclusion of an extensive study of the factors influencing doctoral success, Barnes and Randall (2012, p. 68) concluded: "… it is the academic discipline, not the university that influences time to degree".

Apart from the known predictors of shorter time-to-degree (i.e., funding, discipline, prior research experience, international student status), it is likely that any *additional* variables influencing time-to-degree will be specific to the institution or discipline demographic, location, context and HDR training program. Thus, for institutions intent on improving *their* HDR outcomes, it is important to identify the variables most strongly associated with timely or tardy completions which the university has the potential to influence or amend. To inform institutional practice, the analyses of doctoral completion times need to be conducted at an institution or discipline level. However, analysing doctoral completion data is fraught with potential problems.

Issues in analysing doctoral completion data

Conducting meaningful analyses of doctoral completion data is a complex undertaking. Typical issues include: unreliable or incomplete data (Kyvik & Olsen, 2014; Palmer, 2016), skewed data (van de Schoot et al., 2013; Visser et al., 2007), methodologically challenging computations (Wao, 2010), and a complex web of time-varying, time-invariant, and confounding variables (Ampaw & Jaeger, 2012; Lott, Gardner & Powers, 2009). For example, it is not unreasonable for the candidacy of a part-time student to span eight years or more and include changes in type of attendance (part-time to full-time or the reverse), mode of study (on-campus or distance), finances (expiration of scholarship funding), and to include multiple leave of absence periods centred on significant life events. In prior studies of doctoral completion times, authors report unmeasured systemic issues, bias, and "unusual" completion times rectified only by data stratification (Rodwell & Neumann, 2008, p.69). Wao and Onwuegbuzie (2011, p.128) discussed the "intertwined" and "complex interplay" in their discrete-time, multilevel event history modelling of candidacy data, and Torka (2020, p.79) refers to the "… often hidden and compound factors that drive completion …".

Compounding the complexities around data and data analyses, are the variations in the format in which results are reported in the literature and the varying definitions of completion time. For example, Zhou and Okahana (2019) reported median time-to-degree for amalgamated data drawn from 212 institutions in the USA; Wright and Cochrane (2000) reported the proportion of students who completed their studies in 4 years at a single institution in the United Kingdom (UK); cumulative completion rates on an annual basis over 8 years (Groenvynck et al., 2013), 9 years (Torka, 2020), and 12 years (Visser, 2007). Such variations in completion times are not unexpected due to the differing entry criteria that exists across HDR programs internationally, nor are the differences in reporting formats of particular relevance unless the results are to be used for institutional benchmarking where comparable metrics are needed. The format in which completion results are reported depends on the method used to analyse the data. If HDR completion analyses are being conducted for internal benefit, the way in which results are reported

need only be in a format of relevance to the institution, noting that such findings may provide limited scope for cross-institutional comparisons.

As with the variations in the reporting formats of doctoral completion data, likewise, the definition of 'completion' tends to vary across studies and nations. The range of definitions of completion time include: the date on which all the course requirements are completed (Torka, 2021), funded time-to-degree (excluding leave of absence periods) (Groenvynck et al., 2013), the number of full time equivalent (FTE) years from the candidates' enrolment date to the date of graduation (Rodwell & Neuman, 2008), the time to 'award of the degree' (which includes the examination period but excludes the time to graduation) (Spronken-Smith et al., 2018, p. 95), and time to thesis submission (Skopek et al., 2020; Thune et al., 2012). In the latter studies, the examination period is excluded from the definition due to its variability which is outside the student's control (Thune et al., 2012). In Australia it is up to individual universities whether 'completion of study' includes or excludes the examination period (Department of Education, Skills & Employment, 2021). The purpose behind the doctoral completion analyses will likely determine the definition of completion time, the analytical methods used, and the format of the results and, as outlined in this paper, the implications of the findings.

Aim

The aim of this paper is to illustrate, using a case study, how the choice of statistical method used to analyse doctoral completion data can influence the implications of the findings. Our results draw attention to the need for caution when searching for meaning in doctoral completion data because different methods may imply different meanings.

Definitions

The terms 'completion', time-to-degree, and time to thesis submission are used synonymously to refer to the FTE years lapsed from enrolment in doctoral studies to thesis submission. 'Timely', and 'on time' are defined as a student completing their doctoral studies within the stipulated, institutional course duration. At the institution in this study, the ideal time to thesis submission is within 3.5 FTE years, although a maximum of 4 FTE years is permitted.

Context

The research was conducted at James Cook University, a mid-sized (~ 20,000 students), research intensive, Australian higher education institution, ranked in the 201-300 bracket of the *Academic Ranking of World Universities* (Shanghai Ranking, 2021). HDR training at the university is administered by a centralised Graduate Research School (GRS). The centralised operating system means that there is uniformity and consistency in the requirements, basic research training, and monitoring of student progress across disciplines. International students, regardless of their origin or discipline, are required to complete additional training in professional academic writing and critical thinking. Following enrolment, all students undergo preparatory research training culminating in a

Confirmation of Candidature milestone. Candidates must also undertake a component of professional development and career capability training (e.g. covering communication skills, innovation, leadership etc) during the HDR, and additional topic-specific training (e.g. statistics, qualitative data analysis) where required. Personalised support is also provided to students in the form of supervision by an advisory panel (which comprises between two and four supervisors who have undergone supervisor training administered by the GRS). Thereafter, progress is monitored by the students' advisory panel and documented twice yearly in standardised (equitable) *Progress Reports*. In addition, monitored major milestones include a *Mid-Candidature Review*, and a formal *Pre-Completion* review 3 months prior to the intended thesis submission date.

Over the 20-year study period (January 2000 to January 2020), 3,067 students embarked on HDR studies, 79% (2,420) were doctoral candidates, with 27% (658) from non-English speaking backgrounds. The composition of females and males was similar, 52.4% and 47.6% respectively, with the annual intake mostly proportional. In 2002, 40% of the candidates were male and in 2013, 2015 and 2016 40% of the intake were female—overall, 602 females and 650 males submitted their thesis. The proportion of international students increased steadily during the study period from less than 20% in 2000 to 48% in 2019—this change over time did not influence the results presented here due to the methodology used (as outlined later in the paper). During the study period a total of 714 domestic and 538 international students completed HDR studies (1,252). This study focuses only on the doctoral completions (1,060).

Method

Data

Data on doctoral students were obtained from the university database. Inclusion criteria were students enrolled in doctoral studies between January 2000 and January 2020 who commenced their HDR studies prior to 1 January 2015 and who had submitted their Doctor of Philosophy (PhD) thesis for examination by 1 January 2020 (to allow sufficient time for thesis submission). Part-time and full-time candidates were included, as were external and internal candidates. Students who commenced their studies in a Masters degree and later upgraded to a PhD were included provided they met the timeframe criteria. Exclusion criteria were students for whom the type of attendance (part-time or full-time), or field of research was not specified; and those who were absent without leave, or may have withdrawn or completed their studies elsewhere and had failed to notify the university of the change. This study focuses on the 1,060 doctoral completions that met the inclusion/exclusion criteria.

The data comprised the following variables: gender, residency (international or domestic [Australia and New Zealand]), type of attendance (full-time or part-time converted to FTE [years]), discipline (by Field of Research code), age category (<30, 30-50, >50 years), and enrolment and thesis submission dates. Part-time and full-time candidacy durations (i.e., the time from enrolment in the degree to the date of thesis submission and excluding leave of absence periods) were converted to FTE years. For students who changed their

type of attendance, the calculated FTE was the average over their candidacy, i.e., 0.75 FTE or above was considered full-time. Discipline was defined according to the 'internationally accepted' Organisation for Economic Cooperation and Development (OECD, 2015, p. 3) major Fields of Research and Development (FORD) descriptions used in Higher Education and the Australian and New Zealand Fields of Research (FOR) Divisions (Australian Bureau of Statistics, 2020) as shown in Table 1. The variables in the study were limited to those permitted under our Ethics Approval (#H7806), as guided by the university privacy officer. All data were de-identified prior to release to the researchers.

Table 1: Disciplines as defined by the OECD major Fields of Research and Development (FORD), and the equivalent Australian and New Zealand Field of Research (FOR)

Broad discipline	OECD FORD*	ANZ FOR divisions (codes)**
STEM	Natural sciences	Biological (31), Chemical (34), Earth (37), Environmental (41), Mathematical (49), Physical sciences (51)
	Engineering, technology	Engineering (40), Information and computing (46)
	Agricultural, veterinary sciences	Agricultural, veterinary and food sciences (30)
Health	Medical and health sciences	Biomedical and clinical (32); Health sciences (42), Psychology (52)
HASS	Humanities and arts; Social sciences	Commerce, management, tourism (35); Economics (38); Education (39); History, heritage, archaeology (43); Human society (44); Indigenous studies (45); Language, communication, culture (47), Law (48), Philosophy, religious studies (50)

* OECD (2015); ** Australian Bureau of Statistics (2020)

Data analyses

Explanatory variables tested were gender (male or female), age group (< 30, 30-50, >50 years), discipline or field of research group (Science, technology, engineering and mathematics [STEM], Health, and Humanities and arts, Social sciences [HASS]), attendance type (full-time or part-time, as defined earlier), and student origin or residency status (domestic or international), as well as two-way interactions between them. The response variable was time to thesis submission (measured in FTE years). Log-rank tests were used to compare the effects of each attribute separately, the proportional odds assumption was checked for each variable for inclusion in Cox regression analyses. To examine factors influencing time to thesis submission, Cox regression coefficient estimates and significance tests were executed using the survival, survminer and car packages in R (v 4.02), with significance set at $p < 0.05$. Confidence intervals (CI) for proportions were calculated using the binom package in R, following the "exact" method (Clopper & Pearson, 1934). Additional details on the statistical methods are provided in subsequent sections, in keeping with the aim of the paper.

Results and discussion

Demographic attributes of participants

Table 2 summarises the numbers of doctoral students and completions for each level of the potential explanatory terms, between January 2000 and January 2020. All the variables (gender, age group, discipline, and attendance) were examined for domestic students, as well as two-way interactions between them. Among international students, relatively few were either part-time (in line with the visa and institution rules pertaining to internal, international students), in the oldest age group, or in the Health discipline and had reached completion, hence the demographics of the student groups constrained the analyses which were possible. Consequently complex comparisons which included international students could not include all two-way interaction variables. For each attribute (gender, age group, discipline, and attendance), international students were:

- More likely to be male than domestic students ($\chi 2$ (1) = 21.9, $p < 0.0001$)
- More likely to be in younger age groups than domestic students ($\chi 2$ (2) = 84.0, $p < 0.0001$)
- More likely to be in STEM disciplines and less likely to be in Health or HASS disciplines than domestic students ($\chi 2$ (2) = 174.4, $p < 0.0001$)
- Less likely to be enrolled part-time than domestic students ($\chi 2$ (1) = 184.0, $p < 0.0001$).

Table 2: Demographic attributes of the domestic and international doctoral students who completed their studies between January 2000 and January 2020

Attribute		Domestic students		International students	
		Students	Completions	Students	Completions
Gender	Female	558 (59%)	331	348 (48%)	220
	Male	385 (41%)	243	382 (52%)	266
Age Group (years)	< 30	382 (41%)	265	411 (56%)	288
	30-50	423 (45%)	246	299 (41%)	187
	> 50	137 (14%)	63	20 (3%)	11
Discipline	STEM	394 (42%)	263	540 (74%)	360
	Health	222 (24%)	127	66 (9%)	42
	HASS	327 (35%)	184	124 (17%)	84
Attendance	FT	548 (58%)	399	645 (88%)	438
	PT	395 (42%)	175	85 (12%)	48

Examining data by median time to thesis submission

When examining data by median time to thesis submission (Table 3), analyses show no significant association between gender (a difference of 0.03 FTE years), or age (which ranged between 3.92 and 4.00 FTE years for the three age categories) ($\chi 2$ (1) = 3.6, p = 0.07; $\chi 2$ (2) = 2.9, p = 0.22 respectively). Similarly, there was no significant association between the median time to submission for Health, STEM, and HASS graduates ($\chi 2$ (2) =

4.6, $p = 0.1$), which were 3.97, 3.99 and 4.00 FTE years respectively, or attendance type and completion time ($\chi 2$ (2) = 1.8, $p = 0.2$), which was 3.99 and 4.00 FTE years for full-time and part-time graduates respectively (Table 3). However, a significant difference ($\chi 2$ (1) = 55.4, $p < 0.0001$) in median time to thesis submission was found between domestic (4.08 FTE years, CI: 4.00 to 4.19) and international candidates (3.85 FTE years, CI: 3.75 to 3.97), as shown in Table 3.

Conclusion
When data are examined by median time-to-degree, gender, age group, discipline and type of attendance are not predictors of completion times.

Significance
This finding is of little significance, for each of these variables the authors could list an extensive number of prior studies in support of, or countering, the findings. At an institutional level, on receipt of these results, HDR trainers may be inclined to rest on their 'egalitarian' laurels.

Table 3: The effects of each explanatory variable on the median completion time (FTE years; 95% confidence intervals and *p*-values) of all students

Attribute		Median completion time (FTE years)	Confidence interval (95%)	*p*-value
Gender	Female	4.00	3.93 - 4.06	χ^2 (1) = 3.6,
	Male	3.97	3.86 - 4.00	$p = 0.07$
Age group (years)	< 30	3.97	3.88 - 4.00	χ^2 (2) = 2.9,
	30-50	4.00	3.94 - 4.10	$p = 0.22$
	> 50	3.92	3.71 - 4.18	
Discipline	STEM	3.99	3.92 - 4.00	χ^2 (2) = 4.6,
	Health	3.97	3.65 - 4.15	$p = 0.1$
	HASS	4.00	3.84 - 4.11	
Attendance	FT	3.99	3.93 - 4.00	χ^2 (2) = 1.8,
	PT	4.00	3.80 - 4.25	$p = 0.2$
Residency	Domestic	4.08	4.00 - 4.19	χ^2 (1) = 55.4,
	International	3.85	3.75 - 3.97	$p < 0.0001$

The need for time-dependent coefficients to overcome proportional hazards assumptions

The output of initial analyses examining single explanatory variables found that the proportional hazards assumption were very substantially violated by several of these variables, so time-dependent coefficients were used for more complex models using Cox regression. To facilitate analyses, three time groups were specified:

a. Time group 1 represents completion times less than 3.5 FTE years – that is, within the recommended period (of <3.5 FTE years) in the Australian system.

b. Time group 2 represents completion times between 3.5 and 5 FTE years – within 18 months of the recommended period.
c. Time group 3 represents completion times greater than 5 FTE years.

Methodological insights
This stratification resolved the proportional hazards assumption for all explanatory variables except student residency status, where a marginally significant violation remained (χ^2 (1) = 4.00, p = 0.045).

Methodological significance
Due to this violation, additional separate analyses were required to stratify the data by residency status (domestic or international). Interaction terms between student residency status and other variables were not in violation. Kaplan-Meier plots with log-rank tests were used to display the significant effects and interactions, and to evaluate any differences between the patterns of completion times in each plot. The separate analyses for domestic and international students were conducted to ensure that the conclusions of the full model were not affected.

Proportion of graduates completing within a specified time period

When considering the proportion of graduates within a discipline who completed within the three time groups, namely, the ideal time period (<3.5 FTE years), or within 18 months of the ideal (3.5-5 FTE years), or 18 months or more beyond the ideal time (>5.0 FTE years), discipline was a significant predictor of completion time—with Health ranked above HASS, and STEM.

Methodological insights
Calculating completion times by median time-to-degree revealed no significant difference between disciplines, but, for the same dataset, when proportional data were considered discipline was a predictor of completion times.

Scholarly significance
Although these findings highlight the importance of methodology when searching for meaning in doctoral completion data, from a scholarly perspective the finding is of little scholarly significance. Our results roughly align with those of Rodwell and Neumann (2008) and Kyvik and Olsen (2014), who, as in our study, also examined their data in the format of proportion of completions within disciplines, albeit across submission timeframes of 3.25 and 4 FTE years respectively, and at national levels (Australia and Norway, respectively). On examining their findings, Rodwell and Neumann (2008) ranked Life Sciences ahead of Social, Hard Sciences, and Humanities, while Kyvik and Olsen (2014) ranked Natural Sciences ahead of Medicine, Humanities, and Social Sciences. The findings are thus in keeping with the long-held consensus that students in the Sciences and STEM fields complete their degree in a shorter time than their peers in HASS fields, regardless of location, and therefore provide no new insights into discipline-related differences.

Significance for the institution
For the institution from which the data are drawn the findings become more meaningful. At our institution, a single GRS ensures that all doctoral students have equable access to HDR training, support mechanisms and processes, and requires all supervisors, irrespective of discipline, to undertake supervisor training, hence, it is worthwhile scrutinising the reasons behind the discipline differences. However, to gain insights into the reasons behind the discipline-related differences, more sophisticated analyses were required—these are outlined forthwith.

What does data stratification reveal? Domestic students

In the sample stratified by residency status, of the 574 domestic students who submitted their thesis between 2000 and 2020 there was a statistically significant association between attendance type and time to submission, χ^2 (2) = 68.70, $p< 0.001$. A significantly higher proportion of domestic part-time students (46.3%, CI: 38.7-54.0) submitted their PhD within 3.5 FTE years (Table 4) than full-time domestic students (15.0%, CI: 11.7-18.9). The majority of full-time domestic students (63.9%) submitted between 3.5 and 5 FTE years. For those domestic students submitting more than 18 months beyond the ideal (>5.0 FTE years), attendance status had little effect namely 21.1% versus 20.0% in full-time and part-time students respectively.

There was a statistically significant association between discipline area and time to thesis submission, χ^2 (4) = 51.89, $p< 0.001$. A significantly higher proportion of domestic Health students (43.3%, CI: 34.5-52.4) submitted their PhD in the shorter timeframe, compared to STEM or HASS students, at 11.8% and 29.9% respectively (Table 4). Most domestic STEM students (61.6%) submitted between 3.5 and 5 FTE years; as did the majority of HASS students (52.7%). Of those students exceeding the ideal submission period by 18 months or more, they were more likely to be in a STEM (26.6%) field of research, than HASS (17.4%), or Health (13.4%). There was no statistically significant association between gender and time to submission, χ^2 (2) = 2.38, $p = 0.30$.

Methodological insights
Data stratification facilitated the unlinking of covariates enabling a finer level of detail to be revealed, notably, that part-time, domestic students complete in the shorter FTE time period. This finding is also reported in Rodwell and Neumann (2008), who, as in our study, stratified their data to remove the influence of confounding variables, and in Spronken-Smith et al. (2018), who similarly conducted survival analyses with Cox regressions.

Significance for the institution
These findings point to three areas for potential action. First, the finding that a large proportion (46.3%) of part-time, domestic students, irrespective of age and gender, completed their PhD within the shorter timeframe has identified a potential marketing opportunity for the institution. For prospective, employed, professionals who might be wavering in a decision to embark on a HDR due to concerns around the time required,

the evidence presented for this demographic group could be used to allay such fears. Second, prior research has shown that students who experience successful educational outcomes (which in the context of our results is likely the students who completed their studies in a timely manner) tend to rate their university experience more highly in student satisfaction surveys (Barnes & Randall, 2012) than those who exceed the course duration (Cowling, 2017). Educators have a duty to students and to society to facilitate positive higher education learning experiences (Barnes & Randall, 2012) and wellbeing (Barry, Woods, Warnecke, Stirling & Martin, 2018; Panayidou & Priest, 2021). In turn, positive student satisfaction reviews serve as an attractant to prospective students (Clemes, Gan & Kao, 2008). Third, the predominance of full-time candidates (63.9%), and STEM candidates (26.6%) to overrun on the ideal period of candidature points to a demographic where efficiencies could be gained. Low levels of satisfaction with the doctoral experience (Barnes & Randall, 2012) and stress (Barry et al., 2018) have been found to slow progress (Devos et al., 2017). Low levels of student satisfaction may be partly supervisor-related (Barry et al., 2018), but are commonly associated with candidates facing a difficult hurdle (Kearns, Forbes, Gardiner & Marshall, 2008) such as writing the final discussion and conclusion components of a thesis. In the latter circumstances, proactive intervention by supervisors or additional training may be warranted (Churchill et al., 2021; Kearns et al., 2008) particularly given that HDR training is not typically centred in the late stages of doctoral candidature. Where delays are associated with an exhaustion of funding (Horta et al., 2019), again supervisors may be able to intervene by advocating for 'top-up' funding on behalf of the students (as discussed later), however, this may be a contentious issue where supervisors have much to gain from employing skilled, late-stage doctoral students as research assistants.

Table 4: The proportion of domestic students submitting their thesis within either <3.5 FTE years, 3.5-5 FTE years, or >5.0 FTE years by type of attendance, discipline and gender

		<3.5 FTE	3.5-5 FTE	>5.0 FTE	Total	*p*-value
No. submissions (%)		141 (24.6)	314 (54.7)	119 (20.7)	574	
Gender	Male	52 (21.4)	140 (57.6)	51 (21.0)	243 (42.3)	$\chi^2(2) = 2.38$,
	Female	89 (26.9)	174 (52.6)	68 (20.5)	331 (57.6)	$p = 0.30$
Discipline	STEM	31 (11.8)	162 (61.6)	70 (26.6)	263 (45.8)	$\chi^2(4) = 51.89$,
	Health	55 (43.3)	55 (43.3)	17 (13.4)	127 (22.1)	$p < 0.001$
	HASS	55 (29.9)	97 (52.7)	32 (17.4)	184 (32.1)	
Attendance	FT	60 (15.0)	255 (63.9)	84 (21.1)	399 (69.5)	$\chi^2(2) = 68.70$,
	PT	81 (46.3)	59 (33.7)	35 (20.0)	175 (31.5)	$p < 0.001$

Stratified data analyses: International students

As with the domestic part-time students, a statistically significant association was found between type of attendance and time to submission, χ^2 (2) = 15.14, $p< 0.001$. A significantly higher proportion of part-time than full-time international students (54.2% and 27.2% respectively) submitted their PhD within the desired time period (<3.5 FTE years; Table 5). The majority of full-time international students (67.6%, C: 63.0-71.9)

submitted between 3.5 and 5 FTE years and, as with part-time students, those submitting 18 months or longer outside the ideal submission time (>5.0 FTE years) were in the minority (5.1% and 4.1% respectively).

Unlike the pattern among domestic students, for international students there was no statistically significant association between discipline and time to submission, χ^2 (4) = 6.71, p = 0.15; there were too few part-time international students in the discipline of Health to provide meaningful results. As with domestic students, in the international student cohort there was no statistically significant association between gender and time to submission, χ^2 (2) = 3.15, p = 0.21.

Table 5: The proportion of international students submitting their thesis within either <3.5 FTE years, 3.5-5 FTE years, or >5.0 FTE years by type of attendance, discipline and gender

		<3.5 FTE	3.5-5 FTE	>5.0 FTE	Total	*p*-value
No. submissions (%)		145 (29.8)	316 (65)	25 (5.2)	486	
Gender	Male	88 (33.1)	166 (62.4)	12 (4.5)	266 (54.7)	$\chi^2(2) = 3.15$,
	Female	57 (25.9)	150 (68.2)	13 (5.9)	220 (45.3)	$p = 0.21$
Discipline	STEM	100 (27.8)	241 (66.9)	19 (5.3)	360 (74.1)	$\chi^2(4) = 6.71$,
	Health	12 (28.6)	26 (61.9)	4 (9.5)	42 (8.6)	$p = 0.15$
	HASS	33 (39.3)	49 (58.3)	2 (2.4)	84 (17.3)	
Attendance	FT	119 (27.2)	296 (67.6)	23 (5.1)	438 (90.1)	$\chi^2(2) = 15.14$,
	PT	26 (54.2)	20 (41.7)	2 (4.1)	48 (9.9)	$p < 0.001$

Scholarly significance

The finding—that international students tend to complete in a shorter time than domestic students—adds little to the scholarly literature because it is a well-established trend (see Ampaw & Jaeger, 2012; Wao, Dedrick & Ferron, 2011; Wright & Cochrane, 2000) seen across multiple global localities (see Geven et al., 2018; Skopek et al., 2020; Spronken-Smith et al., 2018; Torka, 2020; Zhou & Okahana, 2019). In this study, the completion times of international students align closely with scholarship and visa durations (i.e., 3.6 to 4.6 years). International students who have not submitted their thesis by the time their visa expires are obliged to return to their home country and complete their studies remotely, or self-fund their Australian living expenses for the duration of any government-approved extensions to their visa—this appears to be a strong driver of their completing within the visa timeframe.

Significance for institutions

Due to the clear association between visa timeframes and the completion times of international students, some institutions in Australia are introducing financial penalties for domestic candidates who fail to submit their thesis on time. However, positive incentives, such as 'added' financial incentives (over and above standard funding arrangements) have been shown to reduce time-to-degree (Kyvik & Olsen, 2014; Thune et. al., 2012) whereas punitive measures have had little effect (Torka, 2020). Positive incentives are thus recommended to drive timely completion. Evidence from a study of 2,250 doctoral

completions in New Zealand showed the size of the effect of having 'adequate' funding to be relatively small, equating to a mere 0.5 FTE years shorter in candidature duration (Spronken-Smith et al., 2018). For some candidates nominal addition funding may be sufficient to enable candidates to complete within the recommended timeframe. Top-up funding is thus one of the areas in which supervisors can be proactive to bring about mutually beneficial outcomes for themselves (i.e., a timely HDR student completion), the institution, and more importantly, the student.

Given the limited and conflicting evidence on the effect of top-up funding versus punitive measures in driving completion times, further investigation is warranted. The data in this study represent a period when no punitive measures were in place for candidature overrun, hence, these findings will form a useful baseline against which to assess the impact of any future financial measures taken at the institution.

The findings point to another potential marketing opportunity, which, in a globally competitive higher education arena (Zhou, Mitic, West & Okahana, 2020) is likely to be of interest to higher education institutions in Australia and New Zealand. That is, for prospective international students who meet the eligibility criteria it may be more cost-effective for them to complete a PhD in Australia or New Zealand within 3.5 years than a lengthier alternative in the USA.

Limitations

The findings in this study use data from one Australian university. However, the purpose of the paper is to use a case study to illustrate the effect of different statistical tests when searching for meaning in doctoral completion analyses. Also, although the Fields of Research are defined according to the OECD (2015) and the Australian Bureau of Statistics (2020) divisions (Table 1), our amalgamation of eight Fields of Research into the three broad groups of Health, STEM, and HASS—which was necessitated by our sample sizes to facilitate statistical analyses—may limit cross-sector discipline comparisons, but, again, this was not the purpose of the paper.

Conclusions

The purpose of this paper was to provide a reflective case study of our methodological journey during a quest to find meaning in our institutional doctoral completion data. The results presented illustrate how the implications of the findings (arising from data analysis) can vary according to the chosen methodology. The findings may be of interest to other institutions or disciplines eager to improve their HDR student outcomes, as the paper draws attention to the cautions which should be heeded when conducting similar statistical analyses. In the process of data analysis, a number of meaningful marketing messages emerged. While it might be argued that these findings have limited applicability to other institutions, they provide insights of relevance to the institutional demographics, context, location, and HDR training system. The results point to potential training opportunities of relevance to HDR educators with the ultimate goal of improving doctoral student efficiencies while paying heed to student wellbeing.

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References

Ampaw, F. D. & Jaeger, A. J. (2012). Completing the three stages of doctoral education: An event history analysis. *Research in Higher Education*, 53(6), 640-660. https://doi.org/10.1007/s11162-011-9250-3

Australian Bureau of Statistics (2020). *Australian and New Zealand Standard Research Classification (ANZSRC), 2020* (1297.0). https://www.abs.gov.au/ausstats/abs@.nsf/mf/1297.0

Barnes, B. J. (2010). The nature of exemplary doctoral advisors' expectations and the ways they may influence doctoral persistence. *Journal of College Student Retention: Research, Theory & Practice,* 11(3), 323-343. https://doi.org/10.2190/CS.11.3.b

Barnes, B. J. & Randall, J. (2012). Doctoral student satisfaction: An examination of disciplinary, enrollment, and institutional differences. *Research in Higher Education,* 53(1), 47-75. https://doi.org/10.1007/s11162-011-9225-4

Barry, K. M., Woods, M., Warnecke, E., Stirling, C. & Martin, A. (2018). Psychological health of doctoral candidates, study-related challenges and perceived performance. *Higher Education Research & Development*, 37(3), 468-483. https://doi.org/10.1080/07294360.2018.1425979

Booth, A. L. & Satchell, S. E. (1995). The hazards of doing a PhD: An analysis of completion and withdrawal rates of British PhD students in the 1980s. *Journal of the Royal Statistical Society: Series A (Statistics in Society),* 158(2), 297-318. https://doi.org/10.2307/2983293

Churchill, M. P., Lindsay, D., Mendez, D. H., Crowe, M., Emtage, N. & Jones, R. (2021). Does publishing during the doctorate influence completion time? A quantitative study of doctoral candidates in Australia. *International Journal of Doctoral Studies,* 16, 689-713. https://doi.org/10.28945/4875

Clemes, M. D., Gan, C. E. C. & Kao, T.-H. (2008). University student satisfaction: An empirical analysis. *Journal of Marketing for Higher Education*, 17(2), 292-325. https://doi.org/10.1080/08841240801912831

Cloete, N., Bunting, I. & van Schalkwyk, F. (2018). *Research universities in Africa.* Cape Town, South Africa: African Minds. http://www.africanminds.co.za/wp-content/uploads/2018/10/Research-Universities-in-Africa-WEB-25102018-OPT.pdf

Clopper, C. J. & Pearson, E. S. (1934). The use of confidence or fiducial limits illustrated in the case of the binomial. *Biometrika,* 26(4), 404-413. https://doi.org/10.1093/biomet/26.4.404

Cowling, M. (2017). *Happiness in UK postgraduate research: An analysis of results from the postgraduate research experience survey*. Higher Education Academy, UK. https://www.advance-he.ac.uk/knowledge-hub/happiness-uk-post-graduate-research-uk-heis

Department of Education, Skills and Employment (2021). *Research training program*. Department of Education, Skills and Employment. https://www.dese.gov.au/research-block-grants/research-training-program

Devos, C., Boudrenghien, G., Van der Linden, N., Azzi, A., Frenay, M., Galand, B. & Klein, O. (2017). Doctoral students' experiences leading to completion or attrition: A matter of sense, progress and distress. *European Journal of Psychology of Education,* 32(1), 61-77. https://doi.org/10.1007/s10212-016-0290-0

European Science Foundation (2017). *2017 career tracking survey of doctorate holders*. Project Report, ESF. https://www.esf.org/fileadmin/user_upload/esf/F-FINAL-Career_Tracking_Survey_2017__Project_Report.pdf

Geven, K., Skopek, J. & Triventi, M. (2018). How to increase PhD completion rates? An impact evaluation of two reforms in a selective graduate school, 1976-2012. *Research in Higher Education*, 59, 529-552. https://doi.org/10.1007/s11162-017-9481-z

Groenvynck, H., Vandevelde, K. & Van Rossem, R. (2013). The PhD track: Who succeeds, who drops out? *Research Evaluation,* 22(4), 199-209. http://doi.org/10.1093/reseval/rvt010

Hansen, H. F., Aarrevaara, T., Geschwind, L. & Stensaker, B. (2019). Evaluation practices and impact: Overload? In R. Pinheiro, L. Geschwind, H. Foss Hansen & K. Pulkkinen (Eds.), *Reforms, organizational change and performance in higher education: A comparative account from the Nordic countries* (pp. 235-266). Cham: Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-030-11738-2_8

Horta, H., Cattaneo, M. & Meoli, M. (2019). The impact of Ph.D. funding on time to Ph.D. completion. *Research Evaluation*, 28(2), 182-195. https://doi.org/10.1093/rev/rvz002

Kearns, H., Forbes, A., Gardiner, M. & Marshall, K. (2008). When a high distinction isn't good enough: A review of perfectionism and self-handicapping. *Australian Educational Researcher*, 35(3), 21-36. https://eric.ed.gov/?id=EJ837977

Kyvik, S. & Olsen, T. B. (2014). Increasing completion rates in Norwegian doctoral training: Multiple causes for efficiency improvements. *Studies in Higher Education*, 39(9), 1668-1682. https://doi.org/10.1080/03075079.2013.801427

Lott, J. L. II, Gardner, S. & Powers, D. A. (2009). Doctoral student attrition in the STEM fields: An exploratory event history analysis. *Journal of College Student Retention: Research, Theory and Practice*, 11(2), 247-266. https://doi.org/10.2190/CS.11.2.e

McGagh, J., Marsh, H., Western, M., Thomas, P., Hastings, A., Mihailova, M. & Wenham, M. (2016). *Review of Australia's research training system*. Report for the Australian Council of Learned Academies. https://acola.org.au/wp/PDF/SAF13/SAF13%20RTS%20report.pdf

Organisation for Economic Cooperation and Development. (2015). *Frascati Manual 2015: Guidelines for collecting and reporting data on research and experimental development*. OECD. http://doi.org/10.1787/9789264239012-en

Palmer, N. (2016). Degree completion as an indicator of quality. In D. Halliday & G. Clarke (Eds.), *2nd International Conference on Developments in Doctoral Education and Training: Conference Proceedings* (pp. 105-121). Staffordshire, UK: UK Council for Graduate Education. https://www.academia.edu/34579982/Degree_Completion_as_an_Indication_of_Quality

Panayidou, F. & Priest, B. (2021). Enhancing postgraduate researcher wellbeing through support groups. *Studies in Graduate and Postdoctoral Education,* 12(1), 42-57. https://doi.org/10.1108/SGPE-06-2020-0038

Rodwell, J. & Neumann, R. (2008). Predictors of timely doctoral student completions by type of attendance: The utility of a pragmatic approach. *Journal of Higher Education Policy and Management,* 30(1), 65-76. https://doi.org/10.1080/13600800701745069

Shanghai Ranking (2021). *2021 Academic Ranking of World Universities*. http://www.shanghairanking.com/

Skopek, J., Triventi, M. & Blossfeld, H.-P. (2020). How do institutional factors shape PhD completion rates? An analysis of long-term changes in a European doctoral program. *Studies in Higher Education,* online first. https://doi.org/10.1080/03075079.2020.1744125

Spronken-Smith, R., Cameron, C. & Quigg, R. (2018). Factors contributing to high PhD completion rates: A case study in a research-intensive university in New Zealand. *Assessment & Evaluation in Higher Education*, 43(1), 94-109. https://doi.org/10.1080/02602938.2017.1298717

Thune, T., Kyvik, S., Sörlin, S., Olsen, T. B., Vabø, A. & Tømte, C. (2012). *PhD education in a knowledge society: An evaluation of PhD education in Norway*. NIFU-report 2012:25. https://www.nifu.no/publications/951985/

Torka, M. (2020). Change and continuity in Australian doctoral education: PhD completion rates and times (2005-2018). *Australian Universities' Review,* 62(2), 69-82. https://aur.nteu.org.au/wp-content/uploads/2021/08/AUR-62-02.pdf

Van de Schoot, R., Yerkes, M. A., Mouw, J. M. & Sonneveld, H. (2013). What took them so long? Explaining PhD delays among doctoral candidates. *PloS One*, 8(7), e68839. https://doi.org/10.1371/journal.pone.0068839

Visser, M. S., Luwel, M. & Moed, H. F. (2007). The attainment of doctoral degrees at Flemish universities: A survival analysis. *Higher Education*, 54(5), 741-757. https://doi.org/10.1007/s10734-006-9021-9

Wao, H. O. (2010). Time to the doctorate: Multilevel discrete-time hazard analysis. *Educational Assessment, Evaluation and Accountability*, 22(3), 227-247. https://doi.org/10.1007/s11092-010-9099-6

Wao, H. O., Dedrick, R. F. & Ferron, J. M. (2011). Quantitizing text: Using theme frequency and theme intensity to describe factors influencing time-to-doctorate. *Quality and Quantity*, 45(4), 923-934. https://doi.org/10.1007/s11135-010-9404-y

Wao, H. O. & Onwuegbuzie, A. J. (2011). A mixed research investigation of factors related to time to the doctorate in education. *International Journal of Doctoral Studies,* 6(9), 115-134. https://doi.org/10.28945/1505

Wright, T. & Cochrane, R. (2000). Factors influencing successful submission of PhD theses. *Studies in Higher Education*, 25(2), 181-195. https://doi.org/10.1080/713696139

Zhou, E. & Okahana, H. (2019). The role of department supports on doctoral completion and time-to-degree. *Journal of College Student Retention: Research, Theory and Practice*, 20(4), 511-529. https://doi.org/10.1177/1521025116682036

Zhou, E., Mitic, R. R., West, P. L. C. & Okahana, H. (2020). *International graduate applications and enrollment: Fall 2019*. Council of Graduate Schools. https://cgsnet.org/international-graduate-applications-and-enrollment-fall-2019-downloadable-figures-tables [for other years, see https://cgsnet.org/search/apachesolr_search/International%20graduate%20applications%20and%20enrollment]

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