A review of the economic and social value produced through funding PhD students

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National Civic Impact Accelerator

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Executive Summary

The scope of this work is to share the findings of a rapid evidence review into the economic and social impacts of PhDs. This report breaks down the economic impacts of PhDs into **five broad sections** of impact on: **wage premiums** by geography, subject and gender; **employment**, including leakage of PhD holders out of research roles; **research and innovation**; **productivity**; and **firm competitiveness**. The social value of PhDs covers three broad areas of impact on: **enhancing human capital**; **knowledge dissemination**; and **broader contributions to society**.

Investing in postgraduate and PhD education can provide significant long-term benefits for individuals and organisations. In terms of wage premiums, **women benefit most from their PhDs, leading to a narrowing of pay and earnings gaps**. However, pursuing a PhD can also **limit career progression in higher paid management and leadership roles** due to a **sometimes narrow specialisation of subjects**. **Employers also benefit from spillover effects** when employees have higher qualifications, resulting in wage increases across the workforce.

UK domiciled PhD graduates earn a nominal wage of £39,200 per annum, which represents an increase of £5,500 compared to Master's degree holders (LEO, 2022). **Earning a PhD increases the probability of earning mid-level wages (earning up to £30,000 per year), but reduces the probability of high earnings (over £50,000 per year**), after controlling for gender, subject, and academic institution (Britton *et al.*, 2020). The probability of PhD holders earning over £30,000 per year increases for both women (9.3%) and men (5.2%) compared to similar non-PhD holders. However, the probability of earning over £50,000 per year is lower for women (6.7%) and men (14.2%) compared to non-PhD holders. The geographical distribution of earnings ranges from £36,200 in South West England to £44,700 in London (LEO, 2022). Additionally, the highest modal wage group by subject discipline (modal group earning over £51,000) are Medicine and dentistry, Computing, Education and teaching, Business and management, and Architecture, building and planning. In contrast, the lowest modal wage earners by subject discipline (modal group earning £30,000 - £32,999) are Geography [social sciences], Biological and sport sciences, and Historical, philosophical and religious studies (HESA, 2022).

When investing in funded PhD interventions, it is essential to consider that investment in higher qualifications is a long-term structural change that should be measured in that context. The course and sector of PhDs matter for economic and social returns, and funding decisions should reflect the relevant priority of these returns. Investing in females generates higher returns in wages than investing in males. **Wider investment in employability, management, and leadership skills is also essential to enable the full returns to be accelerated or enhanced**.

PhD education enhances the employment rate of graduates, and they are more likely to be in graduate-level, high-skilled roles. **PhD graduates also place importance on personal values, such as intellectual curiosity, social impact, or work-life balance**. However, academia needs to **retain students** by focusing on **social value, career progression, and funding of research**, while greater integration between the learning and experience of the workplace is necessary to maximise the impact on business.

Only a small percentage of PhD graduates become permanent research staff or progress into professorial roles, indicating a **highly competitive career path within academia**. **Career progression needs to be built into the university process to enable talent retention**, and PhD students need **transferable skills to succeed in the public, private, or third sector, maximising the impact of their advanced study**.

Smaller-sized cohorts across a wider range of universities could be encouraged through policy to spread skills and expertise across the UK. **R&D active firms employing PhD researchers have higher rates of patenting and collaboration** with higher education institutes and other firms. Competitive grant-funded PhDs produce more academic outputs, while **PhD graduates in industry help in absorptive capacity and foster innovation** by collaboration and engagement with universities.

PhDs are a public good that benefits society as a whole, as **holders of PhDs generate production externalities that raise the productivity of those without a PhD alongside whom they work**. Those holding PhDs also teach the next generation, creating multiple long-term effects on society. Growth models

see education as enhancing technical progress, regardless of how that education is provided, and society has a strong argument for sponsoring education to enhance growth through its impact on society.

Overall, the PhDs had impacts which led to **increasing competencies** for 95% of firms, **increasing knowledge** (95% of all firms), **increasing competitiveness** (81%), **strengthening contacts** with academic institutions (77%), and **strengthening potential for new R&D investments** (76%). The **largest benefits were gained by small businesses**, compared to large firms.

Table 1 Outline indicators of the impacts of PhDs

Broad Indicator	Specific indicator	Additional value	Reference
Wage Premium	Nominal wages of PhD graduates compared (UK domiciled).	£39,200 salary per annum.	LEO (2022)
Wage Premium	Wage premiums of PhDs compared to Master's degrees.	Increase in wages by £5,500 per year.	LEO (2022)
Wage Premium	Wage premiums of PhDs by gender, controlled by gender, subject, and academic institution.	Increase earnings by 7.5% for women. But reduce earnings for men by 9%. After controlling by gender, subject, and academic institution.	Britton *et al.* (2020)
Wage Premium	Probability of PhD holders earning over £30,000 per year by gender, compared to non-PhD holders.	Increase of 9.3% for women. Increase of 5.2% for men, compared to non-PhD holders.	IFS (2020)
Wage Premium	Probability of PhD holders earning over £50,000 per year by gender, compared to non-PhD holders.	Decrease 6.7% for women and decrease of 14.2% for men compared to non-PhD holders.	IFS (2020)
Wage Premium	Geographical distribution of earnings of PhD holders.	Range from £36,200 in the South West to £44,700 in London	LEO (2022)
Wage Premium	Highest modal wage earnings by subject discipline (percentage of PhD holders earning £51,000 and above).	Medicine and dentistry (35%); Computing (29%); Education and teaching (28%); Business and management (28%); Architecture, building and planning (24%).	HESA (2022)
Wage Premium	Lowest modal wage earnings by subject discipline (percentage of PhD holders earning £30,000 - £32,999).	Geography [social sciences] (28%); Biological and sport sciences (20%); Historical, philosophical and religious studies (14%).	HESA (2022)

Employment	Employment rate in high-skilled jobs compared to undergraduates.	76.5% of postgraduates employed in high-skilled jobs, compared to 65.4% of graduates, an increase of 11.1 percentage points.	DfE (2019)
Employment	Employment rate as post-doctoral fellows within three years after graduation.	40% of PhD students become post-doctoral fellows within three years of graduation.	Hayter and Parker (2019)
Employment	Leakage of PhD holders outside of academia.	44% of PhD students working in academia three years after graduation.	Conti and Visentin (2015).
Employment	Leakage of PhD holders outside of research.	30% of PhD holders became post-doctoral early career researchers after graduation.	Jones and Warnock (2015).
Employment	Leakage of PhD holders into non-research roles	70.2% of PhD holders leave academia. Of these, 46.2% leave to a non-research role.	Hancock (2020).
Employment	Employment in research roles beyond academia.	Biomedical sciences (61.8%); Biological sciences (66.1%); Physical sciences & engineering (57.3%); Social sciences (29.2%); Arts & humanities (23.8%).	Hancock (2020).
Employment	Employment in research roles in industry.	34% were employed in existing businesses in industry. Of these, 54% were employed in research centres; 25% in non-R&D-intensive firms; 105 in R&D-intensive-firms; 6% in administration roles.	Conti and Visentin (2015).
Employment	Gender employment gap.	Women receive 50% of life sciences PhD, but hold 33% of posts in research-intensive universities.	Gibbs and Griffin (2013).
Research and Innovation	Patent rates for firms employing PhD holders.	R&D active firms which employed researchers have patents 2.5 times greater than firms which do not.	Fordás (2010)
Funding	Academic output productivity for PhD holders awarded through competitive funding compared to self-funded PhDs.	Grant-funded PhDs, rather than self-funded PhDs, provide more: articles produced during PhD (+0.187), citations (+4.5), articles after PhD (+0.727), citations after PhD (+13.8), publications in different fields (+0.291), and complete the PhD quicker (3 years rather than 5).	Horta et al. (2018)
Funding	Increase in funding and tenured positions after graduation.	Additional top-up scholarships increase probability of tenure-track position nine years after graduation by 15%.	Chandler (2018)

Funding	Second year top-up funds are more likely to support high quality PhDs.	Second-year students who win grant funding are more likely to finish in 9 years than winners of awards in the first year (79.1% compared to 68.1%).	Chandler (2018)
Profitability	Factors leading to increased profitability by percentage of firms employing PhD holders.	Collaborate with knowledgeable clients (79%), plan and implement projects (78%), act as a supervisor or mentor (71%), identify and collaborate with foreign experts (70%), attracting new employees (67%), find solutions (67%), increasing efficiency of the organisation (64%), and collaborate with other industries (61%).	Brochner and Sezer (2020)
Competitiveness	Factors leading to increased competitiveness of firms employing PhD holders.	Increasing competencies (95%), increasing knowledge (95%), increasing competitiveness (81%), strengthening contacts with academic institutions (77%), and strengthening potential for new R&D investments (76%).	Thune and Børing (2015)
Human Capital	Percentage of PhD holders seeing increases in personal development factors after conducting PhD.	Quicker to obtain relevant knowledge (88%), helped get a more holistic view (87%), increased linguistic ability and ability to present in public (85%), strengthened self-confidence and professionalism (83%), better at delegating (79%), and created a social network (70%).	Brochner and Sezer (2020)
Human Capital	Career development opportunities outside of academia.	16% of students had structured career development opportunities outside their training.	Gibbs and Griffin (2013)
Human Capital	Percentage of academic post holders with good work-life balance.	5% of students noted they had faculty members at research universities who lived balanced lifestyles.	Gibbs and Griffin (2013)

Recommendations

Funders should encourage cross-disciplinary PhD topics and work alongside other departments at other universities. PhDs which are too specialised reduce the chances of students becoming the highest earners by 14.2% for men and 6.7% for women.

PhDs do increase earning power, especially for women in the labour market, and funding PhDs for females in various sector could be part of the approach to evening out wage inequality.

Funders should provide further funding opportunities for PhD students in their second year to provide additional research – this improves productivity and academic outreach.

Funders should encourage the embedding of research culture within businesses in the arts, humanities, and social science sectors by encouraging PhD students to undertake placements in firms working in these sectors.

Introduction and Overview

This report aims to investigate the economic and social value of funding PhDs and to identify the factors that influence the value produced by funding. It is based on a review of existing evidence, including academic papers, government reports, policy documents, and grey literature, to answer three overarching questions:

- What economic and social value is created by funding PhD students?
- What factors influence the value produced by funding PhD students?
- How can funders maximize the value produced by PhD students?

The literature reviewed draws on findings from the UK as well as internationally. The report identifies the main economic and social impacts of PhDs, including their contribution to economic growth, job creation, innovation, and solving societal problems, as well as the impact of knowledge transfer from PhDs. Contextual factors that may influence the value created by funding PhD students could include the design of the PhD program, the PhD discipline, funding-related factors, and comparisons to other types of research funding.

Methodology Used

In preparing this report we have undertaken:

- Review of existing reviews we have identified through keyword web searching.
- Systematic searches of the key bibliographic databases (ERIC, Econlit, Web of Science (WoS)) to answer the three research questions using combinations of the following search terms: Value OR “economic value” OR “social value” OR “social impact” OR “economic impact”; fund*; PhD OR doctorate OR doctoral degree; Economic growth OR jobs OR innovation OR skills; “third stream” OR Knowledge transfer.
- Wider searches of the grey literature not captured by Conference Proceeding Citation Index (part of WoS core collection) through target web searches.
- Search of ‘Ellicit’ database for metareviews.
- Reference harvesting from included texts.

A comprehensive overview of the methods used can be found in Annex A1.

As a disclaimer, with the data available, is not always possible to break down impacts between Master’s and PhDs. Where this has not been possible, the research has simply highlighted the difference between postgraduate and undergraduate outcomes.

Economic Value of PhDs

Reviewing the literature identified five main economic impacts of PhDs. These are:

Wage premiums: Students develop their specific professional skills and softer skills over the course of a PhD. Once they graduate, the skills that PhD students develop are ready for career in a highly technical and well-paid job.

Employment: Postgraduate education, including master's degrees and PhDs, has a greater impact on an individual's likelihood of reaching high-skilled employment. Although graduates and postgraduates have similar overall employment rates, postgraduates had a higher proportion of employment in high-skilled jobs in 2018, with a difference of 11.1 percentage points.

Research and innovation: PhD students conduct cutting-edge research and produce new knowledge that can have commercial and industrial applications. This research can lead to the development of new technologies, products, and services that can improve productivity, create new jobs, and contribute to economic growth.

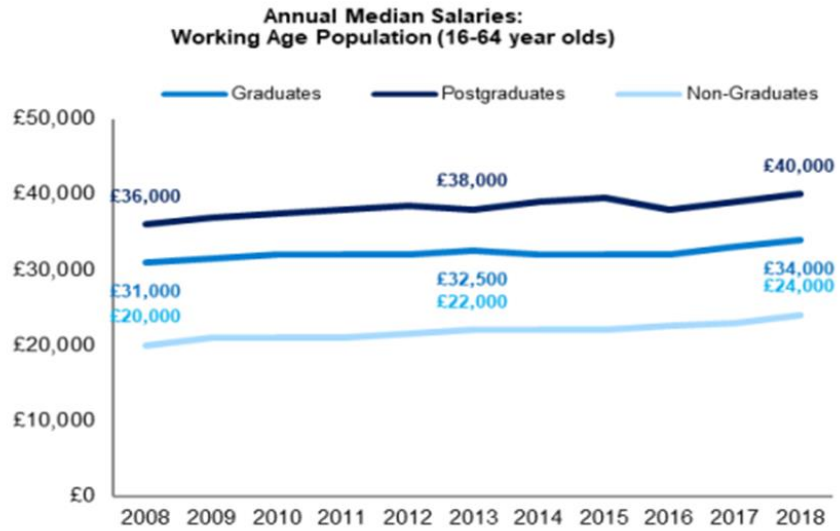
Increased productivity: PhD students are often involved in research projects that focus on improving efficiency and productivity in different sectors. The implementation of the research findings can lead to increased productivity and cost savings, which can positively impact the economy.

Increased competitiveness: The funding of PhD students helps produce a highly skilled workforce that can compete on a global level. Government-funded PhDs can increase skill levels and competitiveness for the UK workforce. PhDs funded by private organisations can lead to increased skills and innovation for a specific industry or purpose. Both government- and privately-funded PhDs develop and train highly skilled students develop a competitive edge in their respective fields.

Wage Premiums

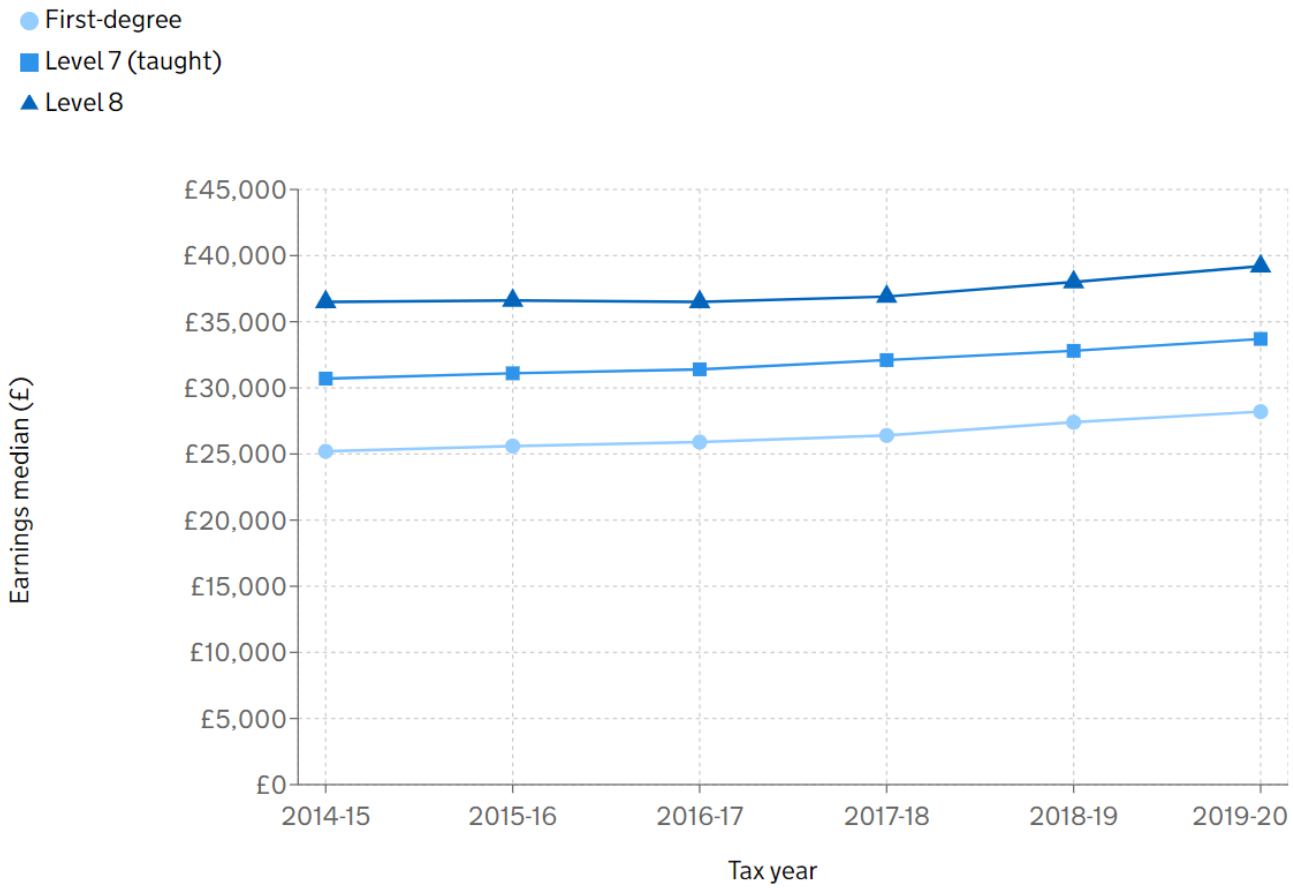
There are **significant wage premiums reported for postgraduate study**, as opposed to a graduate or non-graduate level. Graduate labour market statistics in the UK are outlined in **Error! Reference source not found.**. This shows that the median salary for graduates in 2018 was £34,000, which was £10,000 more than the median salary for non-graduates (£24,000). Postgraduates had an even higher median salary of £40,000, which was £6,000 more than graduates. The differences in salary between these qualification groups remained the same as in 2017. These figures represented a nominal increase of £3,000 for graduates and £4,000 for postgraduates and non-graduates since 2008.

Figure 1: Annual Median Salaries for Working Age Population in the UK, aged 16-64 (DFE, 2019)



Data from LEO (2022) provides a distinction in wage premium between Level 7 (Master's degrees) and Level 8 (PhDs) in the UK. **Error! Reference source not found.** shows the median earnings of first-degree students in 2019/20, who graduated five years earlier, is £28,200. For Level 7 (taught Master's) students this rose by £5,500 to £33,700. The increase to Level 8 (PhDs) rose again by £5,500 to £39,200. The wage premium for Level 7 and Level 8 qualifications has stayed at a similar level over recent years. After adjusting for inflation (real terms), between the 2014/15 and 2019/20 tax years, at five years after graduation: First degree graduate earnings increased by £700 (2.7%) to £25,900 in real terms; Level 7 (taught) graduate earnings increased by £200 (0.8%) to £30,900 in real terms; Level 7 (research) graduate earnings increased by £100 (0.4%) to £32,200 in real terms; and Level 8 graduate earnings decreased by £600 (1.6%) to £35,900 in real terms.

Figure 2: Median Earnings of UK domiciled first degree graduates and post-graduates from English HEIs, FEDs and APs five years after graduation, 2014/15 to 2019/20 tax year (LEO, 2022)



Research by the Institute for Fiscal Studies (IFS, 2020) shows that **completing a PhD in the UK is associated with a wage premium of around 26% for men and 17% for women compared to those with a bachelor's degree**. The study also found that the **wage premium for PhD graduates is higher in the private sector than in the public sector**, and that the size of the premium varies depending on the field of study, with PhDs in science, technology, engineering, and mathematics (STEM) subjects having **higher** returns than those in non-STEM subjects. However, it is important to note that the study also found that the wage premium for PhDs may be decreasing over time.

The same study by the IFS (2020) shows that, **whilst PhDs decrease the chances of low earnings, they reduce the chances of very high earnings**. The IFS (2020, p.44) attributes this to being because "PhDs tend to result in people pursuing specific interests – such as working in a research environment – that are not necessarily the most lucrative". Gaining a PhD increases the probability of earning over £20,000 by 9.8% for women and 3.9% for men and increases the probability of earning over £30,000 by 9.3% for women and 5.2% for men. However, holding a PhD reduces the probability of earning over £50,000 by

6.7% for women and 14.2% for men after controlling for age, background, and the subject studied, degree class gained, and university studied at, at undergraduate level.

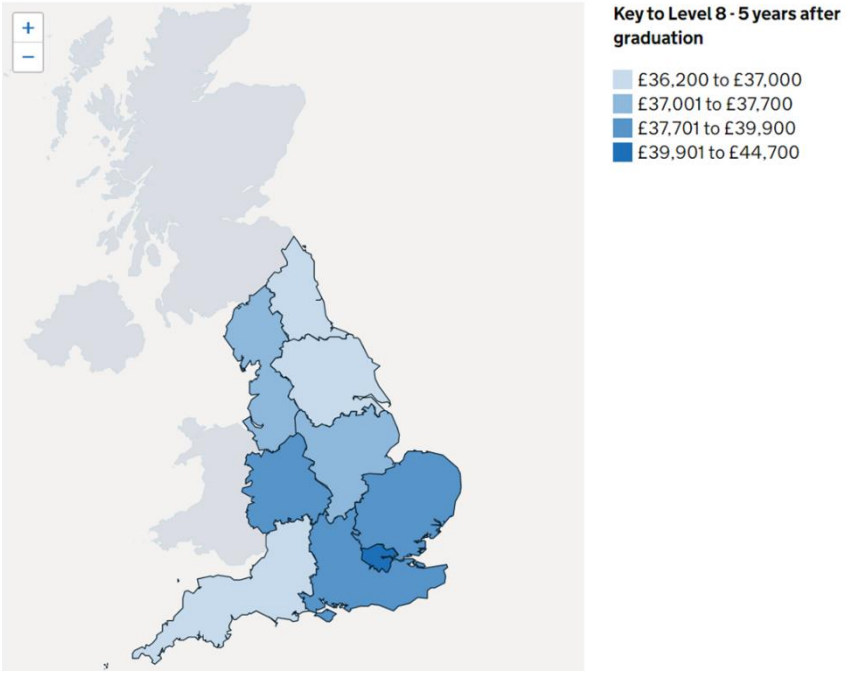
Academic studies into wage premium impact of PhDs are somewhat dated. A study from Greenaway and Haynes (2003) indicated that the graduate premium for undergraduates is often quoted at around £160,000 to £400,000 over a working lifetime compared to people with A Levels but who chose not to go to university. A review from Casey (2009) shows that the wage uplift for postgraduate study produces a continued wage premium. In addition, whilst men with a postgraduate degree see a significant uplift in wages, the greatest rises in wages are for women. Men with a master's degree earn 29% more than the base, while women with a Master's degree earn 55% more than women without a Master's degree. Obtaining a PhD raises the premium further to 31% for men and 60% for women. The value of education on wage premiums is clearly shown, and its impacts are especially significant for women. Whilst the figures from older studies cannot be compared directly with current figures, there is merit in considering the percentage changes that a graduate premium bring. These figures could be used for supporting assumptions when modelling the economic impacts of PhD funding.

Geographic Variations in Wages

There is a **regional variation in PhD earnings across the country**. Although data from LEO (2022) only covers England, it shows that the graduate earnings five years after graduation for PhD holders varies from a low of £36,200 in the South West and a high of £44,700 in London. The regional variation of wage distribution in **Error! Reference source not found.** is similar to the pattern of wages across the country, with the largest wages in London and the South East and East of England in comparison to the North West, North East, and Yorkshire and the Humber.

For international students, earnings of EU and non-EU graduates who stayed in the UK from 2019/2020 were greater than UK graduate earnings (LEO, 2022). Level 8 EU graduate earnings were £40,600 and non-EU earnings were £39,900, 3.7% and 1.9% higher than UK earnings (£39,200) respectively. Further, the increase in earnings for EU and non-EU graduates were greater than the increase in earnings for UK graduates too. Non-EU domiciled level 8 graduate earnings increased from £36,500 in 2014/15 to £39,900 in 2019/20 (9.3% increase). EU domiciled graduate earnings increased from £37,200 to £40,600 (9.1%) over the same period, with UK domiciled graduates increasing from £36,500 to £39,200 (7.3%) (ibid.).

Figure 3: Earnings by current region, five years after graduation, of UK domiciled male and female first-degree graduates and postgraduates from English HE providers, 2019/20 tax year (LEO, 2022)



Wage Differentials and Subject Discipline

There is little academic research specifically on the impact of PhDs on wage differentials by subject discipline. There is, however, data from HESA (2022) on the modal salary band of earnings of research postgraduates as shown in Table 1. The modal salary band for postgraduate researchers is £51,000 and above in fields of: Medicine and dentistry (35% earning £51,000 and above); Computing (29%); Education and teaching (28%); Business and management (28%); Architecture, building and planning (24%); Social sciences (19%); Media, and communications (18%); and subjects allied to medicine (17%).

The lowest modal salary bands were in historical, philosophical and religious studies (14% earned between £30,000 - £32,999); Geography [social sciences] (28% earned between £30,000 - £32,999); Biological and sport sciences (20% between £30,000 - £32,999); Language and area studies (16% earned between £33,000 - £35,999; 16%); Geography, earth and environmental sciences [natural sciences] (26% between £33,000 - £35,999); Design, and creative and performing arts (15% between £33,000 - £35,999); Physical sciences (26% between £33,000 - £35,999); and Mathematical sciences (23% between £33,000 - £35,999).

Table 2: UK domiciled graduates in full-time paid employment in the UK by subject area of degree and salary band 2019/20 (HESA, 2022)

	Less than £15,000	£15,000 - £17,999	£18,000 - £20,999	£21,000 - £23,999	£24,000 - £26,999	£27,000 - £29,999	£30,000 - £32,999	£33,000 - £35,999	£36,000 - £38,999	£39,000 - £41,999	£42,000 - £44,999	£45,000 - £47,999	£48,000 - £50,999	£51,000+	Total
01 Medicine and dentistry	0%	0%	0%	1%	2%	4%	11%	15%	11%	9%	3%	4%	4%	35%	100%
02 Subjects allied to medicine	0%	1%	3%	5%	8%	7%	14%	16%	9%	8%	4%	5%	4%	17%	100%
03 Biological and sport sciences	1%	2%	3%	5%	7%	10%	20%	20%	10%	6%	4%	4%	2%	7%	100%
04 Psychology	0%	1%	1%	2%	1%	2%	8%	9%	24%	14%	11%	14%	9%	4%	100%
05 Veterinary sciences															
06 Agriculture, food and related studies															
07 Physical sciences	0%	1%	1%	3%	6%	5%	21%	26%	12%	8%	4%	3%	3%	7%	100%
09 Mathematical sciences	0%	0%	1%	1%	5%	3%	19%	23%	9%	11%	7%	3%	7%	12%	100%
10 Engineering and technology	0%	0%	1%	1%	3%	5%	16%	20%	15%	10%	7%	4%	4%	14%	100%
11 Computing	2%	0%	0%	0%	0%	1%	12%	20%	11%	10%	7%	4%	4%	29%	100%
13 Architecture, building and planning	0%	2%	1%	1%	2%	4%	14%	16%	11%	12%	4%	2%	8%	24%	100%
15 Social sciences	0%	1%	1%	2%	3%	5%	10%	19%	11%	8%	7%	7%	5%	19%	100%
16 Law	0%	0%	2%	3%	3%	3%	12%	17%	17%	11%	8%	10%	4%	13%	100%
17 Business and management	1%	0%	0%	1%	1%	0%	7%	14%	11%	13%	9%	11%	4%	28%	100%
19 Language and area studies	3%	4%	10%	10%	12%	10%	12%	16%	9%	8%	2%	3%	1%	3%	100%
20 Historical, philosophical and religious studies	1%	2%	7%	11%	12%	12%	14%	12%	11%	3%	3%	3%	2%	7%	100%
22 Education and teaching	0%	0%	0%	0%	1%	2%	9%	11%	5%	11%	10%	8%	11%	29%	100%
23 Combined and general studies															
24 Media, journalism and communications	0%	0%	4%	6%	7%	5%	8%	13%	10%	9%	17%	0%	3%	18%	100%
25 Design, and creative and performing arts	4%	5%	7%	4%	13%	8%	4%	15%	11%	8%	5%	4%	3%	10%	100%
26 Geography, earth and environmental studies (natural sciences)	0%	0%	1%	2%	7%	10%	24%	26%	10%	7%	3%	3%	2%	6%	100%
26 Geography, earth and environmental studies (social sciences)	0%	0%	4%	0%	7%	4%	28%	18%	16%	12%	4%	0%	0%	9%	100%
Total	**0%**	**1%**	**2%**	**3%**	**5%**	**6%**	**15%**	**18%**	**12%**	**9%**	**6%**	**5%**	**4%**	**15%**	100%
Total non-science CAH level 1	**1%**	**1%**	**4%**	**4%**	**6%**	**6%**	**11%**	**15%**	**10%**	**8%**	**7%**	**6%**	**5%**	**16%**	100%
Total science CAH level 1	**0%**	**1%**	**1%**	**3%**	**5%**	**6%**	**16%**	**19%**	**13%**	**9%**	**5%**	**5%**	**4%**	**14%**	100%

Wage differentials and Gender

Research by Britton *et.al* (2020), looked at the impact that different levels of qualifications had on future earnings returns. Researchers investigated this by comparing the impact that undergraduate, masters and PhD degrees have on earnings returns, looking at the difference in returns by gender, subject, and institution type. Figures 4 and 5 below, show estimated returns for PhD degrees by subject and gender. As seen in Figure 4, whilst **female PhD graduates of all subjects on average have higher earnings than those with undergraduate degrees**, once controlled for difference in background and attainment these differences are considerably reduced. Many of the estimated returns by subject are not significantly different from zero, this means that for many subjects there is little uplift in earnings when compared to undergraduate degrees. However, for a handful of subjects there was a significant uplift in earnings, including psychology, veterinary science, technology and degrees allied to medicine. The differing uplift in

earnings with regards to subject at PhD level, is largely driven by the differing types of occupations that PhDs in different disciplines open up for their graduates.

Figure 4: Returns to PhD degrees at age 35, by PhD subject (women) (Britton et.al, 2020)

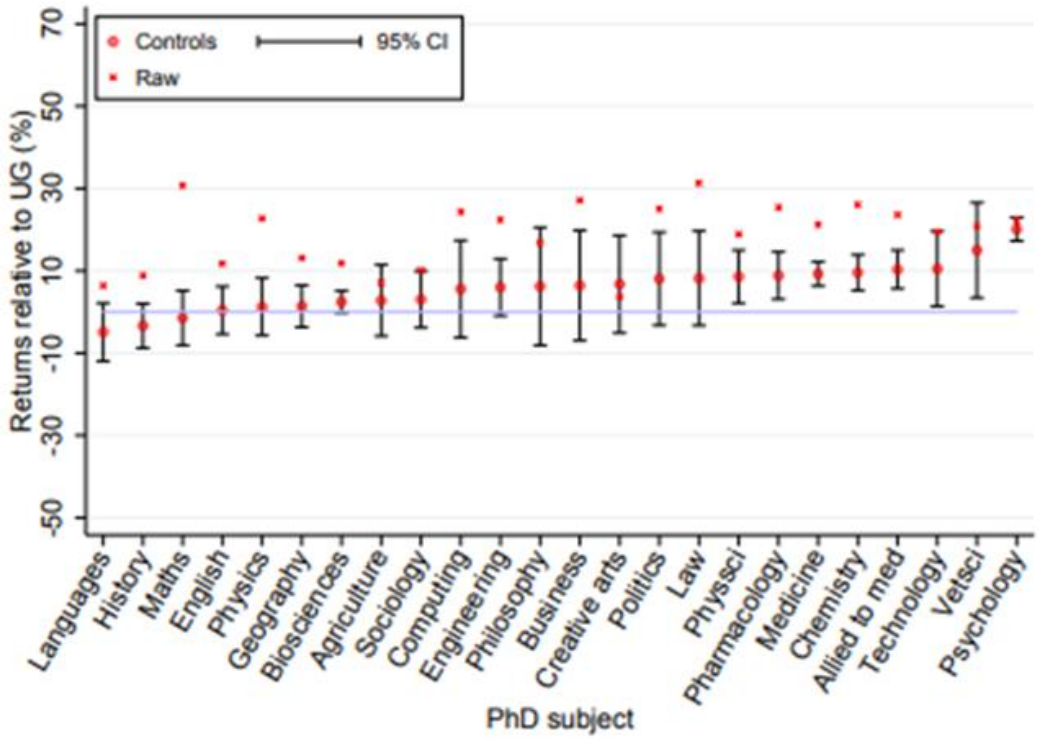
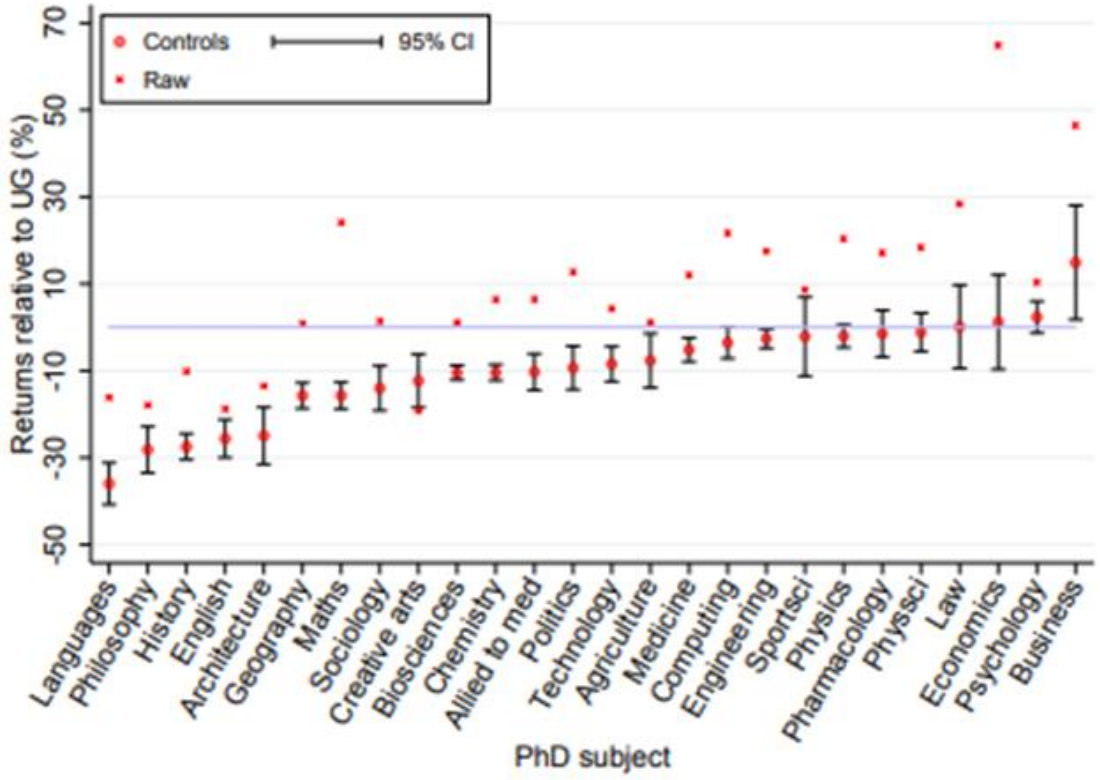


Figure 5: Returns to PhD degrees at age 35, by PhD subject (men) (Britton et.al, 2020)



However**, comparative to women men see a much less positive return across the board on various subjects**. Only business PhDs for men see a significantly positive return on earnings, more than half of the other subjects all see negative returns. Returns for degrees are around -25% for architecture and English, even lower for languages, philosophy and history. It should be noted however, that these are returns for 35-

year-olds and returns continue to increase after 35, hence PhD returns later in life may be more positive than evidenced here (Britton et.al, 2020).

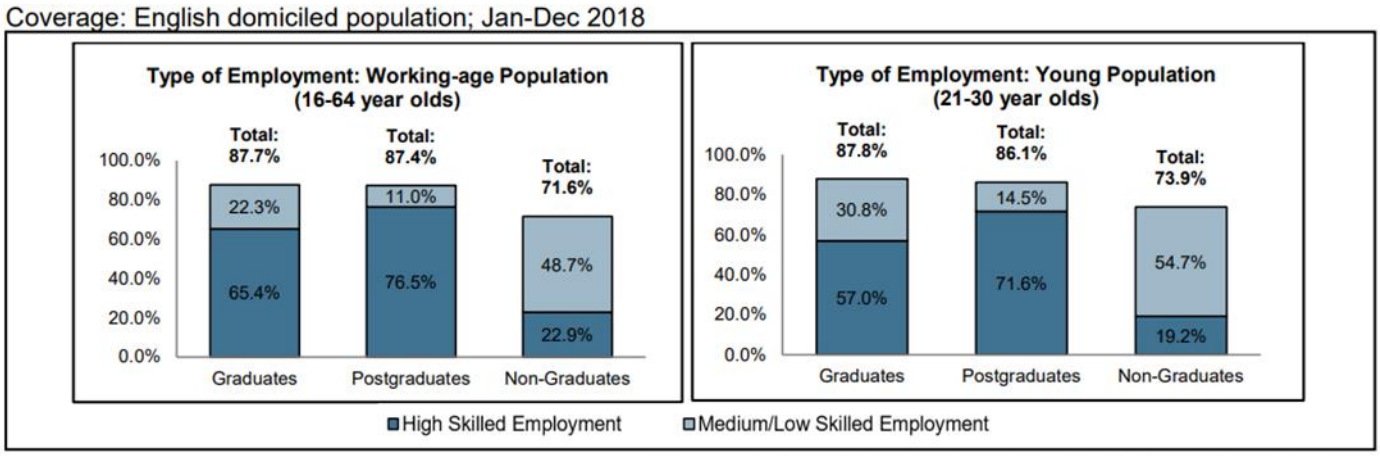
Overall, researchers found that **PhD degrees boost earnings for women by around 7.5% but reduce earnings for men by 9%**. For women, there was little variation in the returns by subject, with most yielding small positive returns (Britton et.al, 2020). Whereas, for men the range of subjects typically studied at PhD level is larger, however the returns are mostly negative, with only business PhDs offering marginally positive returns. However, it should be noted that **returns for PhDs do continue to grow after the age of 35, as individuals become more experienced**. Suggesting that the outlook might be more positive for those at later points of their career.

Working with colleagues who have postgraduate education also provides wage uplifts for the wider workforce. A study from (Battu et al., 2003) indicated that, in the UK, employing a colleague with 1.2 years more education than the average worker can boost one's earnings by 11%. Further, a 1% increase in the labour force share of college graduates in the US drove up wages by 1.9% for workers without a high school diploma, 1.6% for those with a high school diploma, and 0.4% for college graduates (Battu et al., 2003).

Impact on Employment

Postgraduate education, covering Master's degrees and equivalent as well as PhDs, has a greater impact on a person reaching high skilled employment (DfE, 2019). Graduates and postgraduates have similar overall employment rates (87.7% and 87.4% respectively). Despite having similar overall employment rates, in 2018, **postgraduates had a higher proportion of employment in high-skilled jobs** (76.5%) compared to graduates (65.4%). The additional contribution of postgraduate study to high skilled employment in the UK is around 11.1 percentage points as show in **Error! Reference source not found.**.

Figure 6: High Skilled employment rates of the working-age and young population (DFE, 2019)



Source: Department for Education analysis of the Labour Force Survey

Error! Reference source not found.6 shows the impact of postgraduate education is even more pronounced for 21–30-year-olds. The employment rate for graduates (87.8%) and post-graduates (86.1%) in this age group is similar, but there is a significantly higher proportion of postgraduates (71.6%) in high-skilled employment than graduates of the same age group (57.0%). The additional contribution of postgraduate education to high skilled employment in this age group is 14.6 percentage points.

Other datasets and findings of the impact of PhDs on employment come from academic studies. **Whilst academic studies are peer reviewed for rigour, they tend to focus on surveying relatively small cohorts of students**. Further, there are not many UK-based academic studies, but there are international insights available. One study from the USA on the impacts of biomedical science PhDs from Gibbs and Griffin (2013) shows that **personal values and structural values are factors influencing the career direction of biomedical science PhD students**. Personal values can play a significant role in determining

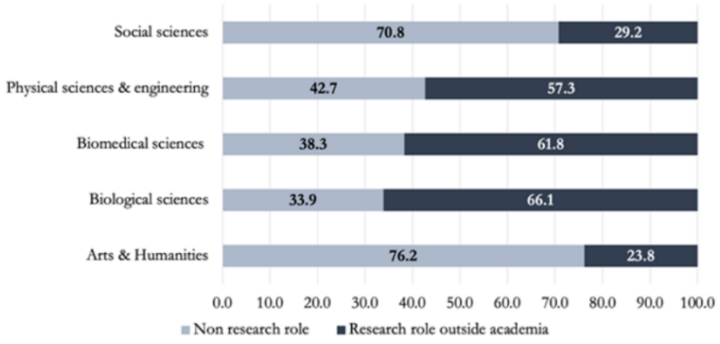
career interests, as individuals may prioritize certain values such as intellectual curiosity, social impact, or work-life balance. Structural dynamics, on the other hand, refer to the broader societal and institutional factors that can influence career trajectories, such as funding opportunities, job market demands, and cultural norms within academia. Whilst 40% of PhD students become post-doctoral fellows within three years of graduating (Hayter and Parker, 2019), the findings from Stephan (2012) indicate that the interest in faculty careers decreases as graduate training progresses. Only 14% of life sciences PhDs hold tenured positions at universities 5 years after graduation (ibid.). This is similar to the findings from (Hayter and Parker, 2019) where less than 15% of post-doctoral fellows in the USA go on to find employment as a tenured academic. There is a significant chance of leakage outside of academia as tenured positions at universities become ever harder to come by. **In order to maximise impact of PhDs, then there should be a conducive environment that supports work-life balance and social impact as much as the opportunities for career trajectories and funding opportunities**. Some of the leakage may be soaked up by industry, but there should be conscious efforts to integrate industry into the PhD subjects in order to reduce leakage and maximise impacts.

Leakage of PhD Holders leaving Research Roles

Data on leakages of PhD students leaving academia can be found from Hunt et al. (2010) and Conti and Visentin (2015). **Three years after graduation, less than half (44%) of PhD students were working in academia.** This drop-off appears to continue with time, particularly in the science, technology, engineering, and maths (STEM) subjects. The Royal Society (2010) reported that, after completing their PhDs, 30% of PhD students became early career researchers (post-doctoral researchers). Of all PhD students, only 3.5 per cent went beyond that to become permanent research staff, and only 0.45 per cent progressed into professorial roles (Jones and Warnock, 2015). Of the students who went into post-doctoral fellowship roles, 24% had stayed at their original institution (Conti and Visentin, 2015). This outlines the importance of pathways for PhD holders looking to make their way into academia. Bringing this back to the UK, where there are 23,865 doctoral students in 2019/20 academic year (HESA, 2022), there can be a potential pool of around 10,000 students who are moving into academic roles each year. There is a gap in the literature in identifying and modelling whether there are enough, or too few, graduates moving into academic roles compared to the number of vacancies.

PhD holders are employed outside of academia and in industry. Findings from Hancock (2020) in **Error! Reference source not found.** from the Higher Education Policy Institute uses data prepared by HESA to show that 70.2% of PhD holders have left the HE sector. Of these, **around half (53.8%) go into a research role outside of academia and the other 46.2% go into a non-research role**. The sectors that have the greatest proportion of PhD holders going into a research role outside of academia are in: biological sciences (66.1%); biomedical sciences (61.8%); and physical sciences & engineering (57.3%). The lowest proportion of PhD holders going into research outside of academia are those from arts and humanities (23.8%) and social sciences (29.2%). There is a mismatch in the value of research in the social sciences and arts and humanities compared to physical and biological sciences.

Figure 7: Research employment outside of academia by PhD subject area (Hancock, 2020)



Whilst **there are very few studies into the multipliers of PhD research impacts**, there are studies looking into the destinations of PhD graduates outside of academia. This can support research looking into the number of jobs that could potentially be filled by PhD holders, and outline whether there is enough supply of doctoral students entering the industry job market compared with the number of job vacancies.

Of the PhD graduates, Conti and Visentin (2015) found that 54% were working in jobs in academia, with 34% of PhD graduates employed by existing businesses industry, with 6% working in start-ups, mainly as founders. Of the PhD holders working in industry post-graduation, 54% are employed in research centres, 25% in non-R&D-intensive firms, 10% in R&D-intensive firms, and 6% in administration, schools, and colleges. This shows that **around two-thirds (64%) of PhD holders who leave academia stay within a research-focused role**. Findings from the construction industry in Sweden (Brochner and Sezer, 2020) show that 20% of managerial roles in companies with five or more employees are held by PhD graduates. This is much larger than the proportion of people with a PhD in the population as a whole at around 2.5%. But this focus is on industrial PhDs. It is rarer for people to move from research to management, leading to the findings from the IFS (2020) that specialised PhDs reduce the chances of people moving to earning the very high wages that managers and CEOs would earn.

There are findings from Conti and Visentin (2015) that **imply the chances of science PhD holders being employed in an R&D-intensive company reduce with larger cohort sizes**. The findings are from a study of science and engineering PhD students at universities in Sweden and Switzerland. This shows that increasing the PhD cohort by 10 students decreases the chances of being employed in an R&D-intensive firm by around 15% relative to working in a low-ranked university or research centre. An increase of cohort size by 10 students also shows a significant decrease of 10% in the probability of a student working for a highly-ranked university compared to a low-ranked university. There are no significant increases in probability of working for highly-ranked universities or R&D-intensive firms with larger cohorts. The paper does not go into the explanatory reasons for this change, but does control for a number of factors including PhD and supervisor characteristics. Policy could encourage smaller sized cohorts across different universities, rather than larger institutions increasing their cohort size. This means that smaller universities are more likely to be embedded with industry and R&D-intensive firms (Conti and Visentin, 2015)

There is still a long way to go to improve representation of PhD holders in research-related roles. For example, research from Gibbs and Griffin (2013) shows that, whilst women receive 50% of life sciences PhDs, only 33% of women hold posts in research jobs at research-intensive universities. There is an even greater under-representation for ethnic minority students. People from ethnic minority backgrounds receive 13% of PhDs but only receive 5% of grants by value and make up 2% of tenured faculty at US medical schools.

There are significant barriers facing black PhD students in UK universities (Williams et al. 2019). Of the 15,560 full-time PhD students in their first year of study in the UK in 2017/18, just 3% were black. This is a long-term implication of the undergraduate black and ethnic minority (BME) attainment gap at undergraduate level. Williams (2019) draws on work from Advance HE (2018), Arday and Mirza (2018), and Tate and Bagguley (2017) to identify **three environmental factors that contribute to the barriers facing BME students at UK universities**. These factors are: **structural**, where internal structures within an individual university create barriers; **organisational**, where equality and diversity interventions do not address long-term change; and **cultural**, where, after acknowledging a need for change, there is still resistance.

Impact on Research and Innovation

Research by the Irish scientific advisors Fordás (2010) found that **R&D active firms in Ireland which employed PhD researchers have higher rates of patenting**, 2.5 times greater than similarly active firms which do not employ PhD researchers and have vastly higher collaboration rates with Higher Education Institutes and other firms. Researchers found that Business Enterprise Research and Development (BERD)

data showed that while only 29% of R&D active companies employed PhD researchers in 2007, these companies accounted for 70% of BERD.

Diamond et.al (2014), found that **PhD graduates in industry helped in 'absorptive capacity'**, this is a firm's ability to identify, adapt and integrate new technologies and ideas. PhD graduates help to foster innovation by contributing to their employer's absorptive capacity through collaboration and engagement with universities. 75% of PhD graduates surveyed in the research, stated that they had engaged in collaborative projects, promoting knowledge exchange between universities and industry. Employers surveyed, claimed that PhD graduates bring with them cutting edge knowledge and ideas which can be applied for commercial benefit (Diamond et.al, 2014).

Analysing employment patterns for PhDs from two major European universities of technology, Conti and Visentin (2015) found that female PhD graduates were more likely to be working in administration or holding positions in universities rather than in non-R&D-intensive companies. Out of female PhD graduates, 19% of PhDs in sciences and 29% of those in engineering were employed in non-R&D-intensive firms after graduation (Conti and Visentin, 2015).

Impact on Increased Productivity

The process in which funders award PhD grants is important. **Students awarded PhDs through competitive grant funding, rather than self-funded PhDs, are more productive at producing academic outputs**. Research from Horta et al. (2018) shows that, compared to self-funded PhDs, grant funded PhDs provide: more articles produced during PhD (0.187), more citations (4.5), international recognition, more articles after PhD (0.727), more citations after PhD (13.8), are younger at completion (35 years old) therefore, quicker in completing the PhD (3 years rather than 5), and produce more publications in different fields (0.291). In terms of academic outputs, grant-funded PhDs are significantly more impactful than self-funded PhDs.

A Canadian study by Chandler (2018) looked into the effects of an increase in grant funding on the productivity of PhD students. Whilst there is no evidence that receiving a larger scholarship affects the probability of PhD completion within either five or nine years, **a larger scholarship increases the probability of having a tenure-track academic position nine years after receiving the award by approximately 15 percentage points**. Extra grant funding was awarded to high performing second year PhD students, rather than providing funding to high performing pre-doctorate students, as has been the case previously. Second-year students who win grant funding are more likely to finish in 9 years than winners of awards in the first year (79.1% compared to 68.1%) with a statistically significant probability of p=0.03. This could be that better decisions are made in the second year of PhD funding than in the first, where better triaging or decision making is made in the second year rather than the first. Second-year student scores are a better predictor of overall award in a positive and significant correlation. One such recommendation resulting from the findings are that funders could have an additional funding opportunity for students in the second or third years to take their research further. This is because better funding decisions on high quality research projects are made after the start of the project has begun. However this needs to be met with an assurance that students are not overburdened with workload, particularly as many students already find the work-life balance of completing a PhD particularly difficult (Gibbs and Griffin, 2013), (Hayter and Parker, 2019).

Research from Brochner and Sezer (2020) showed that the **hiring of PhD holders in the Swedish construction industry improved the profitability of organisations**. The focus of the research was looking into the factors that caused the difference in profitability, and the additional value that having a PhD brought to the profitability of the business. Employers were asked to score the impact of PhD holders out of 100 on the PhD holders' ability to improve profitability. The greatest added value of PhD holders on profitability of the business were to: Collaborate with knowledgeable clients (where PhD holders scored 79 out of 100 units of impact), plan and implement projects (78), act as a supervisor or mentor (71), identify and collaborate with foreign experts (70), attracting new employees (67), Find solutions to urgent technical

problems (67), increasing efficiency of the organisation (64), and collaborate with other industries (61). The only other question asked was around how PhD holders supported digitalisation in the organisation and this scored lowest at 41. There was no statistical significance between the role of an industrial-funded or university-funded PhD on the profitability of the businesses.

Impact on Increased Competitiveness

Findings from Thune and Børing (2015) evidenced the impacts of professional PhDs for industry. **Firms had four main motivations to take part in industry-academic PhDs**: to increase the competitiveness of the firm; to increase the firm's competence; because the project was related to the core competence of the firm; and the project would increase the innovation capability of the firm.

On the whole, the PhDs had impacts for increasing competencies for 95% of firms, increasing knowledge (95% of all firms), increasing competitiveness (81%), strengthening contacts with academic institutions (77%), and strengthening potential for new R&D investments (76%). Yet the largest benefits were gained by small businesses, who achieved all objectives set out in by some extent or a large extent (Table 2). Medium-sized companies met all the objectives except for three: developing new contacts at academic institutions; inputting to new collaborative projects with academic partner; and development of new products. The impact for large companies met all the objectives to either some or a large extent except four objectives. These were: contribution to the long-term strategy; increased ability to carry out a long-term R&D project; inputting to new collaborative R&D projects; and developing new products.

Table 3: Assessment of results from participating in an industry PhD projects. Percent of firms who have responded to have achieved results to a large extent or to some extent. By size of firms (Thune and Børing, 2015)

	Small	Medium	Large	Total	N
Provided the firm with necessary competencies	98	97	92	95	126
Increased the level of knowledge in the firm in one or more areas	98	90	94	95	128
Contributed to realising the long term strategy of the firm	94	97	74**	87	127
Contributed to making the firm more competitive	87	80	76	81	128
Increased the firm's capability for innovation	84	80	84	83	126
Strengthened the firm's potential for starting new R&D projects	82	77	70	76	125
New contacts at academic institutions	62	43*	54	54	125
Strengthened established contacts with academic institutions	71	53	78	70	125
Access to scientific frontier	82	77	74	77	124
Increased ability to carry out a long term R&D project	87	73	70**	77	125
Input to new R&D projects	73	60	56	63	125
Input to new collaborative R&D projects with the academic partner	69	37***	48**	53	125
Development of new product candidates	69	50*	54*	58	125
Increased competencies in scientific methods	76	73	72	74	125

Social Values of PhDs

Social benefits of PhDs are split into three main impacts:

Enhancing human capital: PhD students are often funded to work on projects that have a social impact. PhDs can have a significant impact on improving soft skills, which are essential for personal and professional development. By developing strong communication, critical thinking, problem-solving, collaboration, and time management skills, PhDs can contribute to the development of a highly skilled and adaptable workforce.

Contribution to society: PhD students often conduct research that addresses social issues and problems faced by communities. By producing research that addresses social problems such as inequality, poverty, and environmental degradation, PhD students produce public goods that can positively impact society.

Knowledge dissemination: PhD students often disseminate their research findings through publications, conferences, and other media. By sharing their knowledge, they can educate the public and help people to make informed decisions.

Enhancing Human Capital

The study by Brochner and Sezer (2020) looked into **personal development of PhD holders as they moved into employment**. On a scale of 1-100, respondents gave a score of 88 to say that it had been worth the effort to study for a PhD. In terms of soft skills gained, PhD holders stated that their PhD had: made it quicker to obtain relevant knowledge (88 out of 100), helped get a more holistic view (87), increased linguistic ability and ability to present in public (85), strengthened self-confidence and professionalism (83), better at splitting problems into subproblems to be solved by others (79), and created a social network (70). The research also looked into the difference between profitability and personal development but found no relationship between the two.

These **improvements in soft skills are especially important for early career researchers** as they “do not appear to articulate their personal skills well and seem to be unable to talk to employers in ‘their’ language” (Morgavi, McCarthy, & Metcalfe, 2007, p. 6). This backs up the findings from Brochner and Sezer (2020) in that graduating with a PhD brings the additional value in terms of soft skills. Still, not all students have the opportunities for career development outside of their academic training as only 16% of students had structured career development opportunities outside their training (Gibbs and Griffin, 2013).

However there are **issues with work-life balance whilst studying for a PhD**. Only 5% of students noted they had faculty members at research universities who lived balanced lifestyles (Gibbs and Griffin, 2013). Findings from Hayter and Parker (2019) found that, post-graduation, many PhD holders were having a “personal crisis” (p.562) of realising about having to leave academia to the reductions in postgraduate tenures. Lots of unsociable working hours and inability to have a good work-life balance.

Contributions to Society

PhDs are a 'public good' that not only affect individual earnings but also the productivity of society as a whole. As noted by Machin and Van Reenen (2007), the production of PhDs is an integral part of the production of basic research, which is itself a public good from which society all benefits. In addition, the holders of PhDs generate production externalities that raise not only their own productivity but also the productivity of those without a PhD alongside the people they work with. Casey (2009) argues that growth models view technical progress as being enhanced by education, regardless of how that education is provided. Therefore, Casey (2009) states, if education can enhance growth through its impact on society as a whole, there is an argument for society as a whole to sponsor it.

PhDs contribute spill over effects to the rest of society. Whilst there are few quantitative studies into the spill over effects of PhDs, Murphy and Topel (2006) have estimated the mean externalities in the USA

is a positive effect of $950,440 per PhD-level job. The study was conducted on research-intensive jobs in the USA. The findings may not be directly applicable to the. However this indicates that there are significant spill over effects for society of medical and research PhDs. Similarly, Teaching PhDs (+$130,706) and Engineering and Programming PhDs (+$18,720) produce further spill over effects for society (Card, 1999; Murphy et al., 1991). Some PhDs have negative spill overs for society. Finance (-$104,000), Management (-$64,800), Law (-$31,200), and Operations and Consulting ($0) contributing negative or zero spill overs for society per PhD-level job (French, 2008; Gabaix and Landier, 2008; Murphy et al., 1991; Bloom et al., 2013). As before, some of these quantitative studies are at least 20 years old and should not be directly comparable to the current UK economy. **However the studies do show that the spill overs are greatest for PhD in research, teaching, and engineering. Whereas the spill over effects are lowest for PhDs in Consulting, Law, Management, and Finance.**

Abulhassn and Roberts (2021) show that traditional teaching methods such as lectures and lack of presentations are insufficient in developing future employees that meet industry requirements. Additionally, MSc and PhD students are unsure about their job prospects post-graduation and how their graduate degree and thesis project will position them in the job market. To address these concerns, **soft skill building through internships, connecting with employers, and understanding the value of PhD for industry are important aspects of training provision.**

Involvement in academic excellence, such as taking part in a PhD, improves abstract and innovative thinking, and operates as a 'social multiplier' (Flynn, 2007). PhD holders become inputs into the learning process, forming part of the environment of striving (Casey, 2009).

There is evidence that PhD programmes are becoming more inclusive of redressing gender imbalances and are being taught in a way that takes in a way that values a wide range of skills and interests. Swedish experiences in the construction industry indicate an increase in proportion of female candidates has been accompanied by a shift away from narrow technology topics. As such, funders and grant awarders in Sweden are aware of the case to broaden interests in construction beyond traditional values, so to broaden the types of PhD candidates on the courses. This is evidence for widening industry relevance, supporting the decisions of government grants providers in the social impact widening participation (Brochner and Sezer, 2020).

Knowledge Dissemination

In order to encourage greater sharing of knowledge dissemination and its societal impact, there is an argument to support teachings of findings between academia and industry. However, as jobs in higher education have low earnings premium compared to industry, there might be an argument for society to subsidise the production of university teachers (Casey, 2009). Casey (2009) makes three salient points for the impact of PhDs in knowledge dissemination. First, as PhD holders have developed soft skills in teaching, they are more adept in being able to share knowledge better. Second, the production of **PhDs produce knowledge into the world from which other academics can all draw, furthering the frontiers of knowledge and innovation**. And finally, Casey (2009) makes the case that spill overs of knowledge do occur and the tacit learning from PhD holders is filtered outwards into the economy and society.

Conclusions

PhDs are an investment in the short term for the organisation and the longer term for the individual. **Wage and earning differentials lead to long term gain** for those that study to that level. **Females benefit more from investment in postgraduate and PhD level education, and this creates a narrowing of pay and earnings gaps**, but again for the longer term.

However, **there is a ceiling to this earning potential**, since studying a PhD by default narrows your specialism, which means higher paid management and leadership roles can be more difficult to secure. **Gaining greater experience and a wider set of skills over your career can overcome this effect.**

Having employees who possess higher qualifications, does **generate spillover effects which lead to wage increases across the wider workforce.**

Issues to consider when investing in funded PhD interventions:

- **Investment in higher qualifications is a long-term structural change** in the skills market and returns should be measured in that context.
- Course and sector of PhDs matter for economic and social returns and funding should take this into account. Decisions on what to fund should reflect a **broad consideration of economic and social returns**.
- **Investing in females creates higher returns in wage**s than investing in males.
- To create better long term results any **PhD investment should also include wider investment in employability, management, and leadership skills** to enable the full returns to be accelerated or enhanced in the workplace.
- Investment in postgraduate and PhD qualifications significantly **enhances the employment rate** of graduates, and they are more likely to be in graduate level, **high skilled roles**.
- **PhD graduates can place more importance on personal values** such as intellectual curiosity, social impact, or work-life balance. However, these personal interests **have significant societal value** to solving the worlds social problems, some of which **may not be monetisable** but are important to future generations.
- There is **significant leakage outside academia**, however the structures of education are not geared up to maximise the benefits of this. To retain students in academia, there needs to be **greater focus on social value, career progression and funding of research**. To maximise the impact on business there needs to be **greater integration between the learning and experience of the workplace** to maximise the outcomes of 'leakage'.
- Only 3.5 per cent of PhD graduates went beyond that to become permanent research staff, and only 0.45 per cent progressed into professorial roles, this indicates the **career path within academia is highly competitive** and career progression needs to be built into the university process to enable talent to be retained. There is also a clear need to **enable PhD students to have transferable skills for them to be successful in the public, private or third sector**, so they maximise the impact of their advanced study.
- Policy could **encourage smaller sized cohorts across a wider range of universities**, rather than larger institutions increasing their cohort size. As smaller universities are more likely to be embedded with industry and R&D-intensive firms. This could also help with distributional effects of spreading the skills and expertise across the UK.
- **R&D active firms employing PhD researchers have higher rates of patenting**, 2.5 times greater than similarly active firms which do not employ PhD researchers and have vastly higher collaboration rates with Higher Education Institutes and other firms. While only 29% of R&D active companies employed PhD researchers (in 2007), these companies accounted for 70% of business enterprise research and development.

- **Students awarded PhDs through competitive grant funding, rather than self-funded PhDs, are more productive at producing academic outputs**.
- **PhD graduates in industry helped in 'absorptive capacity'**, this is a firm's ability to identify, adapt and integrate new technologies and ideas. They help to foster innovation by collaboration and engagement with universities. They engage in collaborative projects, promoting knowledge exchange between universities and industry. Employers surveyed, claimed that PhD graduates bring with them cutting edge knowledge and ideas which can be applied for commercial benefit
- **PhDs had impacts on increasing competencies for 95% of firms**, increasing knowledge (95% of all firms), increasing competitiveness (81%), strengthening contacts with academic institutions (77%), and strengthening potential for new R&D investments (76%). This is especially so for small and medium sized enterprises.
- **PhDs are a 'public good'.** They do not just affect individual earnings but are productive for society as a whole. The production of PhDs is an integral part of the production of basic research – itself a public good from which all benefit. The holders of PhDs, when they are employed, generate production externalities – in other words, their having a PhD raises not only their own productivity but also productivity of those without a PhD alongside whom they work. Those holding PhDs also teach the next generation, creating multiple long-term effects on society.
- **Growth models that see technical progress as endogenous**. They see it as being enhanced by education, regardless of how that education is provided. If **education can enhance growth through its impact on society**, there is an argument for **society as a whole to sponsor investment in PhD education.**

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Annex

A1. Methodology

Methodological stage	Process for identification	Number of texts identified
Stage 1 – Broad base evidence capture	Search terms of Value OR “economic value” OR “social value” OR “social impact” OR “economic impact”; fund*; PhD OR doctorate OR doctoral degree; Economic growth OR jobs OR innovation OR skills; “third stream” OR Knowledge transfer from key bibliographic databases (ERIC, Econlit, Web of Science (WoS))	2347
Stage 2 – Review of grey policy-related literature	Commissioning a targeted web search of key search terms.	29
Stage 3 – Initial filtering	Identify key texts from database through key word searches relating to economic and social impact, explicitly referencing PhD or post-doctoral study, year to include studies post-20, and location to include economies similar to the UK.	314
Stage 4 – Final filtering	Identify the 30 most relevant academic texts and 30 most relevant policy texts through key word searches relating specifically to economic and social impacts of PhDs	60

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