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Gender Differences in Graduate Degree Choices[1]

by

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Abstract

While gender differences in the decision of what to study at undergraduate level are much studied, there is relatively little attention paid to subsequent study decisions of graduates. Given the increased importance of graduate education in recent decades, these decisions can have major labour market implications. In this paper, we use administrative data from Ireland to study these choices. We find systematic and substantial differences by gender in choice of graduate field, even when taking account of the exact undergraduate programme attended and a large set of controls measuring academic interests and aptitudes. Female graduates are less likely to do further study in STEM fields and more likely to enter teaching and health programmes. When we explore the effect of these choices on early career gender gaps in earnings, we find that they tend to exacerbate earnings gaps. Even after accounting for the exact undergraduate programme and detailed school subject choices and grades, there is an 8% gender gap in earnings at age 33 for persons who pursued a graduate degree; the choice of graduate programme can explain about 15% of that gap.

[1] This paper uses Educational Longitudinal Database (ELD) data provided by the Irish Central Statistics Office (CSO). Results are based on analysis of strictly controlled Research Microdata Files. The CSO's role was limited to providing the data and the CSO does not take any responsibility for the views expressed or the outputs generated from this research. We are grateful to Brian Stanley and Kieran Culhane for helpful discussions in relation to the ELD data.

1. Introduction

Much research has shown that men and women make very different college major choices at undergraduate level with women being heavily underrepresented in science, technology, engineering, and mathematics (STEM) majors. Given the greater salaries associated with many occupations that flow from male-dominated college majors, these significant gender gaps in college field choice are considered to be an important contributor to lower average female earnings in the labour market (Card and Payne, 2020). However, despite the increasing importance of graduate degrees such as taught masters, particularly in Europe, there has been little research on how gender relates to the choices made at this point in the education trajectory. In this paper, we use Irish administrative data that contain rich information about college graduates to examine gender differences in graduate degree choices. Further, we use information on post-college earnings to evaluate the extent to which these decisions influence gender gaps in earnings for college graduates.

In addition to estimating the gender gaps in choices at graduate level, we use a Gelbach decomposition (Gelbach, 2016) to evaluate three broad explanations for the gaps. The first, and most likely, is that the undergraduate (UG) field choices and performance differ markedly by gender and that these predict subsequent gender differences in graduate (henceforth, PG) choices. Our data are well suited to this inquiry as we know the exact undergraduate programme and educational institution that the student graduated from. The second possibility is that, even conditional on UG experiences, there are systematic gender differences in interests and aptitudes across differing subjects and fields. We use detailed information on the subject choices made in high school and the grades received in these subjects to evaluate this possibility. We have grades for each of the 7 or 8 subjects taken in the end of high school Leaving Certificate examinations. These high-stakes exams are centrally set and graded and so are comparable across all students and provide a detailed description of academic readiness at

the end of secondary schooling. While mathematics, English, and Irish are compulsory subjects for Leaving Certificate, students tend to choose 4 or 5 optional subjects, providing valuable information about their interests and aptitudes. A third, albeit unlikely, possibility is that there are gender gaps in demographic variables such as socio-economic-status (SES) characteristics or the types of schools attended. We also allow these differences to relate to PG choices.

There is a small but growing literature studying the decision to pursue graduate studies. Bedard and Herman (2008), Johnson (2013), and Ulvestad and Skjelbred (2023) examine how the business cycle affects graduate school enrolment. In addition, Altonji et al. (2016) provide an excellent survey of the determinants of field choice in college and graduate school. Several papers have looked at the returns to studying a graduate degree by gender but, to the best of our knowledge, none have focused exclusively on gender differences in the field of study at graduate level.[2] This is despite the fact that a large amount of research has focused on gender differences in college major choice at undergraduate level.[3] There is also a set of papers that study gender differences in STEM persistence during the undergraduate period and into the labour market (for example, Hunt, 2016; Jiang, 2021; Speer, 2023; Delaney and Devereux, 2022). However, despite the increasing importance of graduate education, there is little work done on gender differences at this stage.[4] One exception is Bertocchi et al. (2023) who use administrative data from Italy to study gender differences in whether college completers choose economics for a master's degree and find that women are underrepresented in economics

[2] There are several papers estimating the returns to postgraduate education: Arcidiacono et al. (2008) study the returns to MBAs in the US, Altonji et al. (2022), Altonji and Zhong (2020) and Altonji and Zhu (2021) study the returns to graduate degrees in the US while Britton et al. (2020), Lindley and Machin (2016), and Walker and Zhu (2011) study the returns to graduate degrees in the UK. Waite (2017) looks at the effect of graduate study on the gender wage gap in Canada and finds that the gap is smaller for those with master's degrees compared to UG or PhD degrees.

[3] See, for example, Card and Payne (2020), Speer (2017), Delaney and Devereux (2019), and Bordon et al. (2020). Kahn and Ginther (2018), McNally (2020), Cavaglia et al. (2020), and Delaney and Devereux (2021) provide reviews of this literature.

[4] Delaney and Devereux (2022) study gender differences in whether STEM degree holders choose to subsequently do a masters in a STEM subject using UK data from the Labour Force Survey. However, they lack detailed information about academic achievement in school and about the undergraduate programme undertaken.

masters. Our study is more broadly focussed, and our data have advantages over theirs in that we observe college degree class and have much richer measures of achievement across a range of subjects in high school.

We find that, even after accounting for undergraduate programme fixed effects and very detailed controls for pre-college academic interests and achievements, there are systematic and substantial differences by gender in the choice of graduate study. Female graduates are less likely to do further study in STEM fields and more likely to enter teaching and health programmes. They are also slightly less likely than males to do a master's or PhD graduate degree (rather than a certificate or diploma) and to study in a university rather than an institute of technology. Gender gaps are generally larger for STEM graduates. Finally, we find that gender differences in choice of field of study at PG level have meaningful effects on the gender gap in early career earnings. Even after accounting for the exact undergraduate programme and detailed school subject choices and grades, there is an 8% gender gap in earnings at age 33 for persons who pursued a graduate degree; the choice of graduate programme can explain about 15% of that gap.

2. Data and Institutional Background

We use the Educational Longitudinal Database (ELD) created by the Irish Central Statistics Office (CSO). It provides data on all students who were enrolled in an Irish third level institution between the 2009/10 academic year and the 2021/22 academic year. Given college degrees in Ireland typically last 3 or 4 years, this implies that we have information on most students who began an undergraduate degree programme between 2007 and 2021. The data also include all college completions (whether at undergraduate or graduate level) that occur between 2010 and 2021. Matching based on a Protected Identifier Key of PPS number (the equivalent of a U.S. Social Security number), the ELD links administrative information on high

school outcomes (from 2006 to 2018), college characteristics and outcomes, and subsequent labour market data (up to 2022). The information on higher education comes from Higher Education Authority (HEA) administrative data and largely comes directly from the third-level institutions in annual transfers of information to the HEA. Earnings and employment data are from the Irish tax authorities (known as the Revenue Commissioners). Secondary school information is provided by the Department of Education through its Post-Primary Online Database (PPOD) and high school subject choices, and grades are provided by the State Examinations Commission (SEC) who organise the centralised set of high school exams known as the Leaving Certificate examinations. Finally, information on whether a student receives a need-based grant comes from the body that allocates these grants (Student Universal Support Ireland (SUSI)).

This dataset has several nice characteristics. Because the earnings data come from tax records and misreporting is treated as a serious crime, earnings are likely to be measured very accurately. Likewise, because we have administrative data from the SEC and HEA, we do not need to rely on self-reports of Leaving Certificate grades or class of college degree received. Additionally, as the administrative match was carried out using anonymised PPS numbers, matching accuracy across the various component datasets is likely to be very high. Due to CSO restrictions relating to data necessity and proportionality, we have a large random sample from the dataset, rather than the full population of students.

Because our focus is on graduate (PG) study, we restrict our analysis sample to individuals who have completed a National Framework of Qualifications (NFQ) Level 8 programme and received an undergraduate honours degree. We include graduates from all third level institutions who finish their undergraduate programme by age 25.[5] A small proportion of

[5] There are around 30 Higher Education Institutions (HEIs) in Ireland. There are 7 institutions that have been universities throughout our study period, and which are generally considered to be the most prestigious institutions. There are also more specialised colleges that offer education for teaching or medical degrees and

sample individuals complete two UG programmes; in these cases, we treat the second graduation as being their relevant UG completion. Some people do multiple PG programmes; in considering PG choices, we focus on the first one attempted unless there is a subsequent PG programme that is at a higher NFQ level which then becomes the PG programme that we study.[6] We drop cases where we do not have information on Leaving Certificate performance, or we do not know the secondary school attended. In doing so, we effectively restrict our sample to students who went to school in Ireland before proceeding to do an Irish undergraduate degree. For each person, we calculate their Leaving Certificate points based on performance in their best 6 Leaving Certificate subjects. In the centralised college application system in Ireland, these points determine what college programmes students qualify to attend. We delete a small number of observations with fewer than 100 points as they most likely represent measurement error.

There are multiple types of PG programme available to students on completing an UG degree. These include non-degree options such as postgraduate certificates, postgraduate diplomas, higher diplomas, and postgraduate occasional study. The more common PG programmes are degree programmes such as taught masters, research masters, and PhDs. We create a binary indicator to distinguish between these two broad types of PG programmes. Programmes are considered to be "higher level" if they are a taught masters, research masters, or a PhD. If instead the type of PG is a certificate, a professional training qualification, or a diploma, we label it as "lower level". We include all full-time PG programmes in our analysis; we show in a robustness check that our results are similar if we omit "lower level" PG programmes.

technological universities (formerly called Institutes of Technology) which tend to be more focussed on STEM and business degrees.

[6] In practice, multiple PGs are rare and the exact rule we use to choose the relevant programme for each person has no meaningful effect on our findings.

The duration of PG programmes varies by the type. Non-degree options such as PG certificates and diplomas typically last at most 1-year.[7] Taught master's degrees usually last 1 year while research master's degrees can last up to 2 years.[8] On the other hand, PhD degrees generally last between 3 to 5 years.[9]

Descriptive Statistics

We begin by showing some descriptive statistics for our sample. Table 1 shows means for our full sample of UG completers (column 1) and then by level of education (UG only, any PG, lower level PG, master's degree, and PhD). Amongst college graduates, about 22% do some type of full-time PG programme with 21% doing one within 3 years of finishing an undergraduate degree. Fifty-seven percent of the sample are female and the average age at graduation from an undergraduate degree is 22.5. About 4% had a disability that required reasonable accommodation in at least one Leaving Certificate exam.[10] In terms of SES, about 20% qualified for a medical card fee waiver for the Leaving Certificate (usually due to low family income), 39% qualified for a means-tested grant during undergraduate study (based on family income and family size), and about 10% attended a DEIS school (a school primarily attended by students from disadvantaged backgrounds).[11] Comparing columns (1) and (3), we

[7] The PG certificates are usually very specialised. Diplomas can be taken by students embarking on a new area of study and can be used as a conversion course for students to later proceed to a masters in that subject area. There typically is no thesis component and they rely on coursework with assessment through examinations.
[8] Up until September 2014, students wishing to pursue a career in secondary school teaching had to undertake a higher diploma. However, since 2014, students wishing to enter the teaching profession must either do a specialised undergraduate degree that lasts 4 years or study a 2-year master's degree called a Professional Master of Education. Therefore, our data for prospective teachers will include both diplomas and master's degrees.
[9] While the government pays the tuition fees of undergraduate Irish students, since 2009/10 students have had to pay a student contribution fee each year to cover examination and other administration costs and to support student services. This fee was €1,500 in 2009/10 but in 2021/22 stood at €3,000 per year. Postgraduate degrees have higher fees ranging from around €3,000 up to €30,000 per year. There is a grant available for lower SES students to cover fees at UG and PG level and for some PG programmes the university will provide funding and external funding bodies can also provide scholarships.
[10] We create a measure of disability using a flag that indicates whether a candidate had a reasonable accommodation in any of their Leaving Certificate exam subjects.
[11] Many schools that attract students from relatively deprived backgrounds have been designated as "DEIS" schools and these receive extra supports from the State (somewhat lower pupil-teacher ratios and extra State funding for other purposes).

can see that enrolees in PG programmes are similar to the full sample of undergraduates in terms of gender composition and disability. A somewhat lower proportion received a medical card fee waiver for Leaving Certificate or went to a DEIS school, but the differences are not large. PG enrolees also have higher average Leaving Certificate points and a higher likelihood of having received a first class or upper second-class honours undergraduate degree.

Table 1: Means by Level of Education

	All	**UG only**	**PG**	**Lower Level PG**	**Masters**	**PhD**
	(1)	(2)	(3)	(4)	(5)	(6)
Age Finished UG Degree	22.50	22.58	22.25	22.23	22.24	22.39
Total Leaving Certificate Points	425.2	420.5	441.8	424.4	438.7	495.4
Disabled	0.041	0.042	0.037	0.035	0.038	0.026
Year Finished UG Degree	2016	2016	2016	2014	2016	2015
Upper Second or First Class Degree	0.649	0.628	0.721	0.600	0.719	0.913
First Class Degree	0.173	0.165	0.198	0.123	0.176	0.515
Female	0.565	0.567	0.558	0.645	0.549	0.518
Grant for UG Degree	0.394	0.399	0.376	0.413	0.373	0.357
Leaving Certificate Fee Waiver	0.201	0.207	0.178	0.178	0.181	0.156
Some PG Degree	0.223	0	1	1	1	1
STEM UG Degree	0.242	0.246	0.229	0.155	0.200	0.599
Economics/Business UG Degree	0.235	0.240	0.217	0.149	0.247	0.035
Fee-paying Secondary School	0.120	0.115	0.137	0.104	0.143	0.127
DEIS Secondary School	0.096	0.100	0.082	0.086	0.082	0.076
Grind Secondary School	0.032	0.030	0.038	0.037	0.039	0.033
Irish Language Secondary School	0.062	0.059	0.070	0.066	0.070	0.070
Mixed-sex Secondary School	0.529	0.533	0.512	0.543	0.507	0.515
PG within 3 Years of Finishing UG	0.205	0	0.872	0.755	0.892	0.882
UG in University	0.624	0.570	0.811	0.774	0.807	0.905
UG in Institute of Technology	0.318	0.368	0.145	0.158	0.151	0.072
UG in Other HEI	0.058	0.062	0.044	0.068	0.043	0.024
N	150,279	116,745	33,534	4,072	26,610	2,852

Note: The table shows the mean outcomes for each variable. The sample includes students who were enrolled in an Irish third level institution between the 2009/10 academic year and the 2021/22 academic year.

Table 2 provides descriptives for an extended range of variables for the sample of PG enrolees. It also shows the means broken down by field of PG study. Amongst PG enrolees, the vast majority (88%) do a degree programme, either a master's or PhD, with about 22% of PG enrolees being in STEM and 31% being in economics/business.

Table 2: Means by PG Field

	PG Degree	STEM	Economics /Business	Teaching	Health	Other Field
Year Enrolled in PG Degree	2016	2016	2016	2017	2017	2016
Grant for PG Degree	0.190	0.155	0.184	0.233	0.120	0.251
Age at UG Graduation	22.25	22.44	22.18	22.04	22.58	22.13
Total Leaving Certificate Points	441.8	458.3	433.8	426.4	461.5	435.3
Disabled	0.037	0.037	0.041	0.028	0.039	0.035
Year Finished UG Degree	2016	2016	2016	2016	2015	2015
Upper Second or First Class Degree	0.721	0.725	0.706	0.679	0.725	0.767
First Class Degree	0.198	0.282	0.162	0.124	0.237	0.196
Female	0.558	0.380	0.482	0.721	0.782	0.603
Grant for UG Degree	0.376	0.370	0.315	0.428	0.399	0.423
Leaving Certificate Fee Waiver	0.178	0.171	0.148	0.214	0.182	0.204
Master's or PhD Programme	0.879	0.897	0.902	0.784	0.797	0.946
STEM PG Programme	0.218	1	0	0	0	0
Economics/Business PG	0.305	0	1	0	0	0
Teaching PG Programme	0.152	0	0	1	0	0
Health PG Programme	0.126	0	0	0	1	0
Other PG Programme	0.200	0	0	0	0	1
STEM UG Programme	0.229	0.724	0.078	0.078	0.207	0.047
Economics/Business UG	0.217	0.074	0.581	0.073	0.013	0.058
Fee-paying Secondary School	0.137	0.129	0.204	0.053	0.107	0.125
DEIS Secondary School	0.082	0.083	0.070	0.105	0.075	0.087
Grind Secondary School	0.038	0.036	0.048	0.020	0.050	0.034
Irish Language Secondary School	0.070	0.066	0.056	0.097	0.064	0.077
Mixed-sex Secondary School	0.512	0.539	0.461	0.579	0.484	0.528
Age Started PG Programme	23.05	23.09	22.69	22.88	24.34	22.88
PG within 3 years of Finishing UG	0.872	0.905	0.923	0.875	0.680	0.885
Median 2022 Earnings for PG Field	61,863	68,707	68,607	56,620	58,747	50,063
Mean 2022 Earnings for PG Field	67,593	75,283	77,954	55,447	63,288	55,334
UG in University	0.811	0.838	0.824	0.722	0.796	0.837
UG in Institute of Technology	0.145	0.157	0.168	0.098	0.175	0.115
UG in Other HEI	0.044	0.005	0.008	0.180	0.029	0.048
PG in University	0.877	0.917	0.863	0.804	0.898	0.897
PG in Institute of Technology	0.076	0.079	0.137	0.006	0.020	0.070
PG in Other HEI	0.047	0.004	0.000	0.190	0.081	0.033
N	33,534	7,297	10,230	5,084	4,216	6,707

Note: The table shows the mean outcomes for each variable. The sample includes students who were enrolled in an Irish third level institution between the 2009/10 academic year and the 2021/22 academic year. Mean and median earnings by graduate field are calculated using earnings in 2022 of persons who finished PG programmes between 2010 and 2013.

In Table 3, we focus on persons who do a PG programme and show descriptive statistics by gender. There are large gender gaps in the proportion taking STEM and economics/business at both UG and PG level.

Table 3: Means by Gender for PG Students

	Female	**Male**
Year Enrolled in PG	2017	2016
Grant for PG	0.203	0.174
Age at UG Graduation	22.21	22.32
Total Leaving Certificate Points	444.6	438.2
Disabled	0.033	0.041
Year Finished UG	2016	2016
Upper Second or First Class Honours Degree	0.745	0.689
First Class Honours degree	0.204	0.191
Grant for UG	0.399	0.347
Leaving Certificate Fee Waiver	0.192	0.162
Master's or PhD Programme	0.860	0.902
STEM PG Programme	0.148	0.305
Economics/Business PG Programme	0.264	0.357
Teaching PG Programme	0.196	0.096
Health PG Programme	0.176	0.062
Other PG Programme	0.216	0.179
STEM UG Programme	0.169	0.303
Economics/Business UG Programme	0.176	0.270
Fee-paying Secondary School	0.109	0.172
DEIS Secondary School	0.076	0.090
Grind Secondary School	0.040	0.036
Irish Language Secondary School	0.067	0.074
Mixed-sex Secondary School	0.480	0.553
Age Started PG Programme	23.10	22.98
PG within 3 Years of Finishing UG	0.852	0.898
Median 2022 Earnings for PG Field	60,531	63,545
Mean 2022 Earnings for PG Field	65,698	69,985
UG in University	0.803	0.821
UG in Institute of Technology	0.137	0.156
UG in Other HEI	0.061	0.023
PG in University	0.867	0.889
PG in Institute of Technology	0.069	0.085
PG in Other HEI	0.063	0.026
N	18,712	14,882

Note: The table shows the mean outcomes for each variable. The sample includes students who were enrolled in an Irish third level institution between the 2009/10 academic year and the 2021/22 academic year. Mean and median earnings by graduate field are calculated using earnings in 2022 of persons who finished PG programmes between 2010 and 2013.

3. Empirical Strategy

First, we analyse whether UG completers choose to do some form of PG study within three years of finishing UG. Then, using the subset of students who enrol in a PG programme, we study what type of programme they choose. The main specification has the form:

$$y = \beta_0 + \beta_1 Female + \delta' X + u \quad (1)$$

where *y* denotes our outcome variable of interest, *Female* is a binary variable denoting female and *X* includes a set of control variables. We first show estimates for female controlling only for indicators for year finished UG and age at UG completion. The coefficient on female from this specification provides something close to the raw gender gap in the outcome variable being studied. We then show estimates using a rich set of covariates that capture differences in UG choices and performance, Leaving Certificate subject choices and performance, and demographic and school characteristics. This set of controls includes UG programme indicators to exploit the fact that we know the exact programme that the student studied at undergraduate level. Programmes are college-specific and tend to be defined quite narrowly – in our sample we have 3,013 undergraduate programmes with an average of 47 students per programme. So, they constitute a fairly precise measure of the type of undergraduate course that the student completed.[12] We include indicators for the college performance as measured by degree class (whether received first class honours and whether received second class honours upper division). We also add information about Leaving Certificate subjects and achievement (indicator variables for subjects taken for Leaving Certificate, a linear function of points achieved in each individual Leaving Certificate subject, and a quadratic function of total Leaving Certificate points) as well as a set of individual and school characteristics.[13] These

[12] We get similar results if we use programme-by-completion-year indicators.

[13] The individual characteristics included as controls are the county of their permanent address when they started UG, an indicator for whether they had a disability in school, an indicator for whether they had a Medical Card that qualified them for a Leaving Certificate fee waiver, and an indicator for whether they received a means-tested

variables are proxies for interests and aptitudes as revealed by choices of subjects and grades in high school.[14] We report robust standard errors for all regressions.

Whether do a PG Programme

Most students who enrol in a PG programme do so within 3 years of finishing an UG programme (84% of persons who completed UG in 2012 and started a PG by 2021, had done so by 2014). Therefore, when estimating the relationship between gender and doing a PG programme, we define doing a PG programme as starting such a programme within 3 years of finishing UG. As the last year of data on enrolment into a PG programme is for the 2021/22 academic year, we restrict the sample to persons who graduated UG by 2019 when studying this variable.[15]

Type of PG Programme

First, we examine the field of study of the PG programme – whether it is in STEM, whether it is economics/business, teaching, health, or whether it is in some other field. Some fields lead to higher-paying jobs than others and we measure the likely labour market returns to the field using information on earnings in 2022 of persons who finished PG programmes between 2010 and 2013. We predict likely earnings from a field as the mean (or median) earnings in 2022 for persons who completed a PG programme between 2010 and 2013 in that

grant for UG study. The secondary school characteristics include whether it is an Irish language school, whether the school charges fees, whether it is a DEIS school, whether it is a "grind" school, and whether it is a mixed-sex school. "Grind" schools are private fee-paying schools that place strong emphasis on maximising the achievement of their students in the Leaving Certificate. They differ from fee-paying secondary schools in that they receive no government support, place little emphasis on extra-curriculars, and tend to enrol only those in the final 2 years of high school (5th and 6th year students) as well as one-year repeat Leaving Certificate students.

[14] In practice, because some Leaving Certificate subjects are taken by small numbers of students, we include indicator variables for choosing 23 of the most popular subjects and for the points earned in those 23 subjects. These subjects are mathematics, Irish, English, history, geography, physics, chemistry, biology, agricultural science, applied mathematics, French, Spanish, German, economics, accounting, business, art, music, home economics, design and communication graphics, engineering, building construction, and technical graphics.

[15] Otherwise, we would face the issue that students who graduated UG in 2021 may indeed do a PG within 3 years but we would not observe it in our data if it started after 2021.

field of study (for this purpose, there are 10 fields of study measured at the 1-digit ISCED level).[16] These variables are created by the CSO using the full population rather than the large random sample we use in the analysis.[17]

We also choose dependent variables to capture two additional dimensions of the PG course choices. First, we study whether it is a master's/PhD programme rather than some other type of PG programme that awards a certificate or diploma rather than a degree. Second, we study whether the programme is in a university rather than in a private independent college or institute of technology.

Gelbach Decomposition

The effect on the female coefficient of adding covariates depends on the order in which they are added. Gelbach (2016) proposes a decomposition that provides an order-invariant accounting of the effect of each set of control variables on the female coefficient. We implement this decomposition to determine the relative roles of (1) undergraduate programme and performance, (2) Leaving Certificate subject choices and grades, and (3) demographic and school characteristics in explaining the changes in the female coefficient due to the introduction of control variables.

[16] While, ideally, we would measure average earnings at the programme-level, this is infeasible both because of small numbers taking many programmes and because PG programmes sometimes change over time so there is no accurate method of mapping many earlier programmes with later ones.

[17] A very small proportion of college graduates become self-employed (1%). Our 2021 income measure includes earnings from self-employment, but our 2022 measure does not. We have verified that estimates using 2021 earnings data are robust to including or excluding self-employed income. We prefer to use 2022 data as sample members are older in 2022 and there is little Covid effect on incomes. In any case, none of our conclusions are meaningfully affected if we use 2021 data rather than 2022.

4. Results

In this section, we focus on the estimates for gender differences in doing a PG programme and differences in the characteristics of the PG programmes chosen. We examine gender differences in the field of study and look at the earnings potential of different fields by studying the realised mean and median earnings of previous graduates from that field of study. We also study the quality of the PG programme by analysing whether it is a higher level programme such as master's or PhD and whether it is provided by a university or not.

A. Gender Differences in Choosing to do a PG Programme

In the columns of Table 4, the dependent variable equals 1 if a graduate entered a PG programme within 3 years of finishing UG and 0 otherwise. Column (1) has estimates for the full sample of undergraduate completers. The coefficient on female is -0.03 without detailed controls and changes little when detailed controls are added (it is statistically significant in both cases). So, men are 3.5 percentage points more likely to do a PG than women, and this gender difference is not explained by choice of UG programme, or by prior academic choices and grades.[18] As shown in Table 1, about 20.5% of students enter a PG programme within 3 years of completing their UG degree and so this means that females are 17% less likely to do a PG degree than similar males. Given the increased focus on PG degrees as being a requisite for entering high paying occupations, this difference may have substantial implications for the gender gap in earnings. We explore this later in the paper.

Decisions on graduate study may vary based on the undergraduate field of study so, in columns (2) and (3) respectively, we show the estimates for persons who finished their undergraduate studies with a degree in STEM (we can consider this a group who are "STEM-

[18] We get similar findings if we simply use all available observations and study whether a person starts a PG programme at any point in our sample period.

ready" for PG) and also for those with an undergraduate degree in economics/business. While female STEM graduates are 5 percentage points more likely to enter a PG programme, this reflects the type of programme they chose within the STEM UG degree. Once we include detailed controls, the coefficient on female becomes negative and is -3.9 percentage points. Around 23% of STEM UG degree holders do a PG degree and so this means that female STEM UG degree holders are around 17% less likely to do a PG degree compared to their observationally equivalent male counterparts. So, it suggests that the gender gap in earnings for those with a STEM UG degree may be partly explained by the higher likelihood that males do a PG degree. For graduates of business or economics, the female coefficient is minus 5 percentage points and this barely changes with the addition of the detailed controls. So, unlike for STEM, the greater tendency for males with an economics/business UG degree to do a PG is not driven by the UG programme or other pre-UG characteristics. Given that only 22% of this group do a PG, this translates into male economics/business UG degree holders being over 20% more likely to do a PG degree compared to their female counterparts.

We also show estimates (column (4)) for a group who are more likely to do graduate study – first class honours graduates (26% of this group do a PG). Here the gender differences are smaller at about 2 percentage points when the full set of controls are included, suggesting that gender becomes less important when students are well prepared for graduate study.[19]

Not everybody who starts a graduate programme finishes – in our data we see 81% of starters finishing within 5 years (82% for females and 80% for males). Therefore, we now show that our estimates are robust to studying PG completion rather than enrolment. The estimates are in the last column of Table 4 and are quite similar to those for PG enrolment in column

[19] As an alternative measure of being academically able, we examined the group who achieved an H1 or H2 in Leaving Certificate mathematics (the top two possible grades). We do not report the estimates as they are quite similar to those who obtained first class honours at undergraduate level.

(1).[20] We prefer to study enrolment rather than completion for a few reasons. First, enrolment may be a better measure of the desired PG choice than completion. Second, enrolment enables a larger and potentially more representative sample as we can observe it up until the 2021/22 academic year; we only observe completions that occur by 2021 so miss out on many PG spells. Therefore, we will continue to focus on PG enrolment rather than completion in the rest of the paper. However, we will show estimates using PG completers to show that our estimates are robust to this choice.

Table 4: Gender Differences in the Probability do a PG within 3 Years of Finishing UG

	(1)	(2)	(3)	(4)	(5)
Specification	All UG Completers	STEM UG	Economics/ Business UG	First Class Honours UG	Whether Finish PG
Basic controls	-0.029***	0.046***	-0.048***	0.000	-0.033***
	(0.002)	(0.005)	(0.005)	(0.006)	(0.002)
Full controls	-0.035***	-0.039***	-0.046***	-0.020**	-0.028***
	(0.003)	(0.007)	(0.006)	(0.008)	(0.003)
Observations	118,676	28,564	27,422	17,955	103,979

Note: Robust standard errors in parentheses. *** p<0.01; ** p<0.05; * p<0.10. Basic controls include indicators for age and year when finishing the UG degree. Full controls include fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. We restrict the sample to persons who graduated UG by 2019. The coefficient reported is that on an indicator for female.

B. Gender Differences in Field Choices

In Table 5, the sample is restricted to students who enter a PG programme at any point after finishing their UG degree. With minimal controls, the gender gap in STEM is 15 percentage points. However, this falls to 4.6 percentage points once all the controls are included. Clearly, most of the gender gap in STEM at PG level can be accounted for by choices of UG programme and by subject choices and performance in the Leaving Certificate.

[20] The sample sizes differ in columns (1) and (5) because in column (1) we include all undergraduates who finish by 2019 while, in column (5) we require that the student finish UG by 2018. This difference is to allow for the fact that the PG will take at least one year to complete.

However, the remaining 5 percentage point gap is not insubstantial given that it remains after taking account of the exact programme studied in UG and the large number of controls for Leaving Certificate subject choices and grades. Moreover, given that 22 percent of PG entrants choose a STEM field, this translates to females being about 20 percent less likely to enrol in a STEM PG degree than observationally equivalent males.

Table 5: Relationship between Gender and PG Field

Specification	(1) STEM	(2) Economics /Business	(3) Teaching	(4) Health	(5) Other Field	(6) Log (Median Pay)	(7) Log (Mean Pay)	(8) Higher Level PG	(9) University PG Degree
Basic controls	-0.153***	-0.097***	0.096***	0.119***	0.035***	-0.046***	-0.062***	-0.045***	-0.024***
	(0.005)	(0.005)	(0.004)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.004)
Full controls	-0.046***	-0.012**	0.050***	0.024***	-0.016***	-0.004**	-0.010***	-0.012***	-0.008*
	(0.004)	(0.005)	(0.004)	(0.003)	(0.005)	(0.002)	(0.002)	(0.004)	(0.004)
Gelbach Decomposition									
UG programme	-0.089	-0.073	0.033	0.089	0.040	-0.037	-0.044	-0.034	-0.008
Leaving Certificate subjects/grades	-0.018	-0.009	0.013	0.006	0.008	-0.006	-0.008	-0.0005	-0.009
Demographics	-0.001	0.0001	-0.001	0.0002	0.001	-0.0003	-0.0002	0.001	0.0007
Observations	33,534	33,534	33,534	33,534	33,534	33,534	33,534	33,534	33,534

Note: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Basic controls include indicators for age and year when finishing the UG degree. Full controls include fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. The sample is restricted to students who enter a graduate (PG) programme. Mean and median earnings by graduate field are calculated using earnings in 2022 of persons who finished PG programmes between 2010 and 2013. The coefficient reported is that on an indicator for female.

Table 6: Relationship between Gender and PG Field of Completion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Specification	STEM	Economics /Business	Teaching	Health	Other Field	Log (Median Pay)	Log (Mean Pay)	Higher Level PG	University PG Degree
Basic controls	-0.164***	-0.099***	0.113***	0.107***	0.043***	-0.054***	-0.071***	-0.049***	-0.013***
	(0.005)	(0.006)	(0.004)	(0.004)	(0.005)	(0.002)	(0.002)	(0.004)	(0.005)
Full controls	-0.047***	-0.013**	0.058***	0.021***	-0.019***	-0.004**	-0.010***	-0.005	0.001
	(0.005)	(0.006)	(0.005)	(0.004)	(0.006)	(0.002)	(0.002)	(0.005)	(0.005)
Gelbach Decomposition									
UG programme	-0.100	-0.073	0.042	0.079	0.051	-0.043	-0.051	-0.039	-0.002
Leaving Certificate subjects/grades	-0.019	-0.010	0.013	0.006	0.010	-0.007	-0.009	-0.005	-0.012
Demographics	0.000	-0.001	-0.001	0.000	0.001	-0.0003	-0.0001	0.001	-0.001
Observations	25,170	25,170	25,170	25,170	25,170	25,170	25,170	25,170	25,170

Note: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Basic controls include indicators for age and year when finishing the UG degree. Full controls include fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. The sample is restricted to students who completed a PG programme. Mean and median earnings by graduate field are calculated using earnings in 2022 of persons who finished PG programmes between 2010 and 2013. The coefficient reported is that on an indicator for female.

When we examine whether the PG is in economics/business, the female coefficient moves from -10 percentage points to only -1 percentage point as more controls are added. So, gender gaps at PG level are smaller in economics/business than in STEM and can be almost entirely accounted for by observable differences between the genders at the point of completing an UG degree.

Female graduates are more likely to do a PG in teaching, with the gap being 10 percentage points without detailed controls and 5 percentage points with the controls. This is quite a large effect given that only about 15% of the sample enter teaching PG programmes. The finding implies that, conditional on detailed controls for high school and UG outcomes and characteristics, females are 33 percent more likely to enter teaching PG programmes than males.

Similarly, females are more likely to enter health PG programmes with the raw gap being 12 percentage points but this falls to just 2 percentage points once detailed controls are added. However, given that health programmes make up just 12.6% of all PG programmes, this implies that females are 19% more likely to enter such programmes.

Another way to evaluate the field of PG programme is based on the typical earnings of graduates of that field. As described above, we use a measure of the mean (or median) earnings for graduates by 1-digit ISCED field of study. We show estimates for the log of mean and median earnings in 2022 calculated using the population of students who completed a PG degree between 2010 and 2013.[21] These provide a sense of whether students are choosing fields of study that lead to high labour market earnings. The findings are consistent whether we study the log mean or the log median – women choose PG fields that have expected earnings that pay about 5-6% less than those chosen by men. However, this gender disparity becomes smaller, around 1%, when we control for UG programme fixed effects and Leaving Certificate choices

[21] These population statistics were provided to us by the CSO.

and performance. Given their situation after finishing UG, there is relatively little systematic difference by gender in how high paying are the chosen PG fields.[22]

Table 5 also reports findings from the Gelbach decomposition for the dependent variables describing the type of PG programme chosen. The results suggest that the reduction in the female coefficient across the two specifications is mostly due to the UG programme fixed effects and UG degree class.[23] Given the UG programme graduated from, other information about the students such as their subject choices and grades for Leaving Certificate have little effect on the female coefficient, and the demographic characteristics have essentially no effect. Our interpretation is that the gender gap in PG fields (other than for teaching and STEM where there remains a relatively sizeable unexplained gender gap of 5 percentage points) is largely explained by observable characteristics at UG graduation and that, of these, by far the most important observable is the UG programme chosen. The finding that high school subject and grades, which likely reflect preferences and aptitudes, do not explain much of the gap is likely due to the fact that they are a strong determinant of UG field of study (see Delaney and Devereux (2019) and Speer (2017)) and so there remains little effect of these variables on subsequent choices once we control for UG programme field of study.

Gender Differences in Other PG Programme Characteristics

When we study other characteristics of the PG programme chosen (also in Table 5), we see that women are less likely to choose a "higher level" PG – one which is a master's programme or PhD programme rather than a PG certificate or diploma. Once again, the gender

[22] The average earnings by field are calculated by the CSO using all graduates from PG programmes between 2010 and 2013. Because our sample includes students who finish UG from 2010 onwards, the 2022 earnings of some of our sample members was used by the CSO in calculating the average earnings by field. Therefore, as a robustness check, we have rerun our estimates using students who finished UG from 2013 onwards and so whose earnings cannot have been used in calculating average field earnings. The estimates are very similar when this restricted sample is used in the estimation.

[23] In fact, the undergraduate degree class is quite unimportant here and all that really matters are the undergraduate programme fixed effects.

difference falls as additional controls are added (from 5 percentage points to 1 percentage point) so that the gender difference is almost entirely explained by observables. Similarly, when the dependent variable is an indicator for doing the PG degree in a university rather than in another type of institution, the coefficient on female is negative but becomes close to zero once the controls are added.

Studying PG Completion

In Table 6, we show estimates where, instead of studying characteristics of the PG programmes started, we instead study characteristics of completed PG programmes. It is quite likely that PG completion rather than entry has the largest effect on the labour market and if there are systematic differences in completion rates by field of study and/or by gender this could lead to a different conclusion. However, the estimates in Table 6 are similar to those in Table 5 suggesting that whether we study PG programme entry or PG completion has little impact on our findings.

C. Heterogeneous Effects

We are particularly interested in whether women are more likely to move away from STEM between UG and PG (the "leaky pipeline"). Therefore, we also carry out the above analysis on the group of students who did an UG degree in STEM. Furthermore, given recent interest in gender differences in persistence in economics, we also examine the PG choices of undergraduates who complete a degree in economics or business.[24] Finally, given that estimates may differ for high achievers, we report estimates for students who attained first class honours at undergraduate level.

[24] Business degrees at undergraduate level are common in Ireland and the number doing UG degrees in business is much larger than those doing degrees in economics.

Gender Differences for Students with an UG Degree in STEM

In Table 7A, we show the same set of outcome variables for students who completed a STEM UG degree – we can consider this a group who are "STEM-ready" for PG. As before, we restrict the sample to persons who enter a PG programme. As in the full sample of people who start a PG programme, there is a gender gap in the proportion who choose STEM which falls from 13 percentage points with basic controls to a not inconsiderable 8 percentage points with all controls. Almost 70% of STEM undergraduates who pursue a PG degree do so in STEM and so a gender gap of 8 percentage points for this "STEM-ready" group translates to female STEM undergraduate degree completers being over 10% less likely to do their PG degree in STEM compared to their male counterparts. Therefore, even for the sample of graduates who have shown an aptitude and preference in STEM subjects, there is still a large gender gap in choosing STEM for PG study. STEM-ready females appear to be more likely to switch to teaching and health fields at the graduate level. At about 3 percentage points, these are relatively large percentage effects as only 5% (11%) of STEM graduates who start a PG programme do so in teaching (health). Interestingly, once we account for controls, there does not appear to be any gender gap in switching to economics/business at PG level for this STEM-ready sample. In terms of expected earnings, we find slightly higher effects for this "STEM-ready" sample which are around 2% when we use the full set of controls. Given that we are looking at a relatively homogeneous group of graduates that have completed an UG degree in a STEM field and subsequently undertaken a PG degree, this difference of 2 percent represents quite a significant effect. Many estimates in the literature have estimated a return to an extra year of education of about 6% and so this gender gap amounts to one third of the return to an extra year of education highlighting that it is quite a meaningful gap.

Gender Differences for Students with an UG Degree in Economics or Business

In Table 7B, we do a similar exercise for people who completed an undergraduate degree in business or economics. Of this group who do a graduate programme, 7% do a PG in STEM, 81% in economics or business, 1% in health, and 5% in teaching. We find no real gender effect on whether they do economics/business for PG, a substantial negative effect on doing STEM (3 percentage points), and an offsetting positive effect on doing teaching (4 percentage points). Unsurprisingly, given the lack of a gender gap in the most common choice (business and economics), the gender gap in expected earnings is very small. The negligible effect on the probability of starting a graduate programme in business or economics is interesting here as it is not consistent with the "leaky pipeline" idea. However, this may remain an issue for economics taken by itself; we have too few students who do an UG degree in economics to test this possibility.

Table 7A: Relationship between Gender and PG Field (STEM Undergraduate Degree)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Specification	STEM	Economics /Business	Teaching	Health	Other Field	Log (Median Pay)	Log (Mean Pay)	Higher Level	University PG Degree
Basic controls	-0.126***	-0.035***	0.044***	0.103***	0.014***	-0.042***	-0.051***	-0.007	0.009
	(0.011)	(0.007)	(0.005)	(0.008)	(0.005)	(0.002)	(0.003)	(0.006)	(0.007)
Full controls	-0.078***	-0.005	0.035***	0.032***	0.016***	-0.015***	-0.020***	-0.004	-0.002
	(0.013)	(0.008)	(0.006)	(0.009)	(0.006)	(0.003)	(0.003)	(0.008)	(0.007)
Observations	7,667	7,667	7,667	7,667	7,667	7,667	7,667	7,667	7,667

Note: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Basic controls include indicators for age and year when finishing the UG degree. Full controls include fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. We restrict the sample to persons who enter a PG programme. Mean and median earnings by graduate field are calculated using earnings in 2022 of persons who finished PG programmes between 2010 and 2013. The coefficient reported is that on an indicator for female.

Table 7B: Relationship between Gender and PG Field (Economics/Business Undergraduate Degree)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Specification	STEM	Economics /Business	Teaching	Health	Other Field	Log (Median Pay)	Log (Mean Pay)	Higher Level	University PG Degree
Basic controls	-0.047***	-0.001	0.038***	0.000	0.010*	-0.003	-0.007**	-0.001	0.003
	(0.006)	(0.009)	(0.005)	(0.002)	(0.005)	(0.002)	(0.003)	(0.006)	(0.007)
Full controls	-0.034***	-0.004	0.038***	0.002	-0.003	-0.002	-0.007**	-0.008	-0.008
	(0.007)	(0.011)	(0.006)	(0.002)	(0.006)	(0.003)	(0.003)	(0.008)	(0.008)
Observations	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292

Note: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Basic controls include indicators for age and year when finishing the UG degree. Full controls include fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. We restrict the sample to persons who enter a PG programme. Mean and median earnings by graduate field are calculated using earnings in 2022 of persons who finished PG programmes between 2010 and 2013. The coefficient reported is that on an indicator for female.

Gender Differences for Students with First Class Honours UG Degrees

About 17% of undergraduates achieve first class honours and these can generally be considered to have the strongest academic capabilities to excel in PG programmes. Therefore, it is interesting to examine whether gender gaps for this group differ from those of the PG enrolees as a whole. Once we include control variables, we do not see any substantial differences between this group (Table 7C) compared to the group as a whole (Table 5). As mentioned earlier, we see similar results if we define high achievement as scoring one of the top two grades in mathematics in the Leaving Certificate exams.

Table 7C: Relationship between Gender and PG Field (First Class Undergraduate Degree)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Specification	STEM	Economics /Business	Teaching	Health	Other Field	Log (Median Pay)	Log (Mean Pay)	Higher Level	University PG Degree
Basic controls	-0.216***	-0.039***	0.076***	0.119***	0.059***	-0.047***	-0.058***	-0.047***	-0.021***
	(0.011)	(0.011)	(0.007)	(0.008)	(0.010)	(0.003)	(0.004)	(0.006)	(0.008)
Full controls	-0.038***	-0.012	0.035***	0.022***	-0.007	-0.001	-0.005	-0.009	-0.000
	(0.010)	(0.009)	(0.008)	(0.008)	(0.010)	(0.003)	(0.004)	(0.008)	(0.008)
Observations	6,656	6,656	6,656	6,656	6,656	6,656	6,656	6,656	6,656

Note: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Basic controls include indicators for age and year when finishing the UG degree. Full controls include fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. We restrict the sample to persons who enter a PG programme. Mean and median earnings by graduate field are calculated using earnings in 2022 of persons who finished PG programmes between 2010 and 2013. The coefficient reported is that on an indicator for female.

5. Implications of the Findings

In this section, we focus on the implications of our previous set of results. In particular, we first study the effect of gender differences in PG choices on the earnings gender gap for those who enrolled in PG programmes and also the effect on the overall earnings gender gap for the full sample of college graduates. Then, we study how differences in field choices at the PG level affect the overall gender gap in STEM and economics/business fields. Lastly, we analyse how the gender gaps in these fields at the PG level compare to the gender gaps at UG level.

A. Effect of PG Choices on Earnings

Our analysis so far suggests that, while there are systematic gender differences in PG field choice, these may not translate into substantial gender differences in earnings.[25] We also saw that there are some gender differences in the level of PG chosen (whether it is at degree level or not) and whether a university or other institution is chosen for PG. We now directly assess whether PG programme choice affects gender earnings gaps, conditional on prior decisions and outcomes such as undergraduate programme, Leaving Certificate subject choices, and Leaving Certificate grades. We do this by contrasting the gender gap in earnings in regressions with our full set of control variables to that measured when we additionally include PG programme fixed effects. To allow for a reasonable period to have passed after the PG, we restrict the sample to persons who start a PG in 2013 or before and use individual-level log income in 2022 as our dependent variable. In this restricted sample, the average age in 2022 is 33. Because some PG programmes are small, we need to drop observations (about 400) for which we only observe one student in the relevant time period. We show estimates using two

[25] There is much work documenting the gender pay gap in Ireland (see Barrett et al. (2022), Doorley et al. (2022), and Doris (2019)). Recent work by Doris et al. (2022) illustrates the dynamics of the gender pay gap for college educated workers and how it varies substantially by field of UG study.

different samples that require differing levels of labour market attachment in 2022. The first set restricts the sample to persons who earned at least €5,000 in 2022, and the second set adds a restriction that the person works at least 26 weeks in 2022.

The estimates are in Table 8A. Consistent with our earlier results, we find that adding the PG programme fixed effects as controls has a small effect on the female coefficient -- it falls from about 8% to 7% in the less restrictive sample and from 10% to 9% in the more restrictive sample. We can infer that, even after accounting for undergraduate programme and other controls, there is a large (8 – 10%) gender gap in earnings at around age 33 and that the choice of PG programme explains just over 1 percentage point or about 10-15% of that gender gap.

In column (3) we only include graduate programmes that we see completed during our sample period and restrict our sample to persons who complete a programme in 2015 or earlier. Once again, we study earnings in 2022 so they are observed at least 7 years after finishing the PG programme. While the conditional gender gap in earnings is slightly larger in this sample at 11%, the effect of adding graduate programme fixed effects on the gender coefficient is similar.

Table 8A: Relationship between Female and Log 2022 Earnings (PG sample)

	(1)	(2)	(3)
	Broad Sample	Narrow Sample	Narrow Sample (Completers)
Full Controls	-0.084***	-0.097***	-0.113***
	(0.019)	(0.016)	(0.016)
Add PG Programme Fixed Effects	-0.072***	-0.085***	-0.096***
	(0.020)	(0.017)	(0.017)
Observations	5,714	5,520	5,710

Note: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Full controls include fixed effects for age and year when finishing UG degree, fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. We restrict the sample to persons who enter a PG programme (columns (1) and (2)) or persons who complete a PG programme (column (3)). The coefficient reported is that on an indicator for female.

Similarly, we can ask the broader question about whether the decision to do a PG and, if so, the PG programme affects the gender income gap. To do so, we include all UG completers up to 2013 and contrast estimates with the full set of controls to those with additional controls for whether do a PG as well as for PG programme fixed effects. Because there is no PG programme for persons who did not do a PG, we create a separate PG programme category for those who did not do a PG.

The estimates are in Table 8B. The gender gap in 2022 is larger for this sample at about 14% conditional on controls but is unaffected by the presence or absence of the PG programme fixed effects. As before, this finding holds when we only include a PG programme if we see that the student completed it (column (3)). Overall, these estimates suggest that, while there are systematic differences in PG choices between men and women, they do not appear to have much effect on early career earnings on average because most graduates do not enter graduate programmes. It is important to note that as data are available only for recent years, we are forced to limit our analysis to studying gender gaps early in the life cycle (at an average age of 33 in 2022 for the group who did a PG) and it may be the case that gender differences in earnings growth rates at later points in the career differ systematically by PG programme.[26]

[26] We have examined whether there are differences in these findings when we split the sample by field of UG degree (STEM versus economics/business) and by whether the student received first class honours or not. Due to the smaller sample sizes, power becomes an issue but the conclusion that choice of PG programme has relatively little impact on the gender gap in earnings continues to hold for all these sample splits.

Table 8B: Relationship between Female and Log Earnings (All UG Graduates)

	(1)	(2)	(3)
	Broad Sample	Narrow Sample	Narrow Sample Completers
Full Controls	-0.140***	-0.142***	-0.144***
	(0.009)	(0.008)	(0.008)
Add PG Programme Fixed Effects	-0.141***	-0.143***	-0.142***
	(0.009)	(0.008)	(0.008)
Observations	29,036	27,994	27,937

Note: Robust standard errors in parentheses. *** p<0.01. Full controls include fixed effects for age and year when finishing UG degree, fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. PG programme fixed effects are interacted with whether do a PG programme so that non postgraduate students are included in the regression. The sample includes all persons who complete an undergraduate programme. The coefficient reported is that on an indicator for female.

B. Do PG Choices Exacerbate the Gender Gaps in STEM and Economics/Business?

While we have seen that there are systematic differences in PG field choice by gender, this does not necessarily imply that PG choices will exacerbate the gender gap in STEM. To examine this directly we contrast the gap in STEM at UG level with the gap in STEM replacing the UG field with the PG field for those who did a PG (we refer to this in the table as *STEM Final*). Table 9, shows that, without controls, the gender gap in STEM is about 21 percentage points for both measures so PG choices do not increase the gender gap in STEM. We then add the usual set of controls but exclude controls for UG characteristics so that the control set for PG and UG field are directly comparable.[27] Once we include these controls, the gender gap increases slightly when PG choices are taken into account, from 8.4 percentage points to 9.3 percentage points. Overall, while there are differences in field choice at PG level by gender, they have small effects on the proportion who end up studying STEM.[28] In contrast, we find no effect of PG choices on whether the final field of study is in economics or business.

[27] Note that we cannot add the UG controls to the regressions that analyse field of study at UG level. Therefore, we choose to also exclude these UG controls from the regression that analyses field of study at PG level so that we can compare the effect on the gender gap at each level for a comparable control set.

[28] This finding may appear to be a puzzle: Why do large gender gaps in STEM choices at PG level not translate into bigger differences in the proportion who end up studying STEM? The reason is that there are a lot more men than women in STEM at UG level and outflows from STEM at PG level are greater than inflows into STEM. So, the higher probability that men choose a STEM PG given any particular UG degree is largely offset by the higher outflow of men from STEM.

Table 9: Relationship between Gender and Field Choices

	(1)	(2)	(3)	(4)
Specification	STEM at UG	STEM Final	Economics/Business at UG	Economics/Business Final
Basic controls	-0.212***	-0.217***	-0.067***	-0.068***
	(0.002)	(0.002)	(0.002)	(0.002)
Full controls excl. UG controls	-0.084***	-0.093***	-0.045***	-0.045***
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	150,279	150,279	150,279	150,279

Note: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Basic controls include indicators for age and year when finishing UG degree. Full controls include fixed effects for the specific UG programme studied, fixed effects for UG performance as measured by degree class, fixed effects for subjects taken for the terminal high school examination (the Leaving Certificate exam), a linear function of points achieved in each individual subject, a quadratic function of total points achieved in the Leaving Certificate exam, a set of individual characteristics including controls for socio-economic status and the type of secondary school attended. The sample includes all persons who complete an undergraduate programme. The coefficient reported is that on an indicator for female.

C. Size of Gender Field Gaps at PG Level Relative to UG Level

The estimates in Table 9 allow a comparison of the gender gap in STEM at PG level relative to that at UG level (about 25% of our sample do STEM at undergraduate level; 22% of those who enrol in a graduate programme do STEM at PG level). We saw in Table 5 that the PG gender gap in STEM without controls is 15 percentage points and falls to 4.6 percentage points with controls. In Table 9, we see that the equivalent numbers for UG are 21 percentage points and 8.4 percentage points respectively. We can conclude that the raw gender gaps at PG level are smaller than those at UG level. However, some care is required in interpreting the estimates with detailed controls because the controls differ between Table 5 and Table 9 as in Table 5 we include all controls that are predetermined at the point of finishing UG. Some of these are excluded from Table 9 as they are not predetermined when choosing UG (such as the UG programme indicators and UG degree class). When we use the same set of controls in both regressions (excluding the UG programme indicators and UG degree class), we find a gender gap of 8 percentage points at PG level, very similar to the gap at UG level.[29] We conclude that,

[29] This gap stays at 8 percentage point if we study PG completion rather than enrolment.

if the control variables are the same, unexplained gender gaps in STEM are about as large at graduate level as at undergraduate level.

For economics/business, the raw gender gaps are larger at PG level -- the gap at UG level is 7 percentage points compared to 10 percentage points at PG level (Table 5). While we can explain relatively little of the UG gap with the full set of controls, the addition of controls almost completely eliminates the PG gap to 1 percentage point (Table 5). As with STEM, however, when the same control set is used, the gender gap at PG is 5 percentage points, very similar to the unexplained gap at undergraduate level.

6. Conclusions

We have used unusually rich information on choices and achievement in secondary school and at undergraduate level to examine the gender gap in choices made at graduate level. As at undergraduate level, there are large gender differences in the types of graduate programmes chosen. Much of the gap can be explained by differences in observed characteristics at the point of undergraduate graduation; of these, by far the most important observable is the undergraduate programme chosen.

However, we find that there are substantial systematic differences in graduate choices by gender even when one conditions on the exact programme of undergraduate study and a wealth of additional controls for student aptitudes and preferences. Conditional on these controls, women are around one fifth less likely than men to choose a STEM graduate programme and one third more likely to choose education at graduate level. Overall, compared to men, women choose PG fields with predicted earnings that are lower by about 1%. Females are also slightly less likely than males to do a master's or PhD graduate degree (rather than a certificate or diploma) and to study in a university rather than an institute of technology.

Even after taking account of observables, we find that the gender gap in choosing STEM at graduate level is large (8 percentage points) for the sample of students who graduated in STEM at UG level, thus adding support to the leaky STEM pipeline hypothesis. Compared to men, female STEM graduates choose graduate fields with 2% lower predicted earnings. When we take account of control variables, we find much smaller gender gaps in the decision to do business or economics graduate degrees, suggesting that gender gaps in these fields are largely determined by the time students complete undergraduate level.

Finally, we find that gender differences in choice of field of study at PG level have meaningful effects on the gender gap in early career earnings. Even after accounting for the exact undergraduate programme and detailed high school subject choices and grades, there is an 8% gender gap in earnings at age 33 for persons who pursued a graduate degree; the choice of graduate programme can explain about 15% of that gap. Therefore, it is important to look beyond undergraduate field choices as programme choices at graduate level further tend to exacerbate gender earnings gaps.

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