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Same degree but different outcomes: an analysis of labour market outcomes for native and international PhD students in Australia

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Abstract

This paper used data on career destinations over the period 1999–2015 to study the labour market outcomes of native and foreign PhD graduates staying on in Australia as skilled migrants. Natives with an English-speaking background emerge as benefiting from positive employer 'discrimination' (a wage premium unrelated to observed characteristics such as gender, age, and previous work experience). The premium is field-specific and applies to graduates in Science, Technology, Engineering and Mathematics (STEM). In contrast, foreign PhD graduates with a non-English speaking background experience inferior labour market outcomes, especially if they work in the university sector. Against expectations to the contrary, completing the highest degree of education in the host country and staying on in the same sector where one acquired human capital does not appear to eliminate lesser labour market outcomes for the foreign-born.

Keywords: PhD graduates, Wage decomposition, Discrimination, International students

JEL Classification: I26, J24, J31, J61

1 Introduction

Over the past two decades, economic globalisation has led to an unprecedented increase in the number of international students. In 2017, they accounted for about 6% of university enrolments across the OECD, but their share was as high as 47% in Luxembourg and about 20% in Australia, New Zealand, and the United Kingdom (OECD 2019a – 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 2019b ibid).

This 'migration for education' phenomenon is noteworthy (Tani and Piracha 2022): on the one side, it has propelled the tertiary sector into becoming a major generator of export revenues. On the other, it has influenced 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 to patenting activity, entrepreneurship (Hunt and Gauthier-Loiselle 2010; Hunt 2011; Roach et al. 2019), international collaborations (Jonkers and Cruz-Castro 2013; Scellato et al. 2015; Carillo et al. 2013; Freeman et al. 2014), and economic activity at large (Ackers 2005).

The economic effects of foreign students are the subject of broad analyses of skilled migration (OECD 2001, 2008 and 2018) and higher education (OECD 2019b; Zhou et al. 2008; Crawford and Wang 2016). However, little is known about the graduates staying on in the country of education as skilled migrants, and how they fare relative

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to comparably educated natives. This particular flow of highly trained individuals is worth studying not only for its association with desirable economic outcomes but also for shedding light on fundamental questions about the potential role of host country education in reducing the loss of human capital typically experienced by migrants (Chiswick and Miller 2009).

An apparent contradiction characterises the economic outcomes of highly educated migrants. Several studies show that emigrants are positively selected. In other words, they are better motivated (Borjas 1987 and 1991; Grogger and Hanson 2011) and educated than those left behind (Carrington and Detragiache 1998 and 1999; Docquier and Marfouk 2004; Docquier et al. 2005) and those returning to the country of origin (DaVanzo 1983; Gibson and McKenzie 2009; Dustmann and Kirchkamp 2002). They are also more educated and motivated than the natives of their respective host countries (Docquier et al. 2014). However, they are more likely to experience 'over-education' (Hartog 2000; Groot and van der Brink 2000; Leuven and Oosterbeek 2011): they earn lower wages and work in jobs requiring less education than what is consistent with their qualifications, especially if they are highly educated (Piracha et al. 2012; Tani 2020).

Such poor labour market outcomes have been attributed to employers' possible distaste for foreigners (Becker 2010) or their unawareness about the signal value of education completed abroad (Altonji and Pierret 2001; Tani 2017). While adding a formal recognition of foreign qualifications helps migrants improve their labour market prospects (Friedberg 2000), it remains unclear whether graduating and working in the host country puts them at par with natives in terms of wages and job quality: is this the case?

This paper helps to fill this knowledge gap by comparing the labour market outcomes of native and foreign students graduating from doctoral (PhD) programmes. Addressing this question is relevant for understanding the determinants of the returns to the most intensive investment in education, and the main source of labour supply for research-intensive employers in academia, government, and parts of the business sector (Hayter and Parker 2019; Garcia-Quevedo et al. 2012; Sauermann and Roach 2012).

There are several reasons to restrict the analysis to graduates with PhDs only rather than including other tertiary-educated graduates. The main one is that the characteristics of students, study programme, and job opportunities for PhD graduates are less heterogeneous than that experienced at lower levels of education. This may limit the bias arising from unobserved heterogeneity—i.e. the set of factors that influence the outcome of interest but cannot be, or are not, measured. In a PhD programme, students tend to develop specialist skills and knowledge that appeal to a relatively limited range of types of people: namely those with interest, motivation, and predisposition for research and detailed work (Wächter 2004; Schneider 2013). This differs from the case of lower levels of education, like Masters and Bachelor degrees, where the variety of student types is wider and the skills developed tend to be generic and suitable for an extensive range of occupations (Beertsen 2006; Cumming 2010). Notwithstanding the self-selection occurring in the choice of doctoral studies, the narrow set of student types and job opportunities lends support to the prior that the determinants of labour market outcomes at PhD level, and any emerging differences between natives and foreigners, are less influenced by unobserved heterogeneity and corresponding estimates less affected by bias.

Other reasons to focus on PhDs is a labour market with effectively full employment (e.g. OECD 2019b—Table B7.5), and a market where the signal value of education is well understood: for instance, an employer gauging the potential productivity of two identical candidates aside from their nationality is unlikely to value differently the PhDs if they are awarded in the same discipline by the same institution. If the employer offered different salaries then other reasons, which could be precisely identified depending on the availability of data, would be at play. This paper contributes to verifying this possibility.

In focusing on PhD graduates this paper contributes to the relatively small literature that links foreign graduates and migration[1]—notwithstanding the general interest in PhD graduates' mobility (Auriol 2007; Solimano 2008; Freeman 2010). Existing literature traditionally studies doctoral programmes from an educational standpoint namely, as formative training for subsequent employment (Mangematin and Mangran 1998; Mangematin 2000; Lissoni 2012) in a global labour market (Auriol et al. 2013; De Grip et al. 2010). PhD graduates' outcomes are the focus of more recent work, which views the emergence of temporary and casual post-doctoral positions (Stephan and Ma 2005) as the result of an over-supply[2] of PhD students (Cyranoski et al. 2011). This stream of research also highlights that more competitive conditions in the

[1] For example, the effect of a substantive number of agreements among universities to encourage student visits and joint international PhD supervision (cotutelle), which provide training and experience recognised across multiple countries of education (Cañibano et al. 2011; Franzoni et al. 2012) remains under-researched.

[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).

academic labour market may have prompted many PhDs to find employment outside the university sector[3] (Su 2013). Overall, foreign-born PhD graduates experience the worst outcomes in terms of job quality and salary.

While situated at the intersection of education, migration, and labour market research this paper studies the returns to a PhD degree using the case of Australia, adding to a limited literature (Harman 2002; Neumann et al. 2008). Australia is one of the most popular destinations for international PhD students (40% of PhD graduates are foreigners versus 25% across the OECD). Australia also uses migration policy to openly attract applicants with tertiary and higher education, and this raises valid reasons to compare outcomes between natives and foreigners completing identical degrees in the country.

The empirical analysis is based on data sourced from the Graduate Destination Survey (GDS). This is a comprehensive educational and employment survey carried out by each university. The GDS has a set of universal questions, which are commonly asked across universities (e.g. student profile, occupational outcomes), and a set of optional questions, which are chosen by each university and cannot be compared across the sector. The data used cover the universal questions for the period 1999–2015, a time of significant developments in the tertiary sector and the overall economy in Australia (Ranasinghe 2015): they include the years of rapid increase in the enrolment of international students (early 2000s), eased by favourable legislative changes that enabled the use of schooling in lieu of local employment to apply for permanent residence (subsequent changes in the next decade restricted this migration pathway). The period also includes the Global Financial Crisis (GFC), which negatively affected hiring decisions and wage growth since 2008.

One distinctive feature of the empirical analysis is the classification of native and foreign students into those with an English-Speaking Background (ESB) and those with a Non-English Speaking Background (NESB), respectively. This distinction captures the multicultural nature of Australia's population, as identified by answer to what language is mostly spoken at home (https://www.abs.gov.au/ausstats/abs@.nsf/mf/1289.0), and the fact that people often identify with and maintain the language and culture of their places of origin even if they are 'natives' overall.[4] The ESB/NESB distinction is common in Australian statistics, but in the context of this paper doing so offers novel insights on the returns to education between various sub-groups of the student population.

Table 1 Data trimming

Condition	N	%
Pooled GDS for PhD, 1999–2015	51,959	100.0
Complete with country of employer	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	

As Australia allows dual citizenship, it is not possible to rely on indicators of nationality or country of birth to clearly distinguish natives from foreigners. This problem is overcome by using university fees, where the categories for domestic and international students do not overlap. Combined with information about each student's cultural background, as recorded by the GDS using the question on language spoken at home, this approach yields a well-defined taxonomy of mutually exclusive categories of PhD graduates in Australia:: (i) native ESB, (ii) native NESB; (iii) foreign ESB, and (iv) foreign NESB.

The GDS unfortunately neither includes indicators of personality or individual preferences, nor schooling performance (e.g. grades, publications during the PhD), duration of the PhD, or whether any prior education was completed in Australia. This potential source of bias is formally tested using the methodology developed by Oster (2019). This test suggests that the results are robust to omitted variable bias.

The empirical analysis is based on PhD graduates in the age group 25–45 in line with international practice (e.g. OECD 2019 – Table B7.2). The initial focus is on the difference in starting wages between the control (native ESB) and the other three groups (native NESB, foreign ESB and NESB, respectively) using the Blinder-Oaxaca decomposition (Jann 2008). Regression analysis is then applied to estimate the influence of individual and institutional characteristics on an expanded set of labour

[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). For other authors, the higher heterogeneity of employers and jobs has also raised the likelihood of mismatch between competences acquired during the PhD training programme 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).

[4] Of the 29,129 PhD graduates of the untrimmed sample (see Table 1) who are Australian citizens or permanent residents in the age group 25–45, only 63.1% speak English at home (ESB) while 36.9% speak a language other than English (NESB). Of the 8,816 PhD graduates of the untrimmed sample who are neither Australian citizens nor permanent residents in the age group 25–45, 29.4% speak English at home (ESB) while the remaining 70.6% speak another language (NESB). Even among those born in Australia, about 5% of PhD graduates are NESB, i.e. they do not speak English at home.

market outcomes that includes hours of work, over-education, and the probability of working in a full-time job.

The results reveal that there is no difference in the average starting salary 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 (between 2.2 and 6.3%). This occurs because of a higher share of women and part-time workers in this group. The native ESB's wage penalty is completely offset when the unobserved component is added up—that is when one takes into account features that are not included in the regressions (see Sect. 4) such as the structure of the labour market, pay rates across industries, and employers' preferences. These factors can nevertheless result in identical people being paid differently across sectors.

Further analysis reveals that the offsetting influence of unobserved variables, which the literature typically refer to as 'discrimination' (e.g. Oaxaca and Ransom 1994), varies by field of study: it is 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 wage penalty is detected in the case of Medicine, Dentistry and Health except for the comparison of ESB-NESB natives, where ESB natives enjoy a 7.2% premium entirely due to the unobserved component. This result occurs almost exclusively at the higher end of the wage distribution, suggesting that unobservable characteristics become more relevant determinants of pay once standard requirements have been met. 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 among the four groups of graduates: they work fewer hours, are less likely to work in a full time occupation, and have the highest probability for looking for another job. This sub-group is the most likely to work in the university sector. These results highlight the apparent contradiction between benefiting from international PhD students and being unable or unwilling to offer these graduates alternative career opportunities. While both universities and foreign PhDs may find this arrangement suitable, it is unclear whether the status quo may negatively affect the learning experience of students at a lower level of tertiary education (who are commonly taught or tutored by seasonal PhD graduates). More data are required to provide an answer.

Overall, acquiring education in the host country is far from putting foreigners and natives on equal pay, even when students complete the same, and highest possible, degree of formal education. There are reasons to question whether this situation is sustainable in the long-term without compromising universities' reputation and their ability to keep attracting high quality international students.

The rest of the paper is organised as follows. Section 2 describes the data. Section 3 discusses the methodology. Section 4 presents the results. Section 5 concludes.

2 Data

The empirical analysis uses sixteen rounds of the GDS, a national survey of higher education graduates. The GDS was administered by Graduate Careers Australia until 2016, when another organisation began collecting data with a new survey that could not be directly compared with earlier editions. The GDS is offered to all new graduates from Australian universities via email, phone, or in person—typically at time of graduation to optimise time and density of respondents. It is widely used to explore the transition between higher education and the labour market. The GDS's average response rate is between 50 and 60% of the native graduand population (Guthrie and Johnson 1997). Lower rates apply for international students (ibid), who predominantly fill in the GDS in person during their graduation days. Although the GDS is an annual survey, there is a strong correspondence between the data it collects and the administrative data collected by Australia's Department of Education (DE): the distribution and evolution of the share of foreign PhD graduates over the period by field of study between population (DE) and sample (GDS) is similar (Fig. 1), as is also formally verified through regression analysis.[5] The sorting of native and foreign PhDs into different fields of education also evolves along similar paths (Fig. 2).

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 (grades, number of publications), and previous education in Australia or work history are not asked, though the GDS records whether or not graduates worked in the final year of their studies. The possibility of omitted variables bias is tested using the technique developed by Oster (2019), but the tests suggest that the results are robust to it: the amount of unobserved heterogeneity required to nullify the effect of nationality is 2–3 times higher than the suggested benchmark.[6] This is highly unlikely.

[5] Regressing by Ordinary Least Square the ratio of Foreign/Native PhD graduates on an interaction term between field of study and time to detect possible separate trends yields coefficient that are statistically no different from zero. Such model includes dummy variables for the field of education and time, but no constant term.

[6] Oster's approach relies on the assumption that observed and unobserved variables are related, from which one can 'reverse engineer' the ratio of unobserved versus observed selection ('*delta*'), which would turn zero the estimate of the explanatory variable of interest ('*beta*'): the delta obtained range from 2.16 to 3.6 versus the benchmark of 1 suggested by Oster. This level of unobserved heterogeneity is highly unlikely, and on this basis it is possible to consider the estimates obtained as 'robust to omitted variable bias'.

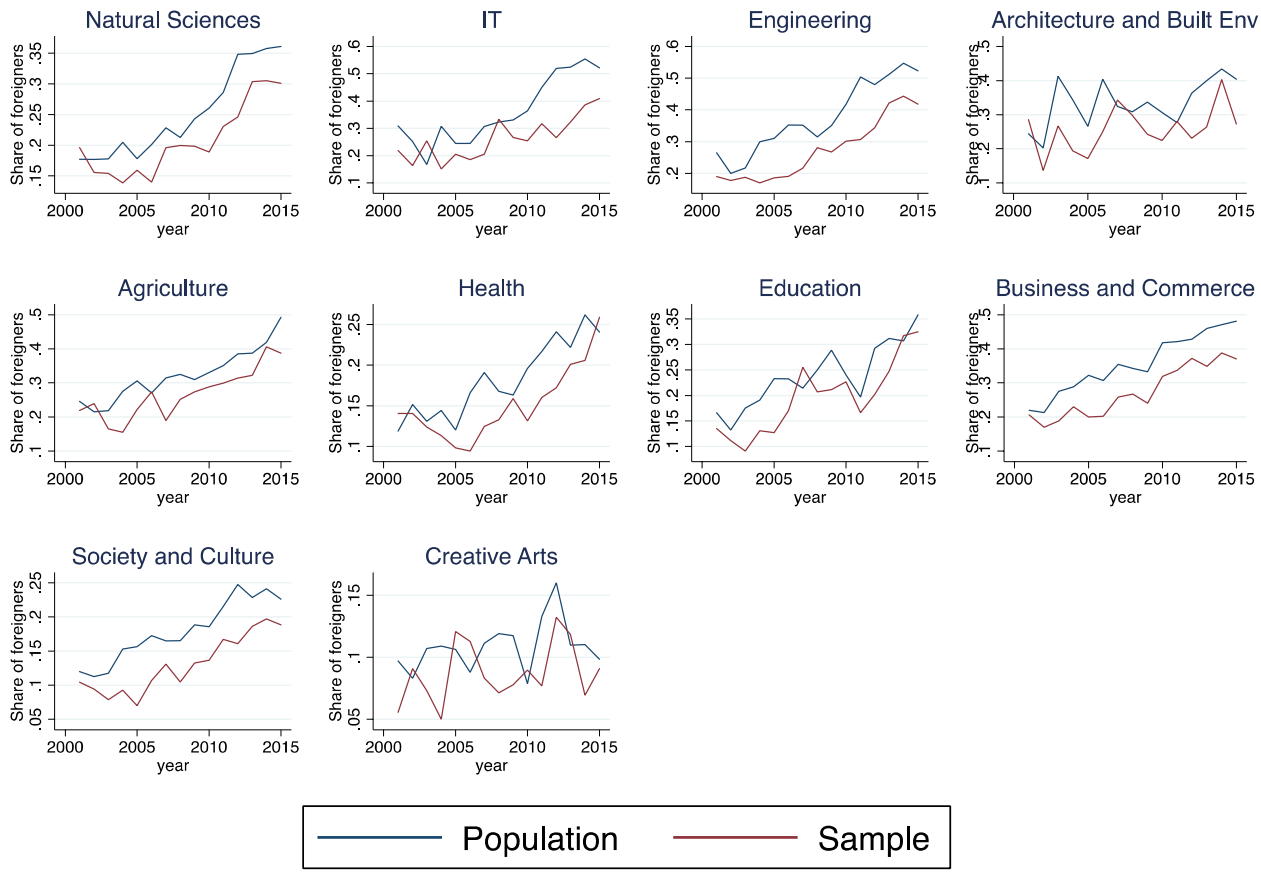

Fig. 1 The evolution of foreign PhDs in Australia by field of education: population and administrative data 1999–2015

2.1 Working sample

From the 16 rounds of the GDS (51,959 observations) the working sample is restricted to observations on those working in Australia (35,716 observations) and aged 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, as used 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 and 99% of the raw distribution) reduce the working sample to 19,087 observations, with 16,945 covering native (88.8%) and 2142 foreigner (11.2%) PhD graduates, respectively. Table 1 summarises the trimming carried out.

Table 2 presents the summary statistics 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 on the basis of t-tests of mean differences.

2.2 Selection issues

Not every graduate remains in Australia, and not everyone staying on is employed. As a result there are two important sources of possible selection. The first is unemployment, but the first row of Table 2 indicates that PhD graduates experience low unemployment rates (lower than the national unemployment rate), though these are higher for foreigners. Formally accounting for selection into employment makes no difference to the empirical results, and therefore it is not further discussed.

The second source of selection is emigration (for natives) and return to the country of origin for foreigners. These effects are more marked: 8.8% of native Australian PhDs move abroad to work with a foreign-based employer while 40.9% of foreign PhDs remain in Australia. This source of selection influences the empirical results, as it is unlikely that those who stay and move (or return) are of identical quality. To account for this source

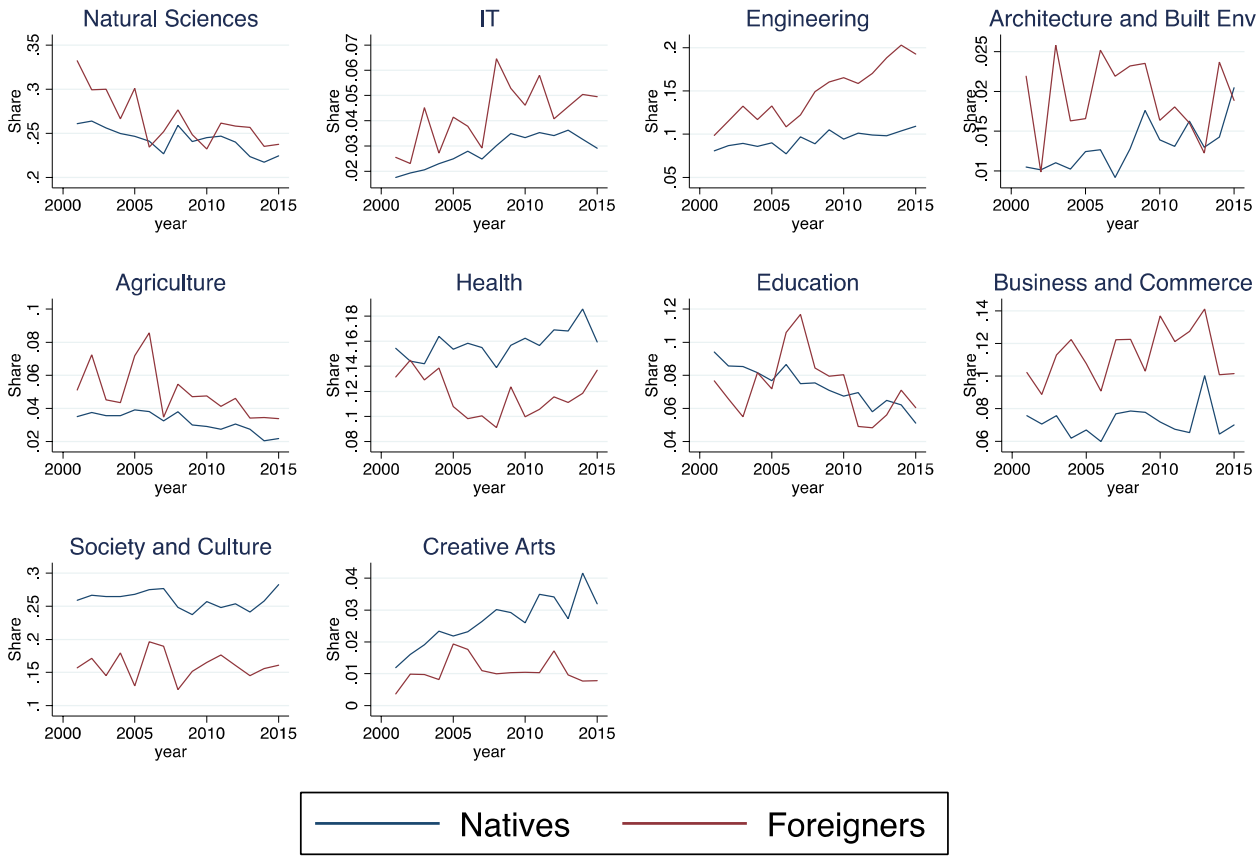

Fig. 2 Field of study of native and foreign PhDs in Australia: 1999–2015

of bias, a new variable is included in the form of an index (inverse Mills ratio) capturing the probability of remaining in Australia upon graduation—i.e. the probability of non-selection. This index is estimated from a probability (probit) 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. The resulting index tries to capture the quality of the PhD graduate using the insights of Roy's (1951) model of self-selection applied to the case of PhD graduates (Heckman and Taber, 2010; Borjas et al. 1992): namely that the migration decisions of native and foreign graduate reflect economic opportunity (e.g. relative income of the country of birth vs. Australia, labour market status in the final year of study), and individual ability (higher if the PhD is completed within the expected time with no delay, and if graduating from a research-intensive university). The inverse Mills ratio that is generated is added to the explanatory variables to better control for the selection into emigration/return to country of origin.

Unavailable data constrain the analysis to omit a third source of selection: native Australians undertaking PhD studies abroad and returning to Australia to work. This is an acknowledged limitation, as this sub-group of students likely includes some of the country's most promising researchers (e.g. Rae 1999), and likely skews downwards the average ability of the native Australians PhDs surveyed by the GDS. Notwithstanding this bias, its possible influence on the results presented in the paper is unlikely to be noticeable given the (very) small number of native Australians completing a postgraduate research degree abroad (e.g. Nerlich 2015—Fig 2).

2.3 Summary statistics

The unconditional means reported in Table 2 show that Australian graduates earn a higher annual and hourly salary than foreigners in absolute terms, but this seems related to working more hours, as the hourly pay of native and foreign PhDs is similar. Even though natives and foreigners work predominantly for the public sector, which in Australia includes 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

Table 2 Summary statistics—original sample and working sample restricted to those working in Australia

Original sample	Natives	Foreigners	Difference
Share	*.818*	*.182*	
Unemployed	.060 (.024)	.103 (.030)	−.043***
Works in Australia	.912 (.283)	.402 (.490)	.510***
N (original sample)	35,549	7,943	
Working in Australia			
Share	*.888*	*.112*	
Wage (annual A$)	60,671 (23,356)	55,577 (23,305)	−5,094***
Ln hourly wage	3.40 (.320)	3.40 (.317)	0.0
Age	33.26 (5.55)	32.55 (4.42)	−.71
Females (share)	.521 (.499)	.367 (.482)	−.154***
English spoken at home	.797 (.402)	.255 (.436)	−.542***
Go8 university	.581 (.493)	.580 (.494)	−.001
Field of study: STEM	.499 (.500)	.656 (.475)	.157***
Humanities	.348 (.476)	.229 (.421)	−.119***
Medicine and Health	.154 (.361)	.115 (.319)	−.039***
Worked in last year	.837 (.370)	.652 (.476)	−.185***
Employer public sector	.685 (.465)	.665 (.472)	−.020
Employer private	.239 (.426)	.238 (.426)	0.001
Employer other	.076 (.265)	.097 (.296)	.021
In part-time work	.341 (.474)	.528 (.499)	.187***
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 +. The t-test of mean difference shows the null of no difference, which is rejected at the 1% ('***'), 5% ('**') or 10% ('*') level of statistical significance

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.[7]

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. They are similar in age, on average in the early 30 s, 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.[8]

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 PhD graduates are overwhelmingly enrolled in technical and scientific disciplines (65.6%). The corresponding proportion among Australians is less pronounced (49.9%), and more balanced in the Humanities (34.8%), and Medical or Health studies (15.4%). The distribution of foreign PhDs across other disciplines is similar to natives', 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 foreign students. Native ESB students account for 79.7% of native PhD graduates, but the remaining 20.3% includes first and second-generation migrants with a NESB cultural background. In other words, a fifth of native PhDs speak a language other than English at home. This proportion includes second generation migrants, born in Australia, and those who are naturalised. The proportions of ESB and NESB students in the foreign group are reversed: 25.5% are ESB (mostly from New Zealand, UK, US and Canada) while the remaining are NESBs. The relatively large shares of ESB and NESB within native and foreign student aggregations are similar to what has been noted at Bachelor level (Carroll and Tani 2002), and illustrate the heterogeneity of backgrounds that characterises students enrolled in Australian universities.

Table 3 focuses on the four subgroups ESB/NESB among native and foreign PhD graduates.

The summary statistics in the table show similar wages per hour despite different underlying wage distributions (Fig. 3) and trends during the period by broad field of study (Fig. 4).

Foreign NESB graduates are predominantly males, concentrate in STEM and are less likely to work in their final

[7] Until 2018 PhD graduates could stay in Australia for up to four years regardless of their labour force status (e.g. https://www.studyinternational.com/news/know-your-rights-can-i-stay-in-australia-after-i-graduate/). Legislative changes have reduced the maximum length of stay, but there are several opportunities to seek work after graduation, as completing a degree in Australia is a common pathway to permanent residence (e.g. https://immi.homeaffairs.gov.au/visas/getting-a-visa/visa-listing/temporary-graduate-485).

[8] 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 (Fig. 3).

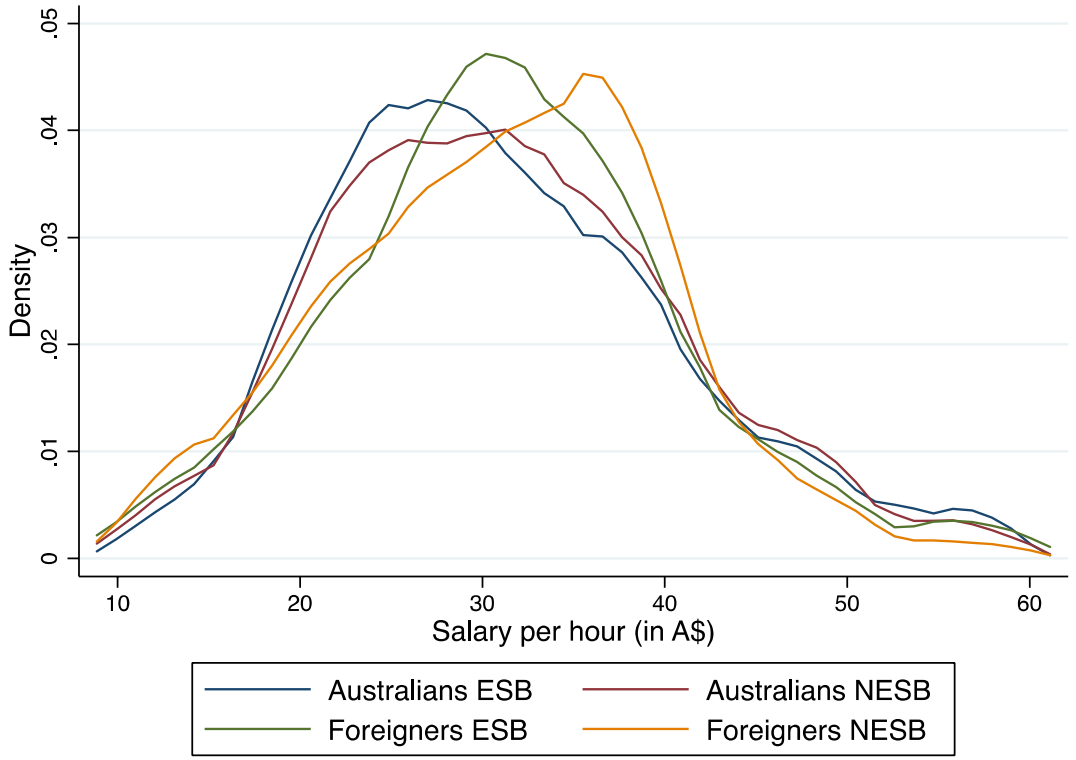

Fig. 3 Average hourly wage distribution of natives and foreigners: 1999–2015

year of study. They also tend to work in part-time positions after their graduation. Native NESB graduates too are characterised by a prevalence of male students, and concentration in STEM degrees and Go8 universities. In contrast, both native and foreign ESB graduates have a more balanced gender ratio, and distribution across fields of education.

3 Methods

3.1 Decomposition at the mean values of the dependent variable

As a preliminary step, the decomposition developed by Oaxaca and Blinder (Jann 2008) is applied to wage differences between the various sub-groups. This approach yields the contribution of observed (composition effect) and unobserved (price or wage structure effect) factors and their interaction. If wages are linearly related to the explanatory variables, it is possible to write the wage equations for two sub-groups of N(ative) and I(nternational) PhD graduates as:

$$W_{Nt} = X_{Nt}\beta_N + \varepsilon_{Nt} \tag{1}$$

$$W_{It} = X_{It}\beta_I + \varepsilon_{It} \tag{2}$$

where W is the logarithm of the hourly wage for group N (or I) at time t, the vector X includes demographic characteristics (gender, age, age squared, whether speaking English at home as main language, if disabled or from an aboriginal[9] 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).

Then the difference of the Ordinary Least Squares (OLS) estimates of (1) and (2) can be written as:

$$\begin{aligned}\Delta_t \;=\; \overline{W}_{Nt} - \overline{W}_{It} =& (\overline{X}_{Nt} - \overline{X}_{It})\beta_{It} + (\beta_{Nt} - \beta_{It})\overline{X}_{It} \\ &+ (\overline{X}_{Nt} - \overline{X}_{It})(\beta_{Nt} - \beta_{It})\end{aligned} \tag{3}$$

where:

(i) $(\overline{X}_{Nt} - \overline{X}_{It})\beta_{It}$ is the explained component. It measures the differences that can be attributed to the observed $\overline{X}$'s (endowment effect).

(ii) $(\beta_{Nt} - \beta_{Nt})\overline{X}_{It}$ is the unexplained component (coefficients). It measures the difference in the returns of each given characteristic (the β's) at their relevant levels; and

[9] Aborigenes are classified as native ESB (https://theconversation.com/10-ways-aboriginal-australians-made-english-their-own-128219#:~:text=Aboriginal%20English%20is%20spoken%20by,spoken%20by%20many%20Aboriginal%20children.).

Table 3 Summary statistics—working sample by main group restricted to those working in Australia

Working in Australia	Natives ESB	Natives NESB	Foreign ESB	Foreign NESB
Share	*.707*	*.181*	*.029*	*.083*
Wage (annual A$)	60,998 (23,446)	59,392* (22,960)	58,321 (23,265)	54,637*** (23,252)
Ln hourly wage	3.39 (.319)	3.41** (.322)	3.40 (.315)	3.40* (.320)
Age	33.2 (5.63)	33.7*** (5.28)	31.7*** (4.28)	32.8 (4.46)
Females (share)	.540 (.498)	.424*** (.494)	.463*** (.499)	.336*** (.472)
Go8 university	.569 (.495)	.625*** (.484)	.600 (.490)	.566 (.496)
Field of study: STEM	.471 (.499)	.609*** (.488)	.605*** (.489)	.676*** (.468)
Humanities	.374 (.484)	.237*** (.425)	.280*** (.449)	.212*** (.409)
Medicine & Health	.154 (.361)	.154 (.361)	.115 (.319)	.112** (.316)
Worked in last year	.856 (.351)	.763*** (.425)	.706*** (.456)	.636*** (.481)
Employer public sector	.695 (.460)	.655*** (.475)	.666 (.472)	.671* (.470)
Employer private	.230 (.421)	.275*** (.471)	.233 (.423)	.236 (.424)
Employer other	.075 (.264)	.069 (.254)	.101 (.301)	.093 (.291)
In part-time work	.329 (.470)	.391*** (.488)	.505*** (.500)	.536*** (.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+. The t-test of mean difference shows the null of no difference with ESB natives, which is rejected at the 1% ('***'), 5% ('**') or 10% ('*') level of statistical significance

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

This decomposition yields the expected change in sub-group *I*'s average wages assuming that people in this sub-group have the same $\overline{X}$'s or β's as those in sub-group *N*. Natives, and within them ESB natives, are chosen as a reference, as they account for the largest share of graduate among all sub-groups. This makes them a natural group for comparing between native and foreigner labour market outcomes. The empirical analysis follows the 'traditional' decomposition, which includes an interaction term to ascertain whether the outcome of interest is influenced by the simultaneous presence of different endowments and coefficients. This turns out not to be the case, as the interaction term is no different from zero in most comparisons.[10]

[10] See Jann (2008) for an exhaustive discussion on alternative implementation of the Oaxaca-Blinder decomposition.

3.2 Decomposition away from the mean of the dependent variable

To extend the analysis 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,[11] which can in turn be decomposed as:

[11] 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:

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

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

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

and

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

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

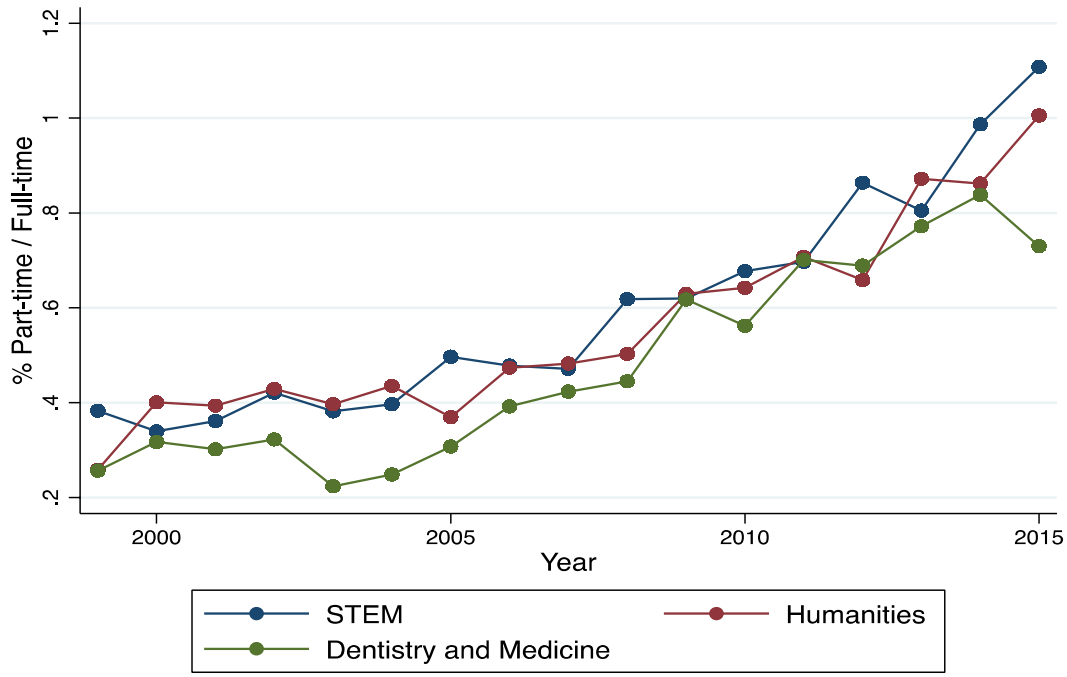

Fig. 4 Average odd ratio of part-time and full-time employment among PhD graduates working in Australia: 1999–2015

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

where the terms $(\overline{X}_{Nt} - \overline{X}_{It})\delta_{It,\tau}$ and $(\delta_{Nt,\tau} - \delta_{It,\tau})\overline{X}_{Nt}$ 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.

3.3 Regression analysis

The study of wage differences is followed by a regression analysis to understand their determinants in more detail using several other labour market outcomes. These include the hours of work (trimmed to the range between 1 and 70 per week), 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, and looking for another job. For each outcome, an Ordinary Least Squares (OLS) regression is based on the statistical model:

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

where y is the labour market outcome of interest for individual i at time t; X is a vector of individual characteristics as previously discussed, which includes an inverse Mills ratio indicator of self-selection into staying in Australia vs. returning to the country of origin or emigrating; IN is the 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 idiosyncratic error term. As the GDS is an annual survey, model (6) is applied to pooled cross-sectional observations with standard errors clustered at university level to capture institutional commonalities.

4 Results and discussion

4.1 Wage decomposition at the mean

Table 4 shows the baseline decomposition of the difference in the logarithm of the average hourly wage between natives and foreigners.

The top row shows the average difference, while subsequent rows report its Oaxaca-Blinder decomposition into components (model 3). The explained component estimates group differences in endowments while the main contributors are reported in the lower rows of the table. A positive Δ_t means that natives enjoy a premium relative to foreigners at the mean value of the relevant dependent variable, while a negative Δ_t means that they experience a penalty. The Δ_t accounts for selection into emigration or return to the country of origin.

As evident from the first row of the table, there is no statistical difference between the average hourly wage of native and foreign ESB and NESB graduates. This result 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 estimated effect is not small: relative to the average starting hourly wage of just over $32[12] a one percentage point increase in the negative contribution of the explained component reduces the hourly wage by about $3.[13] Added up over the course of a working life, such an hourly penalty is indeed large.[14] The items under 'Contribution to E' in the bottom part of the table identify the sources of this penalty. They are 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 (year dummy indicators are all negative and statistically different from zero). Natives' penalties would be worse were it not for working more hours.

Against the effect of observed components, native ESB graduates enjoy a premium from unobserved characteristics. This can be thought of as a positive externality or favourable structural feature of the labour market that cancels out the wage penalty from observed variables. 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 graduates. The interaction term is statistically equivalent to zero.

To understand whether these results vary across fields of education, separate regressions are carried out, and the results are reported in Table 5. The pooled regressions mostly reflect what graduates in STEM experience. This is the only field 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 graduates experience compensating effects of penalty from observed and premium from unobserved characteristics.

No wage gap arises between natives and foreigners in the Humanities, while in Medicine and Health, where Australia has traditionally experienced labour market shortages until recently, foreigners enjoy a premium.

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)

All observations with complete information. Mean wage decompositions are carried out using Oaxaca-Blinder method (Stata command: oaxaca). The reference group is the natives ESB. 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

4.2 Wage decomposition away from the mean

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 along the wage distribution: 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 graduates have a more balanced gender mix, as the gender pay gap disadvantages women and, indirectly, natives. Correspondingly, the unexplained component has the opposite sign but it is statistically different from zero only at the 75th quantile. Native ESB seem to benefit from unobserved determinants relative to every other sub-group when jobs are better paid and competition is likely tougher. This finding is novel, and is consistent with the

[12] This is obtained from e^3.39 (from Table 3, second row) = $32 (approximately).

[13] From Eq. (3), a 1% increase in $(\overline{X}_{Nt} - \overline{X}_{It})$ reduces Δ_t by 0.00045 (i.e. − .045, in row 3 column 1 of Table 4, multiplied by the 1% increase), which is .00045/.004 = .11 (approximately), or $3 (i.e. $32 x .11), relative to the value of Δ_t(.004 from Table 4, row 1 column 1).

[14] Assuming no inflation for simplicity, a 3$ hourly difference in an 8-h/day (5 working day/week, 45 working weeks/year and a 30 year career) is worth about $162,000 (= $3 × 8 × 5 × 45 × 30) or almost 3 years of work given an average annual salary of $60,000—a large effect.

hypothesis that the PhD labour market is not only influenced by observed determinants where they matter most: at the top of the job scale.

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. Wage gaps however present only one dimension of the labour market.

4.3 Regression analysis

To better understand the type and quality of the employment of PhD graduates, model (6) is applied to several outcomes besides hourly wages. This set of estimates is summarised in Table 7. The first two columns show the results when the hours of work and the probability of working full-time are used as dependent variable, respectively. The next column shows the determinants of the probability of working in higher education, either as lecturer or tutor, followed by the probability of over-education. The last column of Table 7 shows the determinants of the probability of looking for another job, which is interpreted as an indicator of overall dissatisfaction with the current job.

The top panel of Table 7 shows the results of pooled regression across fields of education, while those in the middle and bottom of the table present those obtained from the regressions performed separately on STEM, Humanities, and Medicine and Health. In each case, model (6) is estimated by OLS using native ESB as the reference group.

The regression on pooled data illustrates 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 of working in a full-time job (−0.068). This occurs in STEM (−0.080) and Humanities (−0.207). The third column shows that foreign PhDs, regardless of their cultural background, are more likely to work in higher education than natives. PhD graduates seem to work in jobs that require a doctoral level of education, as indicated by the lack of statistical significance of the estimates reported in the fourth column of Table 7. However, as NESB foreign PhDs are more likely to look for another job (last column), they do not seem to work in highly desirable positions within the tertiary sector. Further examinations of annual salary data and hours of work reveal that native ESB PhDs work about 8% more hours than their foreign NESB equivalents when in full-time employment, but 26% more hours when working part-time. In other words, foreign NESB graduates experience a penalty relative to their native equivalents especially when working part-time. In addition, at the lowest end of the earning distribution (up to A$10,000 per annum or about 20% of the average salary of a PhD graduate), where there is higher likelihood of temporary and casual positions, foreign NESB graduates account for more than 30% of the PhD graduate workforce. However, they represent only 13% of the PhD graduate workforce earning between A$10,000 and A$50,000, and 11% of that earning between A$50,000 and A$100,000—salaries overwhelmingly drawn from full-time employment. This evidence is consistent with the hypothesis that foreign PhDs commonly take up temporary and casual/sessional positions—the least secure, and possibly less rewarding, academic jobs—from which they are trying to move out (last column of Table 7). This hypothesis, which is somewhat puzzling as the tertiary sector trains those very students and knows well their abilities and strengths from their curriculum, applies especially to PhD graduates in STEM and the Humanities but not to those completing Medicine and Health degrees, for whom the labour market outcomes by nationality are statistically identical.

4.4 Universities as employers

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. The results are summarised in Table 8. Relative to native ESB graduates, every other sub-group working in higher education receives lower wages (−3.2% for native NESB 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 natives (−6.6%) or foreigners (−26.1%). The penalty for foreign ESB is substantial (−9.6%) though this group has similar likelihood of carrying out a full time job as native ESB graduates.

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 of working full-time, suggesting that nationality and cultural background have less influence in accessing jobs. 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. This set of

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**
Δ_t, $\Delta_t(\tau)$	−.037*** (.012)	.029 (.028)	.091** (.044)	−.022* (.012)	−.009 (.019)	.066** (.026)	−.012 (.027)	.063 (.051)	−.381 (1.59)	−.046*** (.014)	.038 (.048)	.108 (.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*** (.010)	−.021 (.033)	−.011 (.079)	−.041*** (.008)	−.010 (.012)	−.022 (.014)	−.073*** (.025)	−.097 (.060)	.148 (2.90)	−.075*** (.015)	−.080** (.033)	−.047 (.202)
Unexplained (U)	.023** (.012)	.062** (.028)	.075* (.044)	.036*** (.012)	.017 (.020)	.072*** (.026)	.067*** (.025)	.080 (.051)	−.392 (1.59)	.046*** (.016)	.099** (.049)	.128 (.095)
Interaction^	Yes	Yes	Yes	−.016** (.007)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Contribution to E^												
Gender	−.007*** (.002)	Yes	Yes	−.005*** (.001)	.004* (.002)	Yes	Yes	Yes	Yes	−.010*** (.003)	Yes	Yes
Age	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NESB	Yes	Yes	Yes	–	–	–	–	–	–	–	–	–
Go8	Yes	Yes	Yes	Yes	Yes	−.012* (.006)	Yes	Yes	Yes	Yes	Yes	Yes
Work part-time	.023*** (.003)	.021** (.009)	.025*** (.009)	.007*** (.002)	.005** (.002)	.006** (.003)	.017*** (.005)	Yes	Yes	.027*** (.003)	.028*** (.010)	.029** (.013)

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 Firpo-Fortin-Lemieux 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												
Δ_t, $\Delta_t(\tau)$	−.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												
Δ_t, $\Delta_t(\tau)$ − *adj. for selection*	.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 and Health												
Δ_t, $\Delta_t(\tau)$	.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)

Quantile wage gap decompositions using 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*				

All observations with complete information. The reference group is the natives ESB. $^{+}$Over-education defined as the difference between a person's actual level of completed education and the level of education consistent with the job performed as classified by the Australian Bureau of Statistics, (https://www.abs.gov.au/articles/how-anzsco-works). 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

results might reflect foreign PhDs' inferior language skills, but this hypothesis cannot be investigated because the quality of English language skills is not surveyed in detail in the GDS. However, were this hypothesis empirically supported, universities could offer PhD graduates extra language courses as part of the education and training provided at doctoral level.

5 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 in 2016. While average wages are statistically identical across groups, this outcome masks two opposing effects: ESB natives generally earn less than comparable foreigners on the basis of observed characteristics but this penalty

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

All observations with complete information. The reference group is the natives ESB. 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

disappears because of the contribution of unobserved factors. This finding emerges especially in STEM and for jobs at the higher end of the hourly pay scale where ESB natives enjoy hourly salary improvements of between 2.2 to 6.3%. This premium is large, particularly when calculated on the course of an entire working life, during which it compounds (e.g. a 5% improvement over the course of 30 years results in a 432% premium in the 30th year).

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 graduates notwithstanding that they complete identical PhD programmes from the same universities. Foreign NESB PhDs experience inferior outcomes with respect to salary, hours of work, probability of working in a full-time job, and in sectors other than higher education. This evidence supports the hypothesis that the partial international transferability of human capital is the result of imperfections in the labour market rather than in the qualifications or education completed. Puzzlingly, the same universities in which foreign PhDs complete their education, especially in STEM and the Humanities, contribute to these graduates' poorer labour market outcomes. While this may reflect poor English language skills, it cannot be analysed with the publicly available data at hand, but hiring universities have that information from their own records and observations of students' performance. It may be possible that the disadvantage emerging in the analysis in this paper is beneficial to both universities and their foreign PhD casual/sessional or part-time staff. However, it is hard to draw a conclusion without further information on the learning experiences of the students that are taught or tutored by these staff.

Overall, 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 with no apparent disadvantage to the natives of the country where one will then work.

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Availability of data and materials
The original dataset used for the current study is not publicly available as it belongs to Graduate Careers Australia, but the sample analysed is available from the corresponding author on reasonable request

Declarations

Competing interests
The author declares that he has no competing interests.

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