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DISCUSSION PAPER SERIES

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ABSTRACT

The Labour Market for Native and International PhD Students: Similarities, Differences, and the Role of (University) Employers

This paper studies the labour market outcomes of native and foreign PhD graduates staying as migrants in Australia, using data on career destinations over the period 1999-2015. Natives with an English-speaking background emerge as benefiting from positive employer discrimination, especially if graduating in Science, Technology, Engineering and Mathematics (STEM), for which they receive a premium that is unrelated to observed characteristics such as gender, age, and previous work experience. In contrast, foreign PhD graduates with a non-English speaking background experience worse labour market outcomes, especially if they work in the university sector. Acquiring education in the host country does not appear to eliminate uneven labour market outcomes between natives and foreigners.

JEL Classification: I26, J24, J31, J61

Keywords: PhD graduates, wage decomposition, discrimination, international students

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1. Introduction

Over the past two decades, economic globalisation has favoured an unprecedented increase in the number of international students. In 2017, the foreign-born accounted for about 6% of university students across the OECD, was but their share was as high as 47% in Luxembourg, and 18%-22% in Australia, New Zealand, and the United Kingdom (OECD, 2019 – Figure B6.1). In the same year, international students enrolled in large numbers in several non-OECD countries too, including China (1.1%) and India (0.8%) (OECD, 2019 ibid).

This 'migration for education' phenomenon is noteworthy, as it has not only propelled the tertiary sector into becoming a major generator of export revenues but also affected the international transfer of human capital between countries of origin and destination, and the skill composition of migration flows. Foreign students contribute to the rapid increase of tertiary-educated migrants (Freeman, 2010; Docquier and Rapoport, 2012), besides adding considerably to patenting activity and entrepreneurship (Hunt, 2011; Roach et al, 2019), among others.

Although the economic effects of foreign students are embodied in broader analyses of skilled migration (OECD, 2001, 2008 and 2018) and international students at large, regardless of their returning choices (OECD, 2019; Zhou et al, 2008; Crawford and Wang, 2016), little is known about the subgroup of foreign graduates staying on in the country of education as skilled migrants. Yet, this particular flow of highly trained individuals can shed light on some fundamental questions about the role of host country education in narrowing migrants' loss of human capital after settlement (Chiswick and Miller, 2009) thereby improving labour market outcomes in their new country. This knowledge is in turn relevant to understand, and possibly change, policies influencing higher education (e.g. number of students visa), migration (e.g. minimum age and education criteria), and the labour market (e.g. hiring, training, and pay conditions), to name a few.

This paper aims at advancing the literature by studying whether native and foreign students staying-on as migrants enjoy similar labour market outcomes in the country of education. To do so, the analysis uses the case of Australia as one of the most popular destinations for international students (40% of PhD graduates are foreigners versus 25% across the OECD), and a country where migration policy favours applicants with tertiary and higher education. In particular, it focuses on recent graduates with the highest level of formal education (Doctorate of Philosophy or PhD) in the age group 25-45 to reduce the influence of unobserved individual differences such as ability, motivation, and career ambitions[1] as well as heterogeneity in prospective employers' awareness about the degree. The analysis further splits native and foreign students into English (ESB) and non-English speaking background (NESB) to capture the fact that many natives are actually first or second-generation migrants, offering novel insights on the returns to education between various sub-groups of the student population. Throughout the paper nationality is identified according to the type of fees (domestic or international) charged by the university. Combined with the cultural background of the student, this approach yields a well-defined taxonomy of the subgroups graduating from Australia's universities.

The data are sourced from the Graduate Destinations Survey (GDS), a comprehensive educational and employment database, for the period 1999-2015 - a period of expansion in enrolments notwithstanding the tougher labour market conditions that followed the Global Financial Crisis (GFC), from 2008.

The analysis focuses initially on the difference in wages between the control group, native ESB students, and the other sub-groups (native NESB, foreign ESB and NESB) to understand the relative contribution of observed and unobserved variables – the latter being interpreted

[1] The working sample covers graduates to avoid the sizeable number of students who complete their PhD studies for motives that are more weakly related to labour market choices, in line with established practice in the analyses of PhD students (OECD, 2019 – Table B7.2).

as a proxy for discrimination. Then, regression analysis is applied to measure the influence of individual and institutional characteristics on a set of labour market outcomes that include hours of work, over-education, and the probabilities of working in a full-time job, in higher education, and to look for a new job.

The results reveal that there is no difference in the average pay of native and foreign PhD graduates, but this masks substantive differences in the contribution of observed and unobserved components. Native ESB are always paid less than any other sub-group on the basis of the observed characteristics (2.2%-6.3%), mainly because of more women and part-time workers in their sub-group. However, their wage penalty cancels out when the unobserved component is accounted for, implying that ESB natives benefit from some degree of employer discrimination. This outcome is especially prevalent among graduates in Science, Technology, Engineering and Mathematics (STEM), while there is no effect for ESB native graduates in other fields of study. No discrimination arises in the case of Medicine, Dentistry and Health except for the comparison of ESB-NESB natives, where EBS natives enjoy a 7.2% premium entirely due to the unexplained component. This result occurs almost exclusively at the higher end of the wage distribution, suggesting that discrimination seems a more relevant determinant of pay in highly technical occupations, where productivity is easier to define and measure, and competition is stronger. ESB natives do not have such an advantage in average- and low-paying jobs.

The regression analysis also shows that NESB foreign PhDs have the worst labour market outcomes despite acquiring the highest level of education in the same country where they stay on after completing their studies: they work fewer hours, are less likely to work in a full time occupation, and have the highest probability to look for another job. As they are also the most likely subgroup to work in the university sector, their poor labour market outcomes seem to reflect constrains from the employers rather than graduates' lack of skills. Overall acquiring

education in the host country does not result in equal job opportunities, even when this occurs at the highest levels of the educational scale.

The rest of the paper is organised as follows. Section 2 briefly summarises the reference literature. Section 3 presents the data. Section 4 discusses the methodology. Section 5 discusses the results. Section 6 concludes.

2. Literature

The labour market outcomes of foreign PhD graduates crosses two distinct literatures: the first studies the labour market outcomes of skilled migrants, where 'skilled' is used as a synonym for educated at a tertiary or higher level, predominantly in the country of birth. The second focuses on the characteristics of PhD students and some of their labour market outcomes, with limited analyses of differences by nationality and field of education.

Skilled migration studies

A large literature studies highly educated migrants and their increased mobility over the past decades (OECD, 2001, 2008, 2018). This research highlights some distinctive features of emigrants: namely, they are better educated than those left behind in the country of origin (Carrington and Detragiache, 1998 and 1999; Docquier and Marfouk, 2004; Docquier, Lohest, and Marfouk, 2005), and host country natives (Docquier, Ozden, and Peri, 2014). They self-select, and are typically more motivated than those who choose not to move (Borjas, 1987 and 1991). They are also more likely to be over-educated in the host country (Hartog, 2000; Groot and van der Brink, 2000; Leuven and Oosterbeek, 2011), experiencing a costly loss of human capital as their education tends to be discounted due to employers' outright (Becker, 2010) or statistical discrimination (Altonji and Pierret, 2001; Tani, 2017). This literature also finds that the probability to migrate rises with the level of education of the would-be migrants, as the expected absolute economic gain from the move is higher (Grogger and Hanson, 2011).

As a result, highly educated individuals leaving low-income countries rarely move back for economic reasons during their working lives (DaVanzo, 1983; Gibson and McKenzie, 2009; Dustmann and Kirchkamp, 2002).

These insights are useful, especially in warning to control for the likely self-selection of foreign students staying on as migrants in the country of education, though this literature tends to otherwise pay less attention to different levels of graduate education, generally pooling together bachelor and higher degrees.

PhD graduates

In contrast, a distinct literature investigates the characteristics and labour market outcomes of PhDs, researching on three broad topics. The first focuses on the characteristics of the PhD programme as a formative training for subsequent employment along with the career prospects, and the main features of the employers. Undertaking a PhD is viewed as equivalent to on-the-job research training (Mangematin and Mangran, 1998), underpinned by an implicit contract between student and supervisor to advance academic and scientific production, including publications and patents (Lissoni, 2012). The training gained by completing a PhD is the main path to start a research-intensive career, as reflected by labour demand. Employers are predominantly universities (Mangematin, 2000) or research-intensive institutions that hire on a worldwide basis, and this feature makes the labour market for PhD graduates a 'global' market (Auriol, 2010; Levin, 1996). Research in this area also notes a possible over-supply[2] of PhD graduates since the early 2000s (Cyranoski et al, 2011), which has led to new employment prospects for fresh PhD graduates: on the one hand, it has created an intermediate labour market where PhD graduates take up temporary or casual post-doctoral positions for several years during which they attempt to access tenured academic

[2] See for example: http://www.phdcentre.eu/nl/publicaties/documents/Ph.D.LabourmarketFinal4112010.pdf (Netherlands); http://www.aqu.cat/doc/doc_18168541_1.pdf (Cataluna); and http://www.economist.com/node/17723223 (US and UK).

jobs (Stephan and Ma, 2005). On the other, some PhD graduates have found jobs outside the university sector, in research-intensive organisations and R&D laboratories of private firms, and non-government organisations (NGO)[3]. Non-academic employers seem to value the transferable generic skills of PhD graduates, like their computational and technical abilities, and non-academic positions appear to resonate well with foreign PhD graduates (Su, 2003).

Along this group of studies, a second line of investigation focuses on the determinants of the international mobility of PhD graduates. Education is a proxy of productivity, and upward trends in the development and adoption of technology has raised the demand for a more technically competent workforce, including PhD graudates. Migration hence occurs predominantly for work-related reasons following precise geographic patterns according to field of study (Canibano et al, 2011; Franzoni et al, 2012). In some cases, migration occurs even when the jobs performed offer no improvement in skills utilisation (De Grip et al, 2010), though this may reflect working as a junior researcher with prominent researchers and organisations to gain experience that will be useful in later stages of career. The studies in this literature also support the hypothesis that mobility is often a one-way path for several PhD graduates, as the most likely reason for returning to one's home country is related to family rather than work in a local university or research centre (Franzoni et al, 2012).

The third line of research in this literature analyses the labour market and productivity impact of PhD graduates in the host country, especially on innovation activity, and the establishment of international research collaborations with the place of origin. Influential work by Hunt and Gauthier-Loiselle (2010) finds that international PhD students contribute disproportionally to

[3] The literature expresses mixed reviews of these job market developments. For some authors, the expansion of labour demand beyond academia and research departments is positive, as it can absorb the increased number of PhD graduates (Lee et al, 2010; Kyvik, and Olsen, 2012; Romero et al, 2014). For other authors, the higher heterogeneity of employers and jobs has also raised the likelihood of mismatch between competences acquired during the PhD and those actually used in the labour market. The mismatch seems to affect a substantial share of recent doctoral graduates, particularly after the Global Financial Crisis of 2007-8 (Mangematin, 2000; Di Paolo, 2014).

US patenting activity, and to employment via new start-ups. The positive contribution of foreign (at times former) students to international research collaborations is well documented across several levels of analysis, including at individual (Jonkers et al, 2013; Scellato et al, 2015), institutional (Carillo et al, 2013), and geographic area level (Freeman, 2014), reinforcing the view that research mobility of young researchers generates positive externalities for the economy and deserves institutional support at both national and international level (Ackers, 2005).

Notwithstanding the evidence documenting the positive economic contribution of foreign PhD holders, imperfect language skills often jeopardise their progression to subsequent managerial positions commanding high wages (Hunt, 2013). This seems to be prevailing in STEMS. For example, Hunt (2013) finds that immigrants with an engineering degree have not only lower wages than natives (despite having higher education), but they also carry out occupations not commensurate with their education at the lower end of the wage distribution.

This paper contributes to the migration and labour market literature by analysing wage differences between native and foreign PhD graduates, and comparing their labour market outcomes. The returns to education at doctoral level for native and international students are under-researched, especially when further examined by cultural background and across broad field of education. This distinction is important as newly arrived immigrants often acquire additional educational credentials before deciding to stay on in the host country as skilled migrants, and more evidence is needed to inform policy in a variety of areas that include migration, education, and employment.

This paper also adds to the almost inexistent literature on the labour market for PhDs in Australia (Harman, 2002), by documenting their choices and outcomes over the most recent decades. The period 1999-2015 covers important developments in the tertiary sector and the

overall economy (Ranasinghe, 2015), as it includes a time of rapid increase in the enrolments of international students, in many cases eased by favourable conditions for remaining in Australia as permanent immigrants. This period also includes the years before and after the GFC, which constrained hiring decisions and wage growth across the economy since 2008.

3. Data

The empirical analysis uses sixteen rounds of the GDS, a national survey of higher education graduates administered by Graduate Careers Australia until 2016, when a different organisation was put in charge, raising issues of comparability with earlier runs. The GDS is offered to all new graduates from Australian universities, and is widely used to explore the transition between higher education and the labour market in Australia. The GDS's average response rate is between 50% and 60% of the native graduand population while that of international students tend to be lower, mostly for logistical reasons as a large portion of the data is collected during graduation days (Guthrie and Johnson, 1997).

The GDS is not immune from drawbacks, as it contains no information on certain demographics that are relevant for labour market studies, like the marital status and the number of children, academic performance, and previous work history though it asks graduates whether or not they worked in the final year of their studies.

From the 16 rounds of the GDS (51,959 observations) the empirical analysis is restricted to observations on those working in Australia (35,716 observations) and with an age comprised between 25 and 45 (26,402 observations). As age is measured at time of graduation, the restriction to age 25-45 covers students enrolling in the PhD programme between the age 21 (completion of Bachelor Degree) and 40, akin to the age group used as a reference in international studies (OECD, 2019). Further restrictions to observations with complete information on salary, hours of work, and employment characteristics as well as plausible salaries (between 1%-99% of the raw distribution) reduces the working sample to 19,087

observations, with 16,945 covering native (88.8%) and 2,142 foreigner (11.2%) PhD graduates, respectively. Table 1 summarises the trimming carried out.

Table 2 presents the summary statistics of the working sample by aggregate nationality. The first two columns report the unconditional means and standard deviation (in parenthesis) of natives and foreigners, respectively, while the third column shows whether these are statistically different from zero at the 1% ('***'), 5% ('**') or 10% ('*') level of significance. The first two rows of the table focus on two important possible sources of selection: employment and migration (return) rates, respectively. PhD graduates experience low unemployment rates (lower than the national unemployment rate), though these are higher for foreigners. Accounting for this source of selection, however, makes no difference to the results, and therefore it is not further discussed. In contrast, the selection into emigration (for natives) and return to the country of origin is more marked: 8.8% of native Australian PhDs moves abroad to work with a foreign-based employer while 40.9% of foreign PhDs remains in Australia. This source of selection influences the empirical results, and hence is included by an inverse Mills ratio capturing the probability of remaining in Australia upon graduation. This index is obtained from a linear probability model linking staying in Australia with information on the country of origin, whether or not the graduate worked in the last year of study, the time spent to complete the PhD, the quality of the university from which they graduate, and time fixed effects.

Table 2 also shows that Australian graduates earn a higher annual and hourly salary than foreigners in absolute terms, but this seems related to working more hours: on an hourly salary basis native and foreign PhD earn similar amounts. Even though native and foreigners work predominantly for the public sector, including academia (68.5% and 66.5%, respectively), foreign PhDs are more likely to work in part-time positions (52.8% vs. 34.1%). The difference in hours of work emerges as one of the most distinctive differences between

these two groups. This is not due to restrictive working rights as foreign PhD students can work full-time in Australia while studying and four years after their completion – this is well within the time in which they are surveyed by the GDS.

The rest of Table 2 summarises demographic, educational, and labour market outcomes for the subsamples of native and foreign PhD graduates that choose to remain in Australia. These graduates are similar in age, on average in the early 30s, and in the choice of university, with over half of each group graduating from one of Australia's Group of Eight (Go8) (58.1% vs. 58.0%, respectively), which gathers the country's oldest and most research-intensive institutions[4].

Natives and foreigners differ in gender composition, field of education, and labour market outcomes. Australian PhDs are predominantly females (52.1% vs. 36.7% among foreign PhDs), and more widespread across fields of study than foreign PhD graduates. While STEM is the most common choice overall, foreign PhDs graduate overwhelmingly from technical and scientific disciplines (65.6%). The corresponding proportion among Australians is less pronounced (49.9%), and more balanced towards Humanities (34.8%), and Medical or Health studies (15.4%). The distribution of foreign PhD across other disciplines is similar, but with lower shares (22.9% and 11.5%, respectively)

The indicator of English-speaking background illustrates the heterogeneity within the main aggregate groups of natives and international students. Native ESB account for 79.7% of native PhD graduates, but the remaining 20.3% includes first and second-generation migrants with cultural background in a language other than English (NESB). The proportion of ESB and NESB among foreign PhDs are reversed: 25.5% have an English speaking background (mostly New Zealand, UK, US and Canada) while the remaining are NESB international

[4] As Go8 universities tend to attract students with higher high school scores, this indicator may be viewed as a crude proxy of the underlying student quality: under this interpretation, emigration attracts the 'best' Australian PhDs, but only in STEM, while Australia seems to attract the 'best' foreign PhDs in each discipline (Figure 1).

students. The relatively large shares of ESB and NESB within native and foreign student aggregations reflect what observed at Bachelor level (Carroll and Tani, 2002), and are illustrative of the heterogeneity of backgrounds that characterises students enrolled in Australian universities, supporting the choice of expanding the analysis to native and foreign ESB and NESB students.

Table 3 focuses on these four subgroups. The summary statistics in the table show similar wage per hour despite different underlying wage distributions (Figure 1) and trend during the period by broad field of study (Figure 2). Foreign NESB are predominantly males, concentrate in STEM and are less likely to work in their final year of study. They also tend to work in part-time positions after their graduation. The prevalence of male students, emphasis on STEM degrees, and doctorates from Go8 universities are also marked features of native NESB. In contrast, both native and foreign ESB have a more balanced gender ratio, and spread of fields of education.

4. Methodology

As a preliminary step, wage differences between the various sub-groups are explored using the decomposition developed by Oaxaca and Blinder to understand the contribution of observed (composition effect) and unobserved (price or wage structure effect) factors, and their interaction. Under the assumption that the conditional expectation of wages given a set of covariates is linear, it is possible to quantify the contribution of each observed covariate by writing the difference of the Ordinary Least Squares (OLS) estimates of the wage equations for two sub-groups I and N:

$$W_{It} = X_{It}\beta_I + \varepsilon_{It} \qquad (1)$$

$$W_{Nt} = X_{Nt}\beta_N + \varepsilon_{Nt} \qquad (2)$$

as:

$$\Delta_t = \bar{W}_{It} - \bar{W}_{Nt} = (\bar{X}_{It} - \bar{X}_{Nt})\beta_{Nt} + (\beta_{It} - \beta_{Nt})\bar{X}_{Nt} + (\bar{X}_{It} - \bar{X}_{Nt})(\beta_{It} - \beta_{Nt}) \qquad (3)$$

where:

(i) $(\bar{X}_{It} - \bar{X}_{Nt})\beta_{Nt}$ is the explained component, summarising estimate differences in the observed $\bar{X}$'s (endowment effect). *W* is the logarithm of the hourly wage while the vector *X* include demographic characteristics (gender, age and age squared, whether speaking English at home as main language, if disabled or from an aboriginal background), educational variables (whether graduating from a university of the Group of Eight group, the share of foreign students in the same field of study and university, mode of attendance), and labour market variables (lagged average wage and lagged unemployment rate by year and field of education);

(ii) $(\beta_{It} - \beta_{Nt})\bar{X}_{Nt}$ is the unexplained component (coefficients), which summarises differences in returns of given characteristics (the β's); and

(iii) $(\bar{X}_{It} - \bar{X}_{Nt})(\beta_{It} - \beta_{Nt})$ is an interaction term, which reflects differences in endowments and coefficients arising from the simultaneous existence of both components.

This decomposition yields the expected change in sub-group *N*'s average wages assuming that people in this sub-group have the same $\bar{X}$'s or β's as those in group *I*. To extend the analysis to wage differences to other points of the wage distribution, a quantile regression model is used (Firpo et al., 2009; Fortin et al., 2011). This applies the Oaxaca-Blinder decomposition to the probability of the wage gap being above a quantile of interest[5], which can in turn be decomposed as:

[5] The wage gap at quantile $q(\tau)$ can be written as the difference between I and N quantiles by replacing the dependent variable in models (1) and (2) with the 'recentred influence function' (RIF) of the wages W_{It} and W_{Nt} for the quantile of interest. This is defined as:

$$\Delta_t(\tau) = q_{It}(\tau) - q_{Nt}(\tau) = (\bar{X}_{It} - \bar{X}_{Nt})\delta_{Nt,\tau} + (\delta_{It,\tau} - \delta_{Nt,\tau})\bar{X}_{It} \qquad (5)$$

where the terms $(\bar{X}_{It} - \bar{X}_{Nt})\delta_{Nt,\tau}$ and $(\delta_{It,\tau} - \delta_{Nt,\tau})\bar{X}_{It}$ capture the observed and unexplained differences between sub-groups at the quantile τ, analogously to the decomposition carried out at the mean by model (3). The empirical analysis is implemented at three quantiles: 25th, 50th, and 75th to explore possibly diverging trends for less/more highly paid jobs.

The study of wage differences is followed by regression analysis to understand in more detail their possible causes and the influence of observed characteristics in determining several labour market outcomes. These include the hours of work (trimmed to the range 1-70), the probabilities of having a full-time job (35+ hours of work), working in higher education, carrying out a job that does not require PhD qualifications (classified in the groups Associate Professionals to Labourers using the Australian and New Zealand Standard of Classification of Occupations), and looking for a new job. For each outcome, an Ordinary Least Squares (OLS) regression is applied to the statistical model:

$$y_{it} = \beta_0 + X_{it}\beta_1 + IN_{it}\beta_2 + t\beta_3 + \eta_{it} \qquad (6)$$

where *y* is the labour market outcome of an individual *i* at time *t*; *X* is a vector of individual characteristics as previously mentioned, which includes an indicator of self-selection into staying in Australia as opposed to returning to the country of origin or working abroad; *IN* is an indicator of nationality and cultural background (native ESB is the reference group). Finally, *t* is a vector of time fixed effects and η_{it} is an idisyncratic error term. As the GDS is

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$$RIF_t(W_t, q) = q(\tau) + \frac{I(W_t \geq q) - (1-\tau)}{f_W(q(\tau))} \qquad (5')$$

where the expression $\frac{I(W_t \geq q) - (1-\tau)}{f_W(q(\tau))}$ is the influence function[5]. The resulting RIF functions for I and N are therefore:

$$RIF_{It} = X_{It}\delta_I + \mu_{It} \qquad (5'')$$

and

$$RIF_{Nt} = X_{Nt}\delta_N + \mu_{Nt} \qquad (5''')$$

respectively. The quantile wage gap is obtained as the difference in conditional expected value of the RIF between the two groups.

an annual survey, model (6) is applied to pooled cross-sectional observations. The standard errors are clustered at university level to capture institutional commonalities.

5. Results

Wage decomposition

The baseline decomposition of the difference in the logarithm of the average hourly wage between natives and foreigners, taking into account the self-selection on staying in Australia, is reported in Table 4. The top row reports the average difference, while subsequent rows report its Oaxaca-Blinder decomposition into the components (model 3). The explained component estimates group differences in endowments while the main contributors are reported in the lower rows of the table.

As evident from the first row of the table, there is no difference between the average hourly wage of native and foreign ESB and NESB graduates. This lack of difference however masks two opposite forces at work. Observed characteristics suggests that native ESB graduates are paid a lower rate relative to every other group, as indicated by the negative and statistically significant estimate of the explained component. The items under 'Contribution to E' in the bottom part of the table identify the sources of this penalty in a more balanced gender mix (being a woman has a negative sign) and a tougher labour market in recent periods, especially after the Global Financial Crisis of 2008 (year dummy indicators are all negative and statistically different from zero). Natives' penalty would be worse were it not for working more hours.

Against the effect of observed components, native ESB enjoy a premium because of unobserved characteristics, implying some form of positive externality or favourable discrimination that completely cancels out the wage penalty associated with observed characteristics. This offsetting relationship between observed and unobserved components

characterises native ESB not only vis-à-vis their foreign counterparts but also vis-à-vis native NESB. This result is entirely associated with the unexplained component, as the interaction effect has no real influence (statistically it is equivalent to zero).

To understand whether these differences equally arise across fields of education, separate regressions are carried out, and the results are summarised in Table 5. What emerges is that the results of the pooled regressions mostly reflect what experienced by graduates in STEM. STEM is the only broad discipline where the point estimates of explained and unexplained components are always different from zero at a 1% level of statistical significance, and where native ESB experience opposite effects of wage discount associated with observed characteristics and wage premium related to discrimination. No wage gap instead arises between native and foreign PhD graduates in the case of Humanities. In Medicine and Health, where Australia has traditionally experienced labour market shortages until recently, there is a premium in favor of foreigners.

The analysis on a wider wage distribution (Table 6) provides some new insights. One is that natives ESB with a PhD in STEM (top portion of the table) are paid less relative to every other graduate sub-group on, above and below average wage: the explained component is always negative and statistically different from zero aside from one case - the lowest wage group in the native ESB vs. NESB comparison. This reflects in part that native ESB are characterised by a more balanced gender mix. Correspondingly, the unexplained component has the opposite sign, but it is statistically different from zero only at the 75^{th} quantile. This finding suggests that native ESB particularly benefit from employers' discrimination relative to every other subgroup of graduates when jobs are better paid and competition is, presumably, tougher. This finding is novel altogether, and supports the hypothesis that the PhD labour market seem to operate less transparently exactly where one would expect to find unquestionable and openly verifiable skills and competence.

In contrast pay differences are effectively zero in the Humanities and in Medicine and Health, with only a couple of minor exceptions in the native ESB vs. NESB and native vs. foreign ESB comparisons at the 50th quantile. On average, graduates in these disciplines seem to receive even salary opportunities regardless of their place of origin and cultural background. Overall the analysis of wage gaps calls for further exploration of PhD graduates' labour market outcomes besides salaries, as carried out below.

Regression analysis

To better understand the type and quality of the employment of PhD graduates model (6) is applied to several labour market outcomes, and the estimates obtained are presented in Table 7. The first two columns summarise the results when the hours of work and the probability of working full-time are used as dependent variable, respectively. The next column reports the estimates of the determinants of the probability of working in higher education, either as lecturer or tutor, followed (over-education) by those of working in a job that classified in by the Australian and New Zealand Standard Classification of Occupations (ANZSCO) at a level that does not require a PhD, like associate professionals, clerks or workers. The last column of Table 6 reports the estimates obtained when the dependent variable is the probability of looking for another job, which is interpreted as an indicator of overall satisfaction with the present job held. Table 7 is organised so that the top panel summarises the results obtained on observations pooled across fields of education, while those in the middle and bottom of the table present those obtained from separate regressions performed for each broad discipline: STEM, Humanities, and Medicine and Health. In each case, model (6) is performed by OLS, using native ESB as the reference group.

The regression on pooled data illustrate the existence of clear differences in the types of job that PhDs in the four subgroups carry out after graduation. Every sub-group works fewer hours than native ESB but only foreign NESB have a significantly lower probability to work

in a full-time job (-.068). This is particularly the case if they hold a STEM (-.080) or Humanities (-.207) PhD. The third column of Table 6 reveals that foreign PhDs are more likely than natives to work in higher education, regardless of their cultural background. Taking the results of the first three columns together, it appears that foreign PhD graduates, and especially those with a NESB background, concentrate in the least secure, and possibly less rewarding, types of academic jobs available rather than spreading across a broader set of occupations and employers in the economy: university jobs with fewer hours than full-time are often temporary or casual in nature. This finding is somewhat troublesome as the tertiary is the one that trains those very students and knows their abilities and interests best, as it learns the true productivity these graduates over the course of their studies. In contrast, the picture arising from Table 6 is that universities seem to employ foreign PhDs in jobs that are less attractive to comparable native PhDs. It is hence not surprising to find that NESB foreign PhDs are more likely to look for another job (last column), notwithstanding that their experience is shared with foreign ESB and native NESB.

Further investigation suggests that these results reflect the experience of graduates in STEM and the Humanities. In contrast, the labour market experiences of foreigners and natives in Medicine and Health seem similar: there is no statistical difference in outcomes between ESB and NESB natives, and no difference with ESB natives arises in the probability of accessing a full-time job.

To explore in more detail the labour market outcomes of native and foreign PhDs working in tertiary education vis-à-vis those working in other sectors, separate analyses are carried out and the results are summarised in Table 8. The point estimates reveal that, relative to native ESB, every other sub-group working in the higher education industry receives lower wages (-3.2% for native NSB up to -13.9% for foreign NESB) and is less likely to have a full-time job. These penalties however are far more pronounced for NESB, be they either native (-

6.6%) or foreigner (-26.1%). The penalty for foreign ESB is substantial (-9.6%) though this group has similar likelihood to carry out a full time job as native ESB. The wage penalty and lower probability of full-time employment is about halved when PhD graduates work outside the university sector, highlighting industry-specific reasons at the core of these results. In industries other than higher education PhD graduates have similar probabilities to work full-time, suggesting that nationality and cultural background have less influence in access to jobs in the broad labour market. The final columns of Table 8 indicate that PhD graduates are likely to look for better job opportunities even shortly after completing their studies and entering the labour market, especially, and unsurprisingly given the relatively poor outcomes previously discussed, if they work in higher education.

6. Conclusions

This paper explores the determinants of wages and other labour market outcomes for native and foreign PhD graduates in Australia over a 15-year period, ending 2016. While average wages are statistically identical across groups, even when their English/non-English cultural background is used to generate distinct sub-groups, this outcome masks two opposing, and statistically significant, effects: ESB natives generally earn less than comparable foreigners on the basis of observed characteristics but this penalty disappears thanks to higher coefficients (discrimination). This finding emerges especially in STEM and for jobs at the higher end of the hourly pay scale, implying that jobs where technical competences ought to be unquestionable are actually the only ones where the discrimination makes a substantive difference: ESB native enjoy hourly salary improvements of about 2.2-6.3%. This discrimination premium is large, particularly when calculated on the course of an entire working life.

Besides areas characterised by chronic skills shortages, such as those in Medicine and Health, where foreign and native PhDs achieve relatively similar outcomes, the labour market does

not offer similar opportunities to native and foreign PhD graduates despite their human capital and qualifications being acquired in the same country. Foreign NESB PhDs receive statistically different and lesser outcomes with references to salary, hours of work, probability of working in a full-time job and in sectors other than higher education. This result supports the hypothesis that what is considered an imperfect transferability of human capital may instead be a symptom of a less than competitive labour market, to which the universities in which foreign PhDs complete their education seem to contribute, especially in STEM and the Humanities.

While tougher conditions in the labour market since the GFC seem to have become a more permanent feature, the results highlight that inequality across national and cultural groups begins at the outset of one's career, even when education is acquired at the highest possible level and in the same host country.

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Figure 1 – Average hourly wage distribution of natives and foreigners: 1999-2015

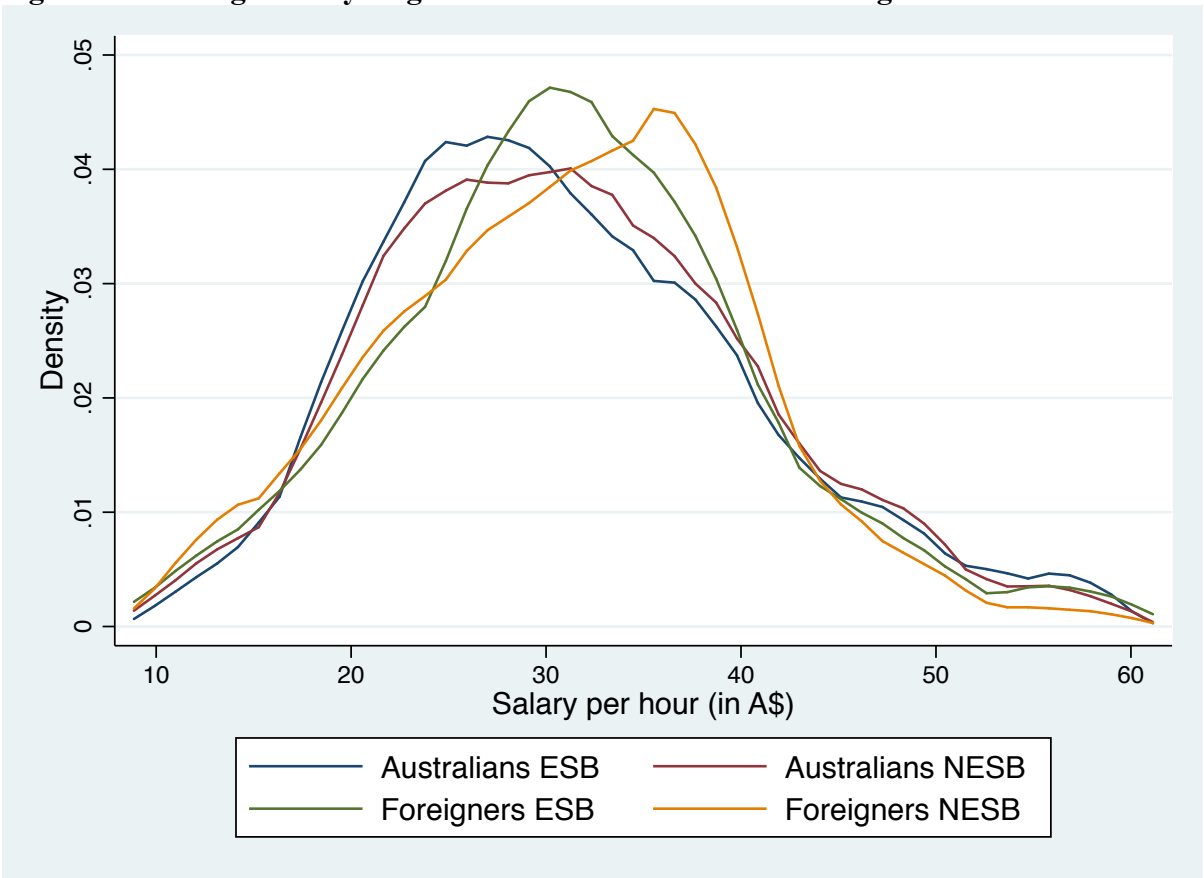

Figure 2 – Average odd ratio of part-time and full-time employment among PhD graduates working in Australia: 1999-2015

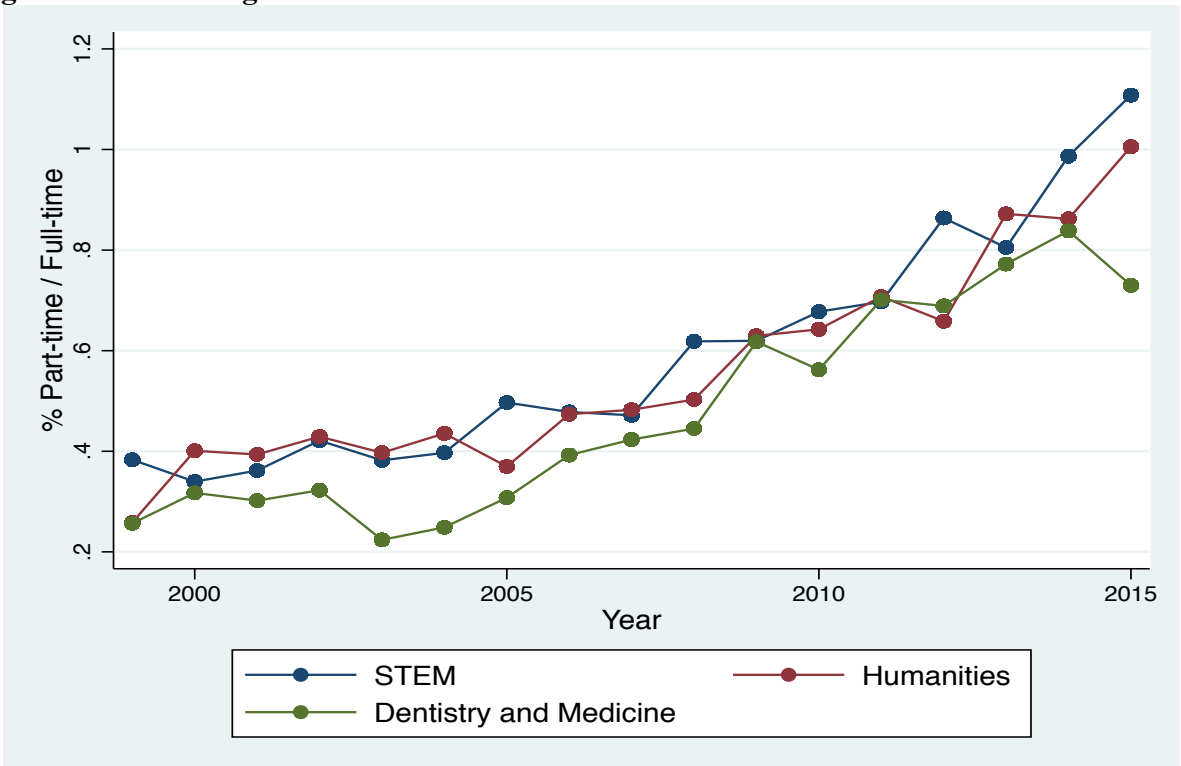

Table 1 - Data trimming

Condition	N	%
Pooled GDS for PhD, 1999-2015	51,959	100.0
With employer nationality	43,617	83.9
Working in Australia, and	35,716	68.7
age 25-45	26,402	50.8
salary and hours information	23,783	45.8
complete demographics	20,843	40.1
variables for selection into emigration	19,537	37.6
employment and state information	19,087	36.7
N working sample	**19,087**	

Table 2 – Summary statistics – working sample

Original sample	**Natives**	**Foreigners**	**Difference**
Share	*.818*	*.182*	
Unemployed	.060	.103	-.043***
	(.024)	(.030)	
Works in Australia	.912	.402	.510***
	(.283)	(.490)	
N (original sample)	35,549	7,943	
Working in Australia			
Share	*.888*	*.112*	
Wage (annual A$)	60,671	55,577	-5,094***
	(23,356)	(23,305)	
Ln hourly wage	3.40	3.40	0.0
	(.320)	(.317)	
Age	33.26	32.55	-.71
	(5.55)	(4.42)	
Females (share)	.521	.367	-.154***
	(.499)	(.482)	
NESB: English at home	.797	.255	-.542***
	(.402)	(.436)	
Go8 university	.581	.580	-.001
	(.493)	(.494)	
Field of study: STEM	.499	.656	.157***
	(.500)	(.475)	
Humanities	.348	.229	-.119***
	(.476)	(.421)	
Medicine & Health	.154	.115	-.039***
	(.361)	(.319)	
Worked in last year	.837	.652	-.185***
	(.370)	(.476)	
Employer public sector	.685	.665	-.020
	(.465)	(.472)	
Employer private	.239	.238	0.001
	(.426)	(.426)	
Employer other	.076	.097	.021
	(.265)	(.296)	
In part-time work	.341	.528	.187***
	(.474)	(.499)	
N (working sample)	16,945	2,142	

Source: GDS, 1999-2015. The working sample is restricted to PhD graduates aged 25-45 at the time of the data collection. This cut-off reflects international practice (OECD, 2019), to reduce the heterogeneity of the PhD student population, which includes age ranging 23-80+.

Table 3 – Summary statistics – working sample by main group

Working in Australia	Natives EBS	Natives NESB	Foreign ESB	Foreign NESB
Share	*.707*	*.181*	*.029*	*.083*
Wage (annual A$)	60,998	59,392*	58,321	54,637***
	(23,446)	(22,960)	(23,265)	(23,252)
Ln hourly wage	3.39	3.41**	3.40	3.40*
	(.319)	(.322)	(.315)	(.320)
Age	33.2	33.7***	31.7***	32.8
	(5.63)	(5.28)	(4.28)	(4.46)
Females (share)	.540	.424***	.463***	.336***
	(.498)	(.494)	(.499)	(.472)
Go8 university	.569	.625***	.600	.566
	(.495)	(.484)	(.490)	(.496)
Field of study: STEM	.471	.609***	.605***	.676***
	(.499)	(.488)	(.489)	(.468)
Humanities	.374	.237***	.280***	.212***
	(.484)	(.425)	(.449)	(.409)
Medicine & Health	.154	.154	.115	.112**
	(.361)	(.361)	(.319)	(.316)
Worked in last year	.856	.763***	.706***	.636***
	(.351)	(.425)	(.456)	(.481)
Employer public sector	.695	.655***	.666	.671*
	(.460)	(.475)	(.472)	(.470)
Employer private	.230	.275***	.233	.236
	(.421)	(.471)	(.423)	(.424)
Employer other	.075	.069	.101	.093
	(.264)	(.254)	(.301)	(.291)
In part-time work	.329	.391***	.505***	.536***
	(.470)	(.488)	(.500)	(.499)
Nr observations	13,496	3,449	547	1,595

Source: GDS, 1999-2015. The working sample is restricted to PhD graduates aged 25-45 at the time of the data collection. This cut-off reflects international practice (OECD, 2019), to reduce the heterogeneity of the PhD student population, which includes age ranging 23-80+.

Table 4 – Baseline results Oaxaca-Blinder decomposition at the mean

	Pooled: Natives vs. Foreigners	**Native ESB vs.**		
		Native NESB	***Foreign ESB***	***Foreign NESB***
Difference in ln hourly wage: Δ_t	.004 (.009)	.002 (.010)	.038 (.024)	.005 (.014)
Nr observations	19,087	16,945	14,043	15,091
Decomposition:				
Explained (E)	-.045*** (.009)	-.022*** (.004)	-.062*** (.018)	-.063*** (.010)
Unexplained (U)	.037*** (.010)	.031*** (.009)	.074*** (.024)	.058*** (.013)
Interaction	.011 (.010)	-.007* (004)	.028 (.018)	.010 (.010)
E contributors:				
Gender	-.009*** (.002)	-.003*** (.001)	-.002 (.002)	-.013*** (.003)
Age	-.004 (-.015)	-.004 (.006)	-.008 (.058)	-.003 (.008)
NESB	.008 (.007)	-	-	-
Go8	.0001 (.0001)	-.0001 (.0001)	-.0001 (.0001)	.0001 (.0001)
Work part-time	.024*** (.002)	.007*** (.001)	.019*** (.005)	.029*** (.003)

Notes: All observations with complete information. Mean wage decompositions are carried out using Oaxaca-Blinder method (Stata command: oaxaca). The reference group is the natives EBS. The covariates used in the model are human capital controls (gender, age, age square, if disable, if Aboriginal, if English is main language spoken at home, if graduated from Go8 university, if worked in last year of study, mode of attendance, share of foreign students in same field of education and university), institutional and labour market controls (lagged average wage and lagged unemployment rate by field of study and year), and dummy variables for the survey year and the geographical location of the employer. Adjustment is made for selection into emigration. Standard errors are bootstrapped (50 draws) and clustered by university. The signs *, **, and *** indicate p-values of < .1, <.05, and <.01, respectively.

Table 5 – Main results Oaxaca-Blinder decomposition by Field of Education

	Pooled Natives-Foreigners			Natives ESB-NESB			ESB Natives-Foreigners			ESB Nat.-NESB Foreigners		
	STEM	**Hum's**	**Me&H**	**STEM**	**Hum's**	**Me&H**	**STEM**	**Hum's**	**Me&H**	**STEM**	**Hum's**	**Me&H**
$\Delta_t, \Delta_t(\tau)$	-.037***	.029	.091**	-.022*	-.009	.066**	-.012	.063	-.381	-.046***	.038	.108
adjusted	(.012)	(.028)	(.044)	(.012)	(.019)	(.026)	(.027)	(.051)	(1.59)	(.014)	(.048)	(.095)
N	9,860	6,380	2,846	8,454	5,890	2,600	6,700	5,213	2,129	7,448	5,393	2,249
Decomposition:												
Explained (E)	-.067***	-.021	-.011	-.041***	-.010	-.022	-.073***	-.097	.148	-.075***	-.080**	-.047
	(.010)	(.033)	(.079)	(.008)	(.012)	(.014)	(.025)	(.060)	(2.90)	(.015)	(.033)	(.202)
Unexplained	.023**	.062**	.075*	.036***	.017	.072***	.067***	.080	-.392	.046***	.099**	.128
(U)	(.012)	(.028)	(.044)	(.012)	(.020)	(.026)	(.025)	(.051)	(1.59)	(.016)	(.049)	(.095)
Interaction^	Yes	Yes	Yes	-.016**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
				(.007)								
Contribution to E^												
Gender	-.007***	Yes	Yes	-.005***	.004*	Yes	Yes	Yes	Yes	-.010***	Yes	Yes
	(.002)			(.001)	(.002)					(.003)		
Age	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NESB	Yes	Yes	Yes	-	-	-	-	-	-	-	-	-
Go8	Yes	Yes	Yes	Yes	Yes	-.012*	Yes	Yes	Yes	Yes	Yes	Yes
						(.006)						
Work part-time	.023***	.021**	.025***	.007***	.005**	.006**	.017***	Yes	Yes	.027***	.028***	.029**
	(.003)	(.009)	(.009)	(.002)	(.002)	(.003)	(.005)			(.003)	(.010)	(.013)

Notes: Mean wage gap decompositions using Oaxaca-Blinder method (Stata command: oaxaca) following the two-step method proposed by Firpo, Fortin, and Lemieux (2011). The covariates used in the model are human capital controls (gender, age, age square, if disable, if Aboriginal, if English is main language spoken at home, if graduated from Go8 university, if worked in last year of study, mode of attendance, share of foreign students in same field of education and university), institutional and labour market controls (lagged average wage and lagged unemployment rate by field of study and year), and dummy variables for the survey year and the geographical location of the employer. Adjustment is made for selection into emigration. Standard errors are bootstrapped (50 draws) and clustered by university. The signs *, **, and *** indicate p-values of < .1, <.05, and <.01, respectively.

^ To ease reading of the details of the Table, only estimates that are different from zero at a 10% of lower level of statistical significance are reported. Estimates that are statistically identical to zero are reported as 'Yes'.

Table 6 – Main results Oaxaca-Blinder decomposition along the wage distribution

	Pooled Natives-Foreigners			Natives ESB-NESB			ESB Natives-Foreigners			ESB Nat.-NESB Foreigners		
	25q	**50q**	**75q**	**25q**	**50q**	**75q**	**25q**	**50q**	**75q**	**25q**	**50q**	**75q**
STEM												
$\Delta_t, \Delta_t(\tau)$ *adj*	-.067***	-.077***	-.019	.0001	-.030**	-.031**	-.046	-.034	.021	-.077***	-.077***	-.032***
	(.022)	(.015)	(.012)	(.018)	(.014)	(.015)	(.044)	(.038)	(.021)	(.025)	(.018)	(.013)
Explained (E)	-.073***	-.089***	-.072***	-.017	-.048***	-.043***	-.080***	-.100***	-.092***	-.063***	-.085***	-.051***
	(.008)	(.007)	(.007)	(.014)	(.008)	(.010)	(.009)	(.009)	(.011)	(.019)	(.014)	(.010)
Unexplained (U)	.005	.012	.052***	-.018	.018*	.011	.034	.066*	.113***	-.014	.008	.018**
	(.021)	(.014)	(.012)	(.012)	(.011)	(.010)	(.045)	(.039)	(.022)	(.015)	(.015)	(.008)
Humanities												
$\Delta_t, \Delta_t(\tau)$ *adj*	.004	.046*	.042	-.026	-.028	.035*	.010	.042	.146	.058	.075	.026
	(.051)	(.025)	(.028)	(.030)	(.027)	(.021)	(.102)	(.116)	(.094)	(.082)	(.050)	(.051)
Explained (E)	-.035***	-.068***	-.040***	-.020	-.034**	.016	-.023*	-.046***	-.023	.071	.016	.031
	(.013)	(.012)	(.012)	(.018)	(.016)	(.017)	(.013)	(.015)	(.015)	(.044)	(.029)	(.040)
Unexplained (U)	.039	.113***	.082***	-.006	.006	.019	.033	.088	.169*	-.013	.059	-.005
	(.051)	(.027)	(.027)	(.023)	(.020)	(.016)	(.098)	(.117)	(.090)	(.062)	(.044)	(.044)
Medicine & Health												
$\Delta_t, \Delta_t(\tau)$ *adj*	.115	.028	.033	.045	.057**	.031	-.518	-.417	-1.28	.114	.042	.062
	(.091)	(.052)	(.058)	(.037)	(.029)	(.032)	(4.72)	(2.32)	(3.59)	(.167)	(.092)	(.076)
Explained (E)	-.010	-.007	.012	.020	.023	.0003	-.009	.006	.031	.039	.046	.064*
	(.020)	(.015)	(.015)	(.024)	(.020)	(.020)	(.025)	(.021)	(.023)	(.038)	(.034)	(.037)
Unexplained (U)	.125	.035	.021	.024	.034*	.031	-.510	-.422	-1.31	.076	-.004	-.001
	(.093)	(.052)	(.059)	(.029)	(.018)	(.024)	(4.73)	(2.32)	(3.60)	(.158)	(.080)	(.070)

Notes: Quantile wage gap decompositions using Oaxaca-Blinder method (Stata commanda: oaxaca) following the two-step method proposed by Firpo, Fortin, and Lemieux (2011). The covariates used in the model are human capital controls (gender, age, age square, if disable, if Aboriginal, if English is main language spoken at home, if graduated from Go8 university, if worked in last year of study, mode of attendance, share of foreign students in same field of education and university), institutional and labour market controls (lagged average wage and lagged unemployment rate by field of study and year), and dummy variables for the survey year and the geographical location of the employer. Adjustment is made for selection into emigration. Standard errors are bootstrapped (50 draws) and clustered by university.

Table 7 – Labour market outcomes of PhD graduates

	Working hours	Employed full-time	Employed in higher education	Over-educated	Looking for a new job
Pooled data					
Native NESB	-1.28***	.012	.007	.011	.099***
	(.233)	(.010)	(.011)	(.008)	(.014)
Foreign ESB	-1.14*	-.019	.071***	.016	.077***
	(.650)	(.018)	(.024)	(.012)	(.027)
Foreign NESB	-3.89***	-.068***	.129***	.011	.133***
	(.471)	(.018)	(.016)	(.009)	(.015)
Adj. R^2	*.0697*	*.0551*	*.0371*	*.0268*	*.0420*
Nr observations	*19,087*	*19,087*	*19,087*	*19,087*	*19,087*
STEM					
Native NESB	-1.72***	-.027**	.037***	.011	.102***
	(.275)	(.010)	(.012)	(.009)	(.017)
Foreign ESB	-.752	-.018	.055	.016	.054
	(.852)	(.021)	(.034)	(.012)	(.038)
Foreign NESB	-3.68***	-.080***	.149***	.015	.116***
	(.484)	(.017)	(.017)	(.011)	(.017)
Adj. R^2	*.0710*	*.0471*	*.0468*	*.0287*	*.0455*
Nr observations	*9,860*				
Humanities					
Native NESB	-2.05***	-.007	.039**	.010	.148***
	(.460)	(.018)	(.018)	(.009)	(.024)
Foreign ESB	-2.62**	-.071*	.150***	.040	.128**
	(1.06)	(.041)	(.035)	(.026)	(.054)
Foreign NESB	-7.77***	-.207***	.193***	.024	.260***
	(.916)	(.034)	(.036)	(.019)	(.032)
Adj. R^2	*.1020*	*.0785*	*.0534*	*.0380*	*.0564*
Nr observations	*6,380*				
Medicine and Health					
Native NESB	-1.44**	.003	-.029	.026**	.074***
	(.544)	(.017)	(.037)	(.012)	(.025)
Foreign ESB	-2.03*	-.005	.038	-.023	.075
	(1.156)	(.038)	(.058)	(.035)	(.057)
Foreign NESB	-3.20***	-.020	.093**	-.011	.100***
	(.764)	(.036)	(.040)	(.016)	(.022)
Adj. R^2	*.0953*	*.0743*	*.0688*	*.0637*	*.0344*
Nr observations	*2,846*				

Notes: All observations with complete information. The reference group is the natives EBS. The covariates used in the model are human capital controls (gender, age, age square, if disable, if Aboriginal, if English is main language spoken at home, if graduated from Go8 university, if worked in last year of study, mode of attendance, share of foreign students in same field of education and university), institutional and labour market controls (lagged average wage and lagged unemployment rate by field of study and year), and dummy variables for the survey year and the geographical location of the employer. Adjustment is made for selection into emigration. Standard errors are clustered by university. The signs *, **, and *** indicate p-values of < .1, <.05, and <.01, respectively.

Table 8 – Labour market outcomes of PhD graduates, by industry

	Wages		Employed full-time		Looking for new job	
	University	**Other**	**University**	**Other**	**University**	**Other**
Pooled data						
Native NESB	-.032**	-.033***	-.066***	.024**	.165***	.085***
	(.015)	(.007)	(.021)	(.012)	(.028)	(.015)
Foreign ESB	-.096***	-.053***	-.086	.004	.170**	.054**
	(.032)	(.013)	(.055)	(.017)	(.079)	(.024)
Foreign NESB	-.139***	-.075***	-.261***	-.020	.200***	.117***
	(.026)	(.013)	(.030)	(.018)	(.027)	(.017)
Adj. R^2	.2108	.2694	.1123	.0548	.0856	.0355
Nr observations	4,411	14,666	4,411	14,666	4,411	14,666

Notes: All observations with complete information. The reference group is the natives EBS. The covariates used in the model are human capital controls (gender, age, age square, if disable, if Aboriginal, if English is main language spoken at home, if graduated from Go8 university, if worked in last year of study, mode of attendance, share of foreign students in same field of education and university), institutional and labour market controls (lagged average wage and lagged unemployment rate by field of study and year), and dummy variables for the survey year and the geographical location of the employer. Adjustment is made for selection into emigration. Standard errors are clustered by university. The signs *, **, and *** indicate p-values of < .1, <.05, and <.01, respectively.