Is a PhD worth more than a Master's in the UK labour market? The role of specialization and managerial position.

Abstract
This paper examines the potential earnings premium associated with a doctoral degree (PhDs, ISCED9) over postgraduate degrees (PGs, or Masters, ISCED7) in the UK. We assess this premium using a decade-worth of UK Labour Force Survey data (2011-2020). To explore the possible endogenous choice of post-graduate tracks, this paper deploys linear regression, (ordinary least squares, OLS), propensity score matching (PSM), and inverse probability weighting (IPWRA) to estimate the pay premium under varying identifying assumptions. The estimates show a positive return in terms of gross hourly pays in all models, along with a relevant role of managerial positions and degree of specialization in employment position. Therefore, although a PhD is arguably mostly driven by taste for scientific pursuit, a PhD has on average also an economic pay-off. However, much of it depends on one's capacity to acquire leadership positions – the most relevant factor disentangling those fulfilling or not their potential in terms of wages. We also provide a cost-benefit analysis over a life course showing that such a premium is overall modest, but subject to positive spikes for those in Science & Technology (STEM disciplines), getting managerial positions, and for women. Our findings suggest investigating further those personal and organizational factors that are conducive of unleashing highly educated potential.

Keywords: education premium; doctoral education; post-graduate education; UK; overeducation; managerial role

Introduction

The argument that the higher the education, the higher one's income is well established. PhD-holders' (International Standard Classification of Education, ISCED, level 8 since 2011; hereafter PhDs) have the highest academic degree. Hence, presumably, they should earn more than people with a Masters qualification(ISCED level 7, also known in the UK as "taught post-graduate", hereafter PGs).
The aim of doctoral education was first and foremost the efficient reproduction of academic staff. However, the idea that PhDs graduates are increasingly seeking employment in the non-academic sector is by now well consolidated: the number of PhD holders is growing everywhere (Sarrico 2022). It is conceivable that as the share of PhD and also PGs are growing, there will be an increasing differentiation in terms of labour market outcomes across tracks, arguably mirroring the difference between undergraduates and postgraduate by degree class, or field of study (Lindley & Machin 2016; Britton et al. 2020). This paper makes a novel contribution by comparing wages of employed PhDs and PGs to analyse, at parity of some conditions, if and how much a PhD title yields in wages. Considering time and money spent in fulfilling a PhD, we also calculate a cost-benefit analysis accounting for opportunity costs – a first ever attempt at our knowledge.
The paper is organised as follows. The next section exposes some key contributions in the literature. It explores the extent to which doctoral education (also known in the UK as

"research post-graduate") differs from "taught post-graduate programmes" (PGs), examining labour market mechanisms that can limit or boost postgraduates' career prospects, with a particular focus on overeducation. In the Data Analysis section, we describe the dataset and detail the estimation strategy and its justification. We provide five different models to estimate the returns associated with PhDs over PGs. The aim is to estimate the PhD wage premium at parity of other conditions, but the difference between the achieved wages and the wages they would have achieved had they not endeavoured, up to successful viva, a doctoral degree. The results section summarises the main findings and includes cost-benefits calculations from a comparison of the total career earnings minus the opportunity costs and fees. Conclusions situate the paper in its research field, discuss limitations of the current study, and develop avenues for future lines of research.

Literature

Becoming an academic, for doing something else

PhD programmes were established to formalise the process of *becoming* an academic and a researcher. However, with the rapid rise of PhD-holders beyond academic positions, the question of what to do with PhDs has become an increasingly pertinent topic in higher education studies over the last couple of decades (Sarrico 2022), overcoming the possible bias of credentialism inflation (Santos et al. 2016). PhDs are increasingly occupying positions outside academia. Whilst literature documents a pay premium (Hanks & Kniffin 2014), PhD-holders are less satisfied with non-monetary aspects of non-academic jobs. In this sense, within the highly developed UK environment, both economy and higher education system represents an interesting context to test what wage premia PhDs may get. Di Paolo (2016) attributes this to self-selection, indicating that PhDs pay a non-monetary price for working outside higher education. The existence of what he calls an "academic rent" is relevant: PhDs who do not work in academia might feel alienation and they may ponder "why have I undertaken a PhD ". This argument is consistent with the question whether researchers (academic or non-academic) do pay for their "taste for science". Stern (2004) finds that job offers received by PhDs are lower in salary than expected, given their skills. Other studies demonstrate that preferences for monetary and non-monetary outcomes are important in understanding industry destinations of PhDs (Roach & Sauermann 2010; Bloch et al. 2015), deepening the cleavage between science on one side, and good pay on the other side.

Although research is not an activity that only PhDs are capable of, it seems reasonable to assume that people who pursue a PhD have a preference for research. They are also those more likely in the position to carry out research at higher standards and in a more autonomous way, including managing others, at least within the domain of research (Mertens & Röbken 2013). The latter point, managerial positions, is not to be given for granted, nor to be assumed to be predominantly a matter of higher formal qualification. In labour markets, highly qualified professionals might be managed anyway, despite their capacity in doing their job at a high level of specialization. This occurs regularly in professional organizations and in other professional activities, including non-academic scientific ones. Managerial positions may not substantially covariate with job autonomy and/or the degree of specialization in one's position either, generating, for instance,

possible spots of high procedural autonomy and/or high degrees of specialization without managerial capacity, which is likely to mitigate wage premia. Nonetheless, given their specialised knowledge, and areas of high specialization, PhDs may in principle access more easily professional and managerial positions at the top of the occupational hierarchy. However, a dearth of empirical studies hampers further elaboration of this point, highlighting the need to investigate these nexuses.

However, PhDs might be more at risk of skills mismatch, if they take on jobs outside higher education or public research institutes (De Grande et al. 2014), posing questions about fulfilling PhDs' potential. Recent research and practices have already addressed the issue of doctoral curricula in terms of transferable skills (Rodrigues et al. 2018), and the role of achieving impact (Marini 2019). Moreover, funding and type of funding during PhD studentship may influence the destination sector of doctoral-holders, whereby no funding at all increases the risk to exit from the academic job market (Herrera & Nieto 2016) – possibly an effect caused by being disconnected from the most influent academic networks. By contrast, receiving funding from non-academic organisations during post-doctoral periods may favour successful transitions into private-sector employment (Marini 2022).
Current research reports mixed results in terms of the monetary returns for PhDs. Professionals who leave their job to pursue a PhD tend to achieve a net earnings premium (Gary et al. 2011). However, Skovgaard Pedersen (2016) reports on undergraduate study, finding that in the Danish labour market a low pay premium over undergraduate degrees. By contrast, Torpey (2021) finds a premium for PhDs working in the US against PGs.
Importantly, Torpey's research is based on the early stages of a professional career. Possibly research about later stages of PhDs career may highlight whether doctoral education sets individuals on track for faster pay growth, thus widening the pay premium as careers progress.
Notoriously, pay premia at tertiary level vary by gender. Using Canadian data, Waite (2007) shows that the gender pay gap is higher among PhD-holders than among PGs. For the UK, Schulze (2015) finds that women lose out especially in non-academic labour jobs relative to men, particularly for those cases of a degree in social sciences.

Potential determinants of labour market mismatch

Job mismatching is one of the main phenomena preventing people to thrive in their work (Flisi et al. 2017), also in the UK (Green & Henseke 2016). This may take the form of overeducation (meaning one's qualification was not necessary to get the job one got), and/or under-skilling (meaning one is not making productive use of all labour-market relevant skills, and potentially losing the unused). PhDs may be particularly at risk of labour market mismatch, making the entry into the labour market, and the eventual steps in career, both critical events for either unleashing the potential or stifling it.

Although the highest education possible, the PhD, might yield advantages, especially in terms of positive externalities or subjective well-being (Canal-Domínguez & Wall 2014), labour market mismatches remain detrimental (Park et al. 2018; Germain-Alamartine 2019). Whilst there is substantial research on graduates' overeducation (McGuinness 2006), scholars have only started to empirically test job mismatch within PhDs. Job mismatch

among PhDs is defined by industry sector of destination, and the required combination of education and skills (Di Paolo & Mañé 2016), but such research does not compare to PGs. Gaeta et al. (2022) show that for the Italian labour market overeducation among PhDs is more likely to happen when they are in non-R&D employments. Other Europe-wide analyses confirm a startling percentage of overeducation among PhDs (75%), and a worrying subset of them being also over-skilled for their position (42%) – with adverse consequences for individuals' pay (Rycx et al. 2022). This latter group of people (overeducated *and* overskilled) is the one which is arguably the worst affected by job mismatch (Sloane & Mavromaras 2020). These studies highlight the heterogeneity in labour market outcomes within PhDs and document a greater need to understand the determinants of both overeducation and under-skilling.
Yet, horizontal mobility in countries like Italy or the UK are likely to be very different, being brain-drain and brain-gain places, respectively. Overeducation in this regard is less likely to be predicted by moving abroad, as found for the case of PhDs who graduated in Italy (Gaeta 2015; Ghosh & Grassi 2020). Overeducation is also more likely to reside on the specific opportunities resulting from the combination of a given industry sector and specific employment position. Moreover, the (over-)supply of high skilled workers itself is likely to be a predictor of overeducation in the labour market, as recent data comparing Canada and the US suggest (Lu & Hou 2020).

Following the international literature on graduate overeducation, we may pose that a mismatch like over-education pay penalty is, at least partly, a by-product of heterogeneity of skill differences at a given moment in life. We account for this via marks, or academic performance, obtained at undergraduate level (see further). Notably, it is unknown the extent to which PhDs are less prone to suffer job mismatch problem if compared to PGs, which is relevant as PhDs might have had a lower, similar, or higher risk of overeducation had they stopped education at "just" PG-level.

Analysis and Findings

Trends and differences between PGs and PhDs

According to estimates from the UK Labour Force Survey (LFS), the number of PhDs in the age bracket 25-69 increased by more than 50 per cent in the last 10 years (2011-2020, this span of data collection allowing statistical robustness otherwise not available from other sources; more recent data would not allow to use specialization data – see further), from a headcount of around 383,000 to 579.000 (see Table 1). Also the number of PGs in the UK increased with an even higher rate during these 10 years: their number rose by two-thirds (see Table 1). Of the total of enrolled students in higher education in the UK, PhD students were around 2.9% of all 10 years ago, for reaching 4% in 2019/2020 academic year (Table 1).

>>>>> Table 1 Gross Number of PhDs and PGs in the labour market, number of total enrolled students at different degrees (HESA) – Time series (sources: Labour Force + HESA <<<<<

Any consideration about the return of higher degrees is highly dependent on the specific disciplines in question. Reliable figures from secondary data about doctoral broad disciplinary fields are available from the Higher Education Statistics Agency (HESA). PhD programs are linked to Departments and hence to disciplines, albeit each single PhD is a unique and original piece of research. HESA data impute field of study from the Cost Centre (typically an academic Department) PhD students are formally associated with. These figures are essential to ponder the extent to which PhD students differ consistently between the pool of potential PhD candidates (arguably those enrolled in postgraduate levels, although in the UK this is not strictly required as it might be in other systems), and the observed numbers from the Labour Force Survey. Notably, the ratio between PhD enrolments and postgraduate enrolments is far from being homogeneous across disciplines, ranging from 5% of PGs doing a PhD in Business, up to Medicine and Physics having 40% of PGs doing a PhD (See Fig. S.1 in Annex). On average, PhD students are some 20% of the total number of students at postgraduate levels. For those in highly employable disciplines such as Business, a PhD might come with substantial opportunity costs, whereas for similarly employable disciplines such as Medicine and other STEM, a PhD may represent a combination of genuine taste for science, a necessity to specialize, or even a traditional job entrance requirement (O'Leary & Sloane 2005).

Observational descriptive statistics from Labour Force Surveys

The pay-off of obtaining a PhD qualification intersects arguably with several covariates. We account for position in employment which was already used for a similar overeducation study among graduates (Chevalier & Lindley 2009), industry sector, type of employer (public/private), field of study at undergraduate level, degree class to approximate academic performance; region of residence; working experience (age is highly correlated with this information, see further); sex; ethnicity; nationality (UK passport-holder or otherwise). We complement the LFS data with occupation-level information about the importance of specialist knowledge on the job and levels of job autonomy (from Skills and Employment Survey, SES – Felstead et al. (2019)). Some relevant determinants of labour market success remain unobserved. First, channels in getting a job might play a role in determining a successful or relatively poor employment (Kucel & Byrne 2008; Marini 2022). Second, we also don't have information about higher education providers for each degree attained, which may matter in a stratified higher education system like the UK one.

We provide some basic characteristics of both PhDs and PGs in the UK labour market, adding the average gross hourly pays (PPP=2020) as a first term of comparison, in Table 2. PhDs on average earn £26.74 per hours; PGs £23.23. This is a significant difference that does not account relevant confounding factors such as, inter alia, experience. Among PhDs, 60%

are men, whereas among PGs sexes are equally balanced. Interestingly, the averages in pays by sex are much more levelled among PhDs than among PGs, whose difference of almost £15 per hour is much wider than that among PhDs. PhDs are also more likely to be of white ethnicity than PG (89% vs. 85%). Respective pays are as well different: those who are white and with a PhD earn almost £27 per hour, while those PhDs who are non-white earn less, but not so distantly from white people (£24.81). Among PGs, this difference is larger. Non-UK passport holders are almost identical in terms of frequency among PhDs and PGs, and they earn slightly less than British people. This is relevant to some literature about the US (Beckhusen et al. 2013; Chiswick & Miller 2009), where immigrants with a PhD do not appear to suffer any particular overeducation effect. On average, looking at the median years of experience in the labour market for both PhDs and PGs (19) ,PGs earn slightly more than PhDs (£25.25 vs. £25.80).

>>>> Table 2 here <<<<<

Almost 53% of PhDs had studied Science or Math at undergraduate level, followed by Other Social Science and Humanities (OSSH) with less than 20%, and Medicine (12.5%). Education was the least common undergraduate subject origin. By contrast, among PGs, Social Sciences, Creative Arts, Education, and Computer, Technology and Engineering (CTE) were all more frequent subject origins in comparison to PhDs. Average pay and the pay differentials associated with completing a PhD are very different across disciplines. A PhD in Medicine adds £7+, in Education Creative Arts it adds £4+, in Other Social Sciences and CTE the premium is only £2+. In Law, Economics and Management a PhD seems to be a minus, arguably for being those professions remunerative in the labour market already at PG level of education.

Industry destination is relevant to understand labour market segmentation for PhDs in the UK. As expected, many PhDs are in academia: a third works in Higher Education, whilst among PGs only 17% are in Higher Education. By contrast, PGs more commonly work in Education other than academia (12% vs. 5%), in Public Administration and Defence (7.9% those with PhD and 10.9% for PGs). “Professional, Scientific and Technical”, “Health, Social Work industries”, and “Manufacturing” employ similar shares of PhD and PG. Almost 30% of PGs is in any other industry non-otherwise specified, whereas only 17% of PhDs are spread in other sectors. The respective differences in hourly pays by industry are often minimal, with even negative difference among Education (excluding higher education) which is presumably a systematic case of overeducation for many PhDs, unless they are managers in that sector. The highest premia for PhDs appear to be in Health and Social Work, and, to a lower extent, but still above the average, in Manufacturing.

Employment in public or private sector is relevant. PhDs are employed in private organisations in 36.6% of the cases, whereas among PGs this is the case for 54.2% of them. On average, private organisations pay higher salaries. There is a premium of around £2 per hour for working in the private sector if PGs, and £5+ for PhDs working in the private sector.

One’s job might require managing or supervise the work of others. This information does not necessarily correlate with the extent to which a given worker is highly skilled or highly

educated, as previously discussed. It deals more frequently, in the British labour market, with power and the hierarchical position one has in relation to responsibility and accountability to performances. Typically, to have a managerial/supervisor function is associated higher pay. From the Labour Force Survey, we observe that PhDs are slightly more often on managerial positions, but this difference is relatively small (60.2% vs. 56.9%). Many PhDs are in jobs without managerial responsibilities. This 40% of PhDs who don't act as managers is made up predominantly by scientific and professional positions. These latter positions require high skills but don't imply necessarily control over the work of others. Yet, this is distinct from job autonomy, for which we find no linear correlation with managerial responsibilities. As expected, the difference in gross hourly pay for those in managerial functions is consistent and similar for PhD (about £8+) and PG (about £6+).

As indicated in the literature (Sun & Kin 2021), job analysis information may detect unfulfilled potential reflected in pays. To this regard we use three-digit fine-grained information from a different source (Skills and Employment Survey – SES) to define to what extent PGs and PhDs hold more or less *autonomous* and more or less *specialized* positions. Specialism reflects information on occupation-specific importance of a given specialist knowledge or understanding. Autonomy is measured as the average level of job autonomy over work task, methods, quality standards, and intensity. Both facets are central to understand skills use, and, occupation-based social class hierarchies (Felstead et al. 2019; Williams 2017). PhDs have, on average, a much higher degree of specialization in their employment in comparison to PGs (0.87 vs. 0.63). The respective averages at around median value has £5+ premium for PhDs. Job autonomy in position, which is a measure of day-to-day involvement in job-related decision-making, is reversed. PGs are on average in jobs with larger autonomy. Interestingly, the respective gross hourly pay at around median value is nevertheless £6+ in favour of PhDs.

Information about workers' undergraduate degree class (i.e., mark) is of particular interest for this type of research, as this approximates academic capabilities. Yet, this may be used as a relevant observable in accounting for selection bias when it comes to discern whether people entering doctoral education are drawn randomly from their distribution of marks or not. PhDs in 38.2% of cases graduates with a "First" from the undergraduate degree, the highest mark, which is consistent with choices to enrol in postgraduate from undergraduate (Britton et al. 2020). Among PGs less than 20% got a First. However, within workers with similar qualifications higher degree class does not map to higher wages. In fact, from the descriptive statistics, those PhDs and PGs who did worse on their undergraduate degree earned more than those who did well. Nonetheless, this pattern shouldn't be over-interpreted. The low percentages who proceed to complete a higher degree without at least 2:2 (referring typically to slightly below the average marks) suggests strong selection effects on unobservables. As in almost all analyses of wage returns of education using observational data, we have no plausible exogenous instrument that shifts individual preferences for education or science. We thus estimate the PhD pay premium under varying identifying assumptions using linear regression, propensity score matching, and inverse probability weighting.

Multivariate analysis

Adopting wage equations we estimated how much PhDs earn compared to PGs at parity of covariates. Model1 is a linear wage equation estimated using OLS that includes the explanatory variables expressed in Table2, with the only difference of discounting 4 more years of experience for PGs. This adjustment is thought to account for the additional years that PGs accrued over PhDs, carrying over four respective gain in salaries. From analysis without this correction, which follows a cost-benefit principle and represents a hidden cost for PhDs, we observe that this adjustment in experience releases a similar penalty across all Models in Table3 of around £1+ less for PhDs (i.e., £2.79 instead of £1.62 for Model1) (full outputs available upon request). In additional checks, we add interaction terms between the PhD/PG and managerial responsibility to the baseline specification (Model2), and managerial function with degree of specialization along with PhD/PG (Model3). Thus, we adjust PhDs (the treated group in our analysis) and PGs (the untreated group) by their pre-labour market and current labour market characteristics, acknowledging that labour market characteristics may refer also to outcomes rather than control, and demand side labour market features. This latter strategy is pursued by testing both Propensity Score Matching (PSM) and Inverse Probability Weighting Regression Adjusted (IPWRA) (Models 4 and 5 respectively). PSM is an established option to make counter-factual comparisons with fewer parametric assumptions than in typical regression models. IPWRA is another approach with application in the analyses of graduate pay differences, especially when some observables are relevant in determining wages (Walker & Zhu 2019). We also performed several transformations of covariates for Model1, for instance including age, and consequently for the other four Models. We opt for the current Models provided in Table3 as they represent the simplest equations at parity of heuristic power.

Results

Effects on hourly pay

There is a statistically significant pay premium associated with a PhD qualification when compared to PGs in all considered Models (Table 3). Compared with OLS coefficient in Model1, PSM and IPWRA yield larger pay effects from completing a PhD. In essence, to have opted to study beyond PG into a PhD program does generate a pay-off of up to £3+ more per hour in real terms. From Models provided in Table3, one may appreciate that men and white ethnicity people, those living in London, and those working in the private sector receive higher hourly pay. Notwithstanding, the most salient finding is that of managerial responsibility and specialization, both yielding a significant and notable difference in hourly wages. In particular, Model 2 reveals that to be a PhD and being on a managerial position gives £6+ more per hour in comparison to PGs without managerial positions. By subtraction, PhDs with managerial role earn £3+ against a PGs with managerial positions. Overall, the main difference seems to be that of securing a managerial role in the first place, beyond the pay advantages associated with a PhD qualification. Model 3 confirms this finding, finding

both a positive role of PhD title per se, but above all the role of management for predicting higher salary.

>>>>>> Table 3 around here <<<<<<

A cost-benefit analysis based on weekly pay

The previous sub-section provides indications that a PhD is overall better off. Nevertheless, the effect of getting a PhD, which costs no less than 3 or 4 years to be obtained, has to discount the respective cost opportunity. We consider following costs:

- Doctoral Fees that are in the region of £5.000 per year (£20.000 per year for internationals),
- Years of lost income (minus the scholarship, if any, which might be in the region of £18000 per year, tax exempted);
- Years of lost accrued experience in employment.

For simplicity we consider the case of a non-international, self-funded doctoral student, which is the mode[1].

To compute an approximate lifetime premium, this study re-estimates the hourly gross wage premium in the sample of full-time workers aged 30-70 years who either obtained a PG or PhD. We use the same equation exposed in Table 3, which already incorporates the experience penalty. In comparison to Table 3 results, the pay advantage is allowed to vary across time. We assume a career length of 36 years, which is relevant considering that the time lost in doing a PhD shortens employment life at a not-negligible extent. The age-specific pay premia are aggregated over the age bracket 30-70 and multiplied to obtain the gross annual income (37 hours per week; 52.14 weeks per year). In so doing, we treat the repeated cross-sections as a pseudo-cohort. Second, income opportunity costs of doing a PhD are measured as the first three years of experience for PGs. The foregone earnings are subtracted from the unadjusted lifetime premium to obtain an estimate of the adjusted lifetime premium. Thus, we characterise offering different scenarios exposed Figure 1 (public employer; women; STEM).

>>>> Figure 1 here <<<<

These results suggest that doing a PhD pays off across the working life although this is relative to a series of conditions such as discipline (e.g. STEM), and being women PhD vs. women PGs. Our estimates account for an arguable deficit of employment experience, therefore we are more likely to underestimate rather than overestimate the actual effect of having done a PhD. Notwithstanding, it is mostly only catching-up the initial deficit, especially if one accounted the financial advantage of having the moneys earlier. Yet, the pay premium is more modest in the following years after PhD attainment, for reaching a

[1] Typically single universities provide online fees by disciplines and visa status.

vertex almost at retirement age, for later declining slightly. Premia becoming wider by time and being higher for women is consistent with previous research (Britton et al. 2020). Nevertheless, the most interesting part of the analysis is to appreciate that any cost-benefit analysis in this topic appears to be highly dependent on if, and at which stage, any PG or PhD will hold managerial responsibilities, provided that specialisation seems to be fairly guaranteed by the PhD title per se. This confirms a particularly high cost-opportunity for PhD candidates in the UK (Hawkes & Griazina 2019) although we deepen empirically knowledge about an overall effect across a lifetime.

Conclusions

This paper offers a contribution in understanding whether pursuing a PhD gives an advantage when compared with the perspective of doing "only" PG degrees. We find some premium for doing a PhD. This holds true although the cost sustained by individuals for obtaining it might, under certain conditions, almost nullify this premium across a life span. Even in the best scenarios, it takes time to fully exploit the PhD premium. Overall, a PhD does not appear to be a critically strong enabler of income premium – evidence that policy makers at different levels (universities, Departments, other employers, PhD-holders and PhD prospect themselves) may wish to address to boost potential of doctoral-holders by means of matching this specific type of education level with labour market opportunities and traps. In relation to traps, tackling labour market mismatch, phenomenon which also affects PGs, may mitigate the notorious problem of the price for having (had) taste for science. Whilst a PhD may secure higher degrees of specialization, the most relevant question this study highlights is that of understanding which factors may help PhDs (and also PGs) to acquire managerial positions at the earliest point – the best position, at least in the UK and at parity of other conditions, to maximise one's education for the sake of higher salaries. This finding is relevant to give empirical grounds to preoccupations of mismatch in the labour market, namely the problem of under-skilling and to a much lesser extent overeducation. Highly educated people are better off as far as they have, and at the earliest occasion, the opportunity to manage others, performing this transversal skill.

Some limitations need to be acknowledged. The way we built the dataset allows some statistical robustness otherwise unavailable. Nevertheless, one may argue that those with a PhD and aged around 55-65 years old in 2011 had a labour market experience which is substantially different from a 30-year-old in 2020. Yet, retirement ages and last stint of working careers are likely to change, making this decade snapshot the first broad analysis of its kind. In this regard, when approaching retirement or facing macro-level uncertainties, PhDs might be in a stronger position to maintain full time employment – this implying a potential gain against PGs in terms of total volume of work during the whole life. Presumably, also analyses about the effect of having a PhD instead of a post-graduation qualification in specific moments or events in career life would be interesting. In other

words, a PhD started when below one's thirties is arguably different from one done in mid-career. Also comparing PhD with other post-graduate degrees in the UK would be of interest. A study about the payoff of MBA against undergraduate degrees demonstrated, for example, a lower bound effect if individual fixed-effects are taken into account, but also an upper bound effect when less prestigious MBA recipients are assessed against non-MBAs (Arcidiacono et al. 2008). It would be interesting to have similar studies comparing PhDs with PGCA (Postgraduate Advanced Certificate in Educational Studies) and other professional doctoral certificates (e.g. in Business, known as DBA). Moreover, future research may want to consider quality of providers (typically prestige of universities) at both undergraduate and postgraduate level.

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Table 1: Trends in postgraduate qualifications

	PGs (ISCED7)	PhDs (ISCED8)	PhDs/Tot ISCED7+8	PhD/Tot	PhD/PG
Source	LFS			HESA	
2012	1,565,000	383,000	19.7%	2.88%	16.85%
2013	1,644,000	379,000	18.7%	3.08%	17.98%
2014	1,721,000	406,000	19.1%	3.24%	18.58%
2015	1,752,000	437,000	19.9%	3.38%	18.81%
2016	1,928,000	425,000	18.1%	3.42%	19.52%
2017	1,991,000	450,000	18.4%	3.36%	18.44%
2018	2,106,000	484,000	18.7%	3.36%	17.65%
2019	2,251,000	473,000	17.4%	3.39%	17.20%
2020	2,436,000	543,000	18.2%	4.32%	20.27%
2021	2,624,000	579,000	18.1%	4.01%	17.62%

Source: UK Data Service LFS and HESA

Table 2. Observational descriptive statistics of PhDs and PGs in the UK Labour Market, and respective gross hourly pay averages (£, PPP=2020) with relative gain (%) in italic (2011-2020, UK Labour Force Survey) (N=3,237)

		Percentages		PhD (£)		PG (£)		Gain (%)	
		PhD	PGs	1	0	1	0		
	Gross Hourly Pay (PPP=2020) [£]	£26.74	£23.23					*13.1*	
	Sex (1= male)	60.20	54.30	27.7	25.3	25.31	20.77	*8.63*	*17.91*
	Ethnicity (1 = white)	88.90	85.20	26.98	24.81	23.62	20.99	*12.45*	*15.4*
	Foreigners (1 = foreigner)	14.80	13.80	25.33	26.99	22.18	23.4	*12.44*	*13.3*
Discipline	Medicine (Med) [base in Table 3]	12.50	7.80	30.49		23.19		*23.94*	
	Science and Math (SM)	52.70	24.70	26.74		23.08		*13.69*	
	Computer, Technology and Eng. (CTE)	9.40	21.20	27.97		25.47		*8.94*	
	Law, Economics, Management (LEM)	3.30	2.30	24.28		26.7		*-9.97*	
	Other Social Science and Hum. (OSSH)	18.70	32.40	24.33		22.27		*8.47*	
	Creative Arts (CA)	2.30	7.40	24.04		20.35		*15.35*	
	Education (ED)	0.80	4.00	27.83		23.54		*15.42*	
Industry Sector	Any other Sector	17.00	29.70	28.8		24.37		*15.38*	
	Manufacturing	7.00	5.40	30.45		23.66		*22.3*	
	Prof., scientific, technical activities	14.30	15.70	25.6		25.49		*0.43*	
	Public administration and Defence	7.90	10.90	27.27		24.27		*11*	
	Education (Higher Education excluded)	5.30	12.10	19.91		20.5		*-2.96*	
	Health and social work	15.50	18.50	31.94		21.78		*31.81*	
	Higher Education (base in Table3)	33.00	17.10	23.93		20.28		*15.25*	
	Managerial function	60.20	56.90	30.13	21.62	25.93	19.67	*13.94*	*9.02*
	Private employment	36.60	54.20	29.43	24.25	24.26	22.02	*17.57*	*9.2*
	Experience (median=19) [years]	17.3	17.1	25.25*		25.80*		*-2.18*	
Mark	First (highest mark)	38.20	18.90	26.96		22.79		*15.47*	
	2:1 (“Second Upper”)	51.30	56.50	26.09		23.38		*10.39*	
	2:2 (“Second Lower”)	6.60	20.10	26.68		22.52		*15.59*	
	Third Class	0.70	2.10	26.29		24.66		*6.2*	
	Pass (lowest mark)	3.10	2.40	35.11		28.17		*19.77*	
	London (1=Yes)	34.50	50.80	28.74	25.69	25.24	21.17	*12.18*	*17.59*
	Specialization** (median=0.752) [score]	0.869	0.63	27.73*		22.37*		*19.33*	
	Autonomy** (median = 0.048) [score]	0.219	0.389	21.51*		15.16*		*29.52*	

Source: own elaboration from UK Data Service LFS

* Averages at median

** SES source

Table 3. Hourly pay premium from 5 models (OLS from observational data, propensity score matching ATET, and Inverse Probability Weighting) and net cost-benefit across a life span.

	m1	m2	m3	m4	m5
	b/(se)	b/(se)	b/(se)	b/(se)	b/(se)
1.phd2	1.623**			3.131***	2.675***
	(0.56)			(0.92)	(0.64)
sex	-2.358***	-2.355***	-2.455***	-0.191***	-0.337**
	(0.44)	(0.44)	(0.44)	(0.06)	(0.11)
white	2.095**	2.103**	2.326***	0.094	0.181
	(0.67)	(0.67)	(0.67)	(0.10)	(0.18)
London	3.529***	3.525***	3.510***	-.258**	-0.453**
	(0.57)	(0.57)	(0.57)	(0.09)	(0.16)
foborn	-0.633	-0.634	-0.751	.284**	0.497**
	(0.66)	(0.66)	(0.66)	(0.09)	(0.16)
manag	3.998***			.064	0.116
	(0.44)			(0.06)	(0.10)
2.mark	-0.349	-0.433	-0.372	-0.431***	-0.738***
	(0.51)	(0.51)	(0.52)	(0.06)	(0.11)
3.mark	-1.951**	-2.026**	-2.132***	-1.228***	-2.145***
	(0.62)	(0.62)	(0.63)	(0.10)	(0.17)
4.mark	-2.016	-1.964	-2.267	-1.423***	-2.437***
	(1.69)	(1.70)	(1.73)	(0.25)	(0.40)
5.mark	2.304	2.061	1.700	-0.792***	-1.334***
	(2.25)	(2.24)	(2.25)	(0.17)	(0.28)
2. SM	0.138	0.164	0.081	0.297**	0.520**
	(0.84)	(0.82)	(0.85)	(0.10)	(0.18)
3. CTE	0.555	0.594	0.457	-0.572***	-0.989***
	(1.02)	(1.02)	(1.04)	(0.12)	(0.22)
4. LEM	-0.007	0.160	0.375	-0.116	-0.177
	(1.73)	(1.72)	(1.74)	(0.18)	(0.3)
5. OSSH	-1.736*	-1.656*	-1.813*	-0.532***	-0.917***
	(0.85)	(0.84)	(0.87)	(0.11)	(0.19)
6. CA	-3.182**	-3.208**	-3.223**	-1.155***	-2.126***
	(1.09)	(1.08)	(1.10)	(0.17)	(0.34)
7. ED	1.145	1.222	1.453	-1.010***	-1.960***
	(1.25)	(1.24)	(1.27)	(0.21)	(0.43)
Private Sector	1.981***	1.951***	2.096***	-0.051	-0.114
	(0.57)	(0.57)	(0.58)	(0.08)	(0.15)
Any other Sector	3.150***	3.096***	3.150***	-0.869***	-1.470***
	(0.74)	(0.74)	(0.75)	(0.11)	(0.20)
Manufacturing	3.148**	3.003**	3.228**	-0.518***	-0.837***
	(1.13)	(1.13)	(1.15)	(0.14)	(0.25)
Prof., scientific, technical activities	3.116***	3.064***	3.247***	-0.707***	-1.182***
	(0.90)	(0.90)	(0.91)	(0.11)	(0.20)
Public administration and Defence	2.756***	2.642***	2.875***	-1.092***	-1.882***
	(0.80)	(0.79)	(0.81)	(0.11)	(0.19)
Education (Higher Education excluded)	-1.145	-1.139	-1.314*	-1.308***	-2.306***
	(0.63)	(0.63)	(0.64)	(0.00)	(0.21)
Health and social work	1.683*	1.537*	1.492*	-1.18***	-2.033***
	(0.66)	(0.66)	(0.66)	(0.00)	(0.17)
cb_exper	0.904***	0.935***	0.980***	0.089***	0.156***
	(0.07)	(0.07)	(0.07)	(0.00)	-0.02

c.cb_exper^2	-0.015***	-0.016***	-0.016***	-.001***	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
z_specialism	3.632***	3.673***		0.398***	0.706***
	(0.38)	(0.38)		(0.06)	-0.14
z_jbautonomy	1.852***	1.929***	2.419***	-0.193***	-0.327***
	(0.33)	(0.33)	(0.33)	(0.05)	(0.08)
PGS * Manager		3.076***			
		(0.51)			
Phd * no Manager		-0.605			
		(0.65)			
Phd * Manager		6.176***			
		(0.77)			
PGS * no Manag.			2.338***		
			(0.46)		
PGS * Manager			4.916***		
			(0.54)		
Phd * no Manager			1.929**		
			(0.63)		
Phd * Manager			7.740***		
			(0.72)		
Year	YES	YES	YES	YES	YES
_cons	5.633***	6.004***	7.044***	-.226	-0.428
	(1.46)	(1.47)	(1.46)	(0.23)	(0.42)
R2	0.2933	0.2974	0.2872	0.2837	
N	3,384	3,384	3,384	3,384	3,384

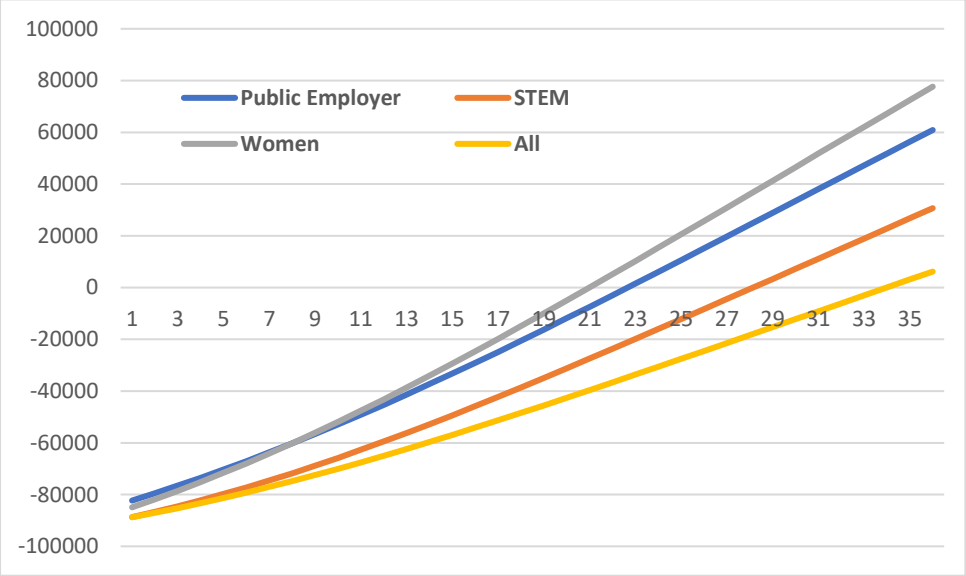
Source: own elaboration from UK Data Service LFS

* $p \leq 0.05$

** $p \leq 0.01$

*** $p \leq 0.001$

Figure 1. Gross income of PhDs against PGs in the UK Labour Market accounting for the Cost Opportunity of first three years of PGs employment experience that PhDs spent in doctoral education, plus doctoral fee. Cumulative in gaining back in a life span of 36 years of working experience



Source: own elaboration from UK Data Service LFS