The economic and social impact of Cardiff University

Final Report for Cardiff University

LE London Economics

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Table of Contents

Executive Summary

London Economics were commissioned to estimate the economic and social impact of Cardiff University across the United Kingdom. Given Cardiff University's primary 'services' to the UK economy include the provision of excellence in research and teaching, assessing the associated economic impact with these activities is challenging. Furthermore, in addition to the purely economic impacts associated with Cardiff University's activities, there are a multitude of non-quantifiable societal and cultural impacts generated at home and abroad.

To undertake this analysis, we applied a range of sophisticated methodologies to estimate the economic impact of Cardiff University across a range of activities including:

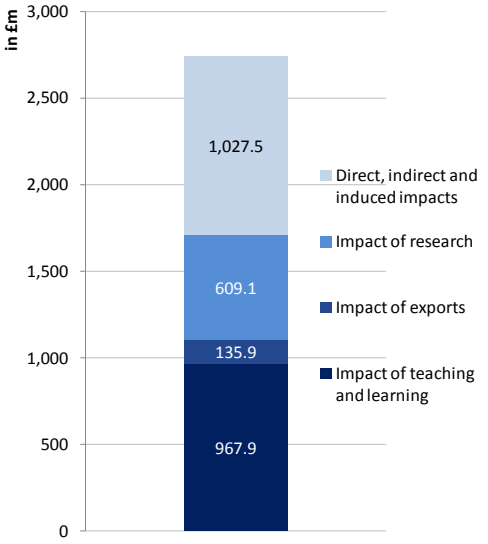
- Teaching and Learning;
- Research;
- Educational exports overseas, and the
- Direct, indirect and induced effects associated with Cardiff University's operational expenditure and the personal expenditure of its students.

Cardiff University's aggregate economic impact

- **We estimated the total economic impact associated with Cardiff University in the UK to be approximately £2,740 million in 2012-13**. In terms of the components of economic impact, the value of Cardiff University's **teaching and learning** activities stands at approximately **£967.9 million** (**35%** of total), while **research** activity contributes **£609.1 million** (**22%**). The economic contribution associated with the **direct and indirect impact** associated with Cardiff University's operational expenditure and the expenditure of its students stands at **£1,027.5 million** (**38%**). The remaining **5%** (or **£135.9 million**) was associated with Cardiff University's contribution to **educational exports**.
- Compared to Cardiff University's total operational costs of approximately **£427 million** in 2012-13, the total economic contribution or benefit to the UK economy associated with the 2012-13 cohort of Cardiff University students was estimated to be approximately **£2,740 million** in 2012-13 money terms, which corresponds to a benefit to cost ratio of almost **6½:1**.

Table 1 Aggregate economic impact of Cardiff University in the UK (£m and % of total impact)

Type of impact (£m in 2012-13)	£m	%
Impact of teaching and learning	**967.9**	**35%**
Students	499.3	18%
Public purse	468.6	17%
Impact of research	**609.1**	**22%**
Net direct research income	66.9	2%
Spillover impact	542.2	20%
Impact on exports	**135.9**	**5%**
Net tuition fee income	67.4	2%
Non-tuition fee income	68.5	3%
Direct, indirect and induced impacts	**1,027.5**	**38%**
Impact of CU expenditure	842.9	31%
Impact of CU student expenditure	184.6	7%
Total economic impact	**2,740.4**	**100%**



Note: Values are presented in 2012-13 prices. ***Source: London Economics' analysis***

Cardiff University's economic impact by Home Nation

Making a number of assumptions on the location of the different strands of impact, we estimated that the total economic impact of Cardiff University on the Welsh economy was approximately **£2,036.7 million**, corresponding to approximately **75%** of the total attributable economic benefit generated by Cardiff University, with the remaining **£703.7 million** (**25%**) accrued elsewhere across the United Kingdom.

The total economic impact associated with Cardiff University was estimated to be approximately £2,740 million

The impact of Cardiff University's Teaching and learning activities

One of the most significant elements of Cardiff University's economic impact results from the improved labour market outcomes achieved by many of its graduates

To model the economic impact of teaching and learning, we estimated the **labour market benefits** associated with higher education qualification attainment (reflected in enhanced earnings and employment outcomes). Using 17 years worth of Labour Force Survey data and a range of econometric models, the analysis was undertaken by gender, domicile of student, prior attainment and mode of study for a range of post-graduate, undergraduate, and sub-degree qualifications.

In addition to looking at the **long-term benefits** associated with qualification attainment, the analysis also addressed the **short-term direct and indirect costs and benefits** incurred by the individual associated with the acquisition of these qualifications (such as tuition fees, student support, foregone earnings etc). In comparing the various costs and benefits, as well as their timing (by discounting the future stream of costs and benefits using an appropriate discount rate), we estimated the **net graduate premium** associated with higher education qualification attainment.

- **For a Welsh domiciled student,** compared to those students possessing 2 or more GCE 'A' Levels (or equivalent) as their highest level of prior attainment, the mean **net graduate premium** associated with a full-time undergraduate degree was estimated to be approximately **£121,000** for a male and **£89,000** for a female in 2012-13 money terms[1].

The net graduate premium associated with a full-time undergraduate degree for a Welsh domiciled student stood at £121,000 for a man and £89,000 for a woman.

The net public purse benefit associated with a full-time undergraduate degree for a Welsh domiciled student stood at £114,000 for a man and £60,000 for a woman.

We also assessed the costs and benefits to the **public purse** associated with the provision of higher education qualifications. These public purse costs include any teaching funding, student support and foregone taxation revenue during the period of qualification attainment (where appropriate), while the benefits include the enhanced income tax, National Insurance and VAT receipts following

[1] See section 2.5 for a full description of the difference in the economic returns to men and women.

graduation. This element of the analysis resulted in estimating the **net public purse benefit** associated with higher education provision.

- For a Welsh domiciled student, relative to possession of 2 or more GCE 'A' Levels (or equivalent), the **net public purse benefit** associated with a full-time undergraduate degree was estimated to be approximately **£114,000** for a male and **£60,000** for a female in 2012-13 money terms.

This information on the various net graduate premiums and net public purse premiums was combined with information on the number of students engaged in a new instance of learning with Cardiff University in 2012-13, as well as the expected completion rate associated with formally recognised qualifications and credit bearing modules.

- Combining the various econometric analyses and the relevant student level data, the analysis suggests that the total economic impact generated by Cardiff University associated with the 2012-13 cohort of students stands at approximately **£967.9 million**, of which approximately **£405.9 million** is associated with Welsh-domiciled students, **£549.6 million** is associated with English-domiciled students, and the remaining **£12.4 million** is associated with students from Scotland and Northern Ireland.
- Of the total economic impact associated with teaching and learning, approximately **£499.3 million** (**52%**) is accrued by the individual, while the remaining **£468.6 million** (**48%**) is accrued by the public purse.

Table 2 Aggregate economic impact of Cardiff University teaching and learning (£m), by students' domicile and type of impact

Type of impact	Wales	England	Scotland	Northern Ireland	United Kingdom
Students/Graduates	**215.4**	**277.8**	**2.0**	**4.1**	**499.3**
Full-time	188.3	260.3	0.8	3.6	**453.0**
Part-time	27.1	17.5	1.2	0.5	**46.3**
Public purse	**190.5**	**271.8**	**2.3**	**4.0**	**468.6**
Full-time	164.5	251.5	0.9	3.5	**420.4**
Part-time	26.0	20.3	1.4	0.5	**48.2**
Total	**405.9**	**549.6**	**4.3**	**8.1**	**967.9**
Full-time	352.8	511.8	1.7	7.1	**873.4**
Part-time	53.1	37.8	2.6	1.0	**94.5**

Source: London Economics' analysis

The impact of Cardiff University's Research activities

Cardiff University is at the forefront of international research activity. Ranked 5th in terms of **research quality** and 2nd in terms of **research impact** as part of the 2014 Research Excellence Framework, academic staff across the University consistently generate world-class research.

From assisting service provision for vulnerable and homeless young people in Wales (*Llamau Ltd*) to the better treatment of prostate cancer through evidenced based research, Cardiff University research activities are achieving a demonstrable improvement in peoples' lives.

With the assistance of Cardiff University seed-funding through the **Cardiff Partnership Fund**, much of the research undertaken within the University has been extended into the commercial world - in research areas ranging from eye surgery (e.g. *Ultravision*) to the early identification of material degradation in bridges (*Mistras Group Ltd*).

Cardiff University is also at the forefront of research collaboration. Reflecting the twin objectives of internationalisation and innovation, the University has engaged in a number of high profile

research collaborations including the **Cardiff University – Peking University Joint Cancer Institute** and **Cardiff University – Capital Medical University Joint Centre for Biomedical research**, as well as the with the **University of Leuven** to improve the quality of teaching and research delivered in Cardiff.

To estimate the **direct** economic impact associated with Cardiff University's research activities, we used information on the total research-related income accrued by Cardiff University in the 2012-13 academic year, including:

- Research grants and contracts provided by:
  - The UK Research Councils and charities;
  - Public corporations, Local Authorities and UK Government;
  - UK Industry and Commerce;
  - EU and overseas sources (e.g. charities, industry and commerce, public corporations, and EU government bodies);
  - Other sources;
- Research-related funding body grants, in terms of Quality Research Funding provided by the Higher Education Funding Council for Wales; and
- Other research-related income, in terms of revenue from intellectual property rights.

Aggregating income streams from these sources, the analysis suggests that the total direct research-related income accrued by Cardiff University in 2012-13 stands at **£129.8 million**. The funding granted by the UK Research Councils and UK charities constitutes the largest funding source for Cardiff University research, contributing **£41.3 million** (**32%**) to research income, followed by the Quality Research Funding grant allocated by HEFCW (**£40.0 million** or **31%**).

To calculate the net impact on the economy, we deducted from total direct research-related income the costs to the public purse of funding the research activities undertaken by Cardiff University. Hence, to arrive at the net impact of Cardiff University's research activities, we deducted the public costs of funding research through direct block grants allocated by HEFCW (i.e. Quality Research Funding), as well as Research Council funding. Together, these public costs amount to **£62.9 million**, implying a **total direct research output** of **£66.9 million** generated by Cardiff University in 2012-13.

Cardiff University is ranked 5th in UK for quality of research and 2nd nationally for research impact

The wider academic literature indicates that investments in intangible assets (such as R&D and Intellectual Property) may have **positive spillovers** for the private sector. Econometric research[2] suggests that there is strong evidence of the existence of spillovers from public R&D expenditure by UK Research Councils and Charities. Our analysis implies a weighted average spillover multiplier of approximately **4.2** associated with Cardiff University research income (based on the 2012-13 academic year). In other words, **every £1m invested in research at Cardiff University results in an additional economic output of £4.2 million for UK companies**.

Combining the **direct economic value** of Cardiff University's research activities (**£66.9 million**) with the **productivity spillovers** estimated for private companies in the UK (**£542.2 million**), the total

[2] Haskel and Wallis (2010).

economic impact of research conducted by Cardiff University in the 2012-13 academic year was estimated to be **£609.1 million**.

Table 3 Total impact of Cardiff University's research activities, in £m

Type of impact	£m in 2012-13
Direct research impact	66.9
Productivity spillovers	542.2
Total	**609.1**

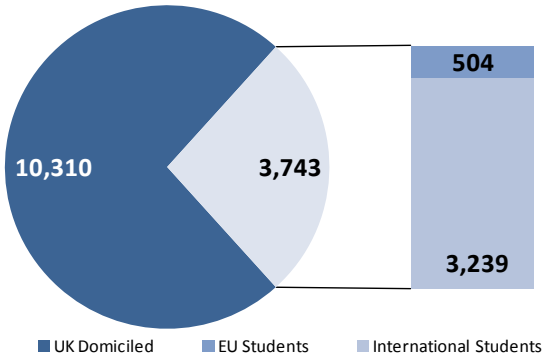
Note: Values are presented in 2012-13 prices.

Source: London Economics' analysis

The impact of Cardiff University's activity on Educational exports

Overseas trade (or international trade) is the sale of goods and/or services across international borders. Education is a tradable sector with imports and exports like any other tradable sector, such as manufacturing or financial services. Educational exports contribute to the UK economy through an injection of income from an overseas source.

Figure 1 Cardiff University student starter profile – by domicile2012-13



In the 2012-13 academic year, out of a total of **14,053** students starting new qualifications or standalone modules with Cardiff University in that year, **3,743** (i.e.**27%** of the total) were non-UK domiciled prior to starting their qualification. Of these **3,743** students, **87%** were non-EU international students, with the remaining **13%** originating from the European Union.

Across both EU and non-EU students, approximately **55%** of students were enrolled on postgraduate Masters qualifications; **4%** of students were enrolled on Doctorate degrees; **22%** were enrolled on undergraduate degrees; and the remaining **19%** of students were enrolled on 'other' sub-degree higher education qualifications.

Using a range of information on overseas students' learning profiles, study duration, completion rates, personal expenditure and fee income generated, the analysis suggests that the present value of **export income** generated by Cardiff University associated with the 2012-13 cohort of overseas students was **£135.9 million** (of which **£67.4 million** was associated with **tuition fee income**, while **£68.5 million** was associated with **non-tuition fee expenditure**).

The impact of Cardiff University on UK exports, based on the 2012-13 academic year, stands at £136 million.

By source of location, approximately **9%** (**£12.9 million**) was generated by EU domiciled students undertaking learning at Cardiff University, while the remaining **£123.0 million** of impact (**91%**) associated with non-EU international students attending the University.

Table 4 Aggregate economic impact on exports (£m), by domicile and type of impact

Type of impact	Domicile		
	EU	Non-EU	Total
Net tuition fee income	1.9	65.5	**67.4**
Non-tuition fee income	11.0	57.5	**68.5**
Total	**12.9**	**123.0**	**135.9**

Note: Values are presented in 2012-13 prices. ***Source: London Economics' analysis***

The direct, indirect and induced effect of Cardiff University's physical footprint

The majority of existing literature on the economic impact of universities focuses (almost exclusively) on the direct, indirect and induced impact of higher education institutions on their local, regional or national economies. An assessment of such effects considers a university as an economic unit creating output within the local economy by purchasing products and services from different industries and hiring employees.

Cardiff University spent a total of approximately **£161.5 million** on the procurement of goods and services within the United Kingdom in the 2012-13 academic year. In addition to purchasing goods and services from suppliers, Cardiff University paid a total of **£249.1 million** in staff costs within the United Kingdom.

The total direct, indirect and induced impact of Cardiff University's staff and non-staff expenditure, and the personal expenditure of its students stood at £1.03 billion in the UK. Of this total, £886 million was accrued in Wales.

In addition to the impact of Cardiff University's own expenditures, traditional HEI impact analyses further consider the economic impact associated with the personal expenditures of university students throughout their studies. Based on estimates of non-tuition fee expenditures per student, combined with information on the CU student profile, average study duration and completion rates, we estimate that the total level of non-tuition fee expenditure associated with the 2012-13 cohort of CU students stands at approximately **£217.5 million**.

Combining this expenditure information:

- Cardiff University had a **total direct economic impact** (in terms of output across the entire United Kingdom) of approximately **£410.6 million** in 2012-13.
- Using a range of output and employment multipliers, we estimated that the additional **indirect and induced effects** of Cardiff University's own institutional expenditures as well as the personal expenditures of its students stood at **£616.9 million**.
- The **total direct, indirect and induced** impacts associated with Cardiff University's institutional expenditure and CU students' personal expenditure stood at **£1,027.5 million** across the UK, of which **£885.9 million** (**86%**) is estimated to accrue within Wales.

In relation to employment, the analysis suggests that in addition to the **5,473** full-time equivalent jobs provided directly by the University in 2012-13, there were a further **5,898** supported by the University's activities across the United Kingdom.

Cardiff University's activities support a total of almost 11,400 jobs throughout the UK, of which 10,100 are in Wales.

The social impact associated with Cardiff University's activities

The impact of Cardiff University is not limited to the merely economic. Reflecting the University's extensive widening participation activities (e.g. *Step-Up Scheme*), as well as Cardiff University links across the commercial world, Cardiff University students and graduates engage in a range of volunteering activities (*Student Volunteering Cardiff*), work placements and internships throughout and beyond their academic careers (e.g. *Santander Internship Scheme*, *Insights*).

In addition, Cardiff University staff engage with the general public through a wide array of high-profile events across Wales (e.g. *Brain Games*), as well as taking an active role in disseminating academic research through the University's successful *Open Access* publishing, and training the professions trough its *Continuing Professional Development* activities.

From the development of cultural capital and environmental protection (*CAER Heritage Project*) to life-changing medical advances (*Cancer research partnerships in China* and *Ultravision surgical advances*), many of these wider social impacts are a direct result of Cardiff University's ongoing commitment to world class research.

1 Introduction and overview

London Economics were commissioned to estimate the economic impact of Cardiff University in Wales and across the UK as a whole. In general, undertaking an economic impact analysis is never a straightforward task. However, assessing the economic impact of Cardiff University is even more challenging, given the University's primary 'products' include undertaking world-class research, as well as the successful delivery of teaching and learning. Furthermore, Cardiff University's physical footprint plays a significant role in the Welsh economy; in addition to being a significant employer in the South Wales region, through its extensive supply chain and by attracting students to the region, Cardiff University also supports a substantial number of jobs indirectly across Wales and the rest of the United Kingdom.

Our general approach to addressing these many impacts is as follows. In the first substantive section of this report (**Section 2**), we assess the improved labour market earnings and employment outcomes associated with higher education attainment through a detailed analysis of the Labour Force Survey. Through an assessment of the lifetime benefits and costs associated with education attainment, we estimate the economic impact of Cardiff University's teaching and learning activity for its **10,310** UK-domiciled students starting qualifications or standalone modules in 2012-13, but also the impact on the public purse (through enhanced taxation receipts).

In **Section 3** of the report, we combine information on the research-related income accrued by Cardiff University in 2012-13 (by income source) with estimates from the wider economic literature on the extent to which public investment in research activity results in additional or subsequent private sector productivity (i.e. positive 'productivity spillovers'). This analytical approach results in an estimate the impact of Cardiff University's research activities.

In addition to the 10,310 UK-domiciled students starting qualifications or modules with Cardiff University in the 2012-13 academic year, a further **3,743** international students enrolled with the University in 2012-13. As such, Cardiff University contributes to the value of UK educational exports through the receipt of income from overseas. **Section 4** of this report assesses the monetary value of the tuition fee and non-tuition fee income associated with non-UK domiciled students, and estimates the contribution of these activities to the UK economy[3].

With more than **6,000** contractual staff and almost **1,200** atypical (i.e. casual academic) staff in 2012-13, through the employment and earnings received by this workforce, the **direct economic impact** of Cardiff University is substantial. However, in addition to these direct effects, Cardiff University also **indirectly** supports the employment and earnings outcomes of many individuals that provide services throughout university's extensive supply chain. Similarly, the spending of students undertaking their learning at Cardiff University within the local economy results in economic benefits to local businesses and throughout their supply chains. In **section 5**, using information from the University's financial accounts, the Student Income and Expenditure Survey, as well as the wider economic literature, we estimate both the direct impact of Cardiff University's expenditure and the spending of its students, as well as the indirect and induced impact across Wales and the United Kingdom.

Section 6 of this report summarises our main findings.

[3] Note that the estimated aggregate impact on exports does not take account of export revenues associated with the off-campus expenditures generated by international visitors to Cardiff, due to data limitations, particularly a lack of information on the number of such visitors attracted by universities).

2 The impact of Cardiff University's teaching and learning

2.1 Introduction and rationale

Almost a decade ago, the Atkinson (2005) report to the Office for National Statistics was tasked with determining the appropriate methodology to be used when assessing the economic impact of a range of public sector activities. Traditionally, to estimate the value associated with **education outcomes**, straightforward *input-output* analysis has been used. This approach simply asserts that the value of inputs into the education system essentially equals the value of outputs associated with educational attainment. However, it is clear that this approach does not adequately capture the productivity or growth impacts associated with having a more highly educated workforce, and as such undervalues the productivity benefits associated with higher education. Although there are many non-economic benefits associated with higher education, Atkinson stated the economic value of education and training is essentially the **value placed on that qualification as determined by the labour market**.

The methodological approach presented in this section values the **teaching and learning activities** undertaken at Cardiff University by considering the labour market benefits associated with enhanced qualification attainment and skills acquisition – to both the individual and the public purse.

To measure these labour market benefits, we estimate the enhanced probability of being in employment and the enhanced (after-tax) earnings associated with qualification attainment. Against these benefits that are accrued by the individual in possession of the qualification, it is necessary to incorporate both the **direct** costs associated with qualification attainment (e.g. the effective tuition fees (net of any subsidy) etc), as well as the **indirect** costs associated with qualification attainment (e.g. the foregone earnings whilst undertaking the qualification).

Simultaneously, the public purse benefits from the receipt of enhanced taxation revenues from individuals completing higher education qualifications (e.g. higher income tax and higher National Insurance contributions). On the cost side, to support students' qualification attainment, the public purse incurs the costs of student fee or maintenance support (e.g. through grants and loans) as well as the costs of teaching funding based on the funding regimes existing in the Home Nations.

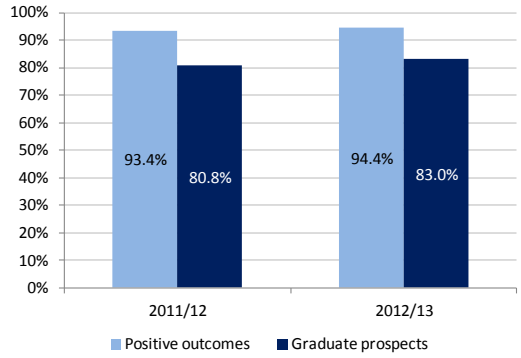
The 2012-13 Destinations of Leavers from Higher Education Survey indicates that 94.4% of Cardiff University graduates secure employment or further study within six months after graduation.

Box 1 Cardiff University graduate destinations

Figure 2 and Figure 3 present employment circumstances six months after graduation based on results from the Destinations of Leavers from Higher Education (DLHE) Survey 2011-12 and 2012-13, evidencing the impact of CU's teaching and learning activities in producing highly employable graduates.

As presented in Figure 2, and reflecting an improvement since 2011-12, the DLHE results indicate that **94.4%** of recent CU graduates surveyed in 2012-13 and who were available for employment had secured employment or were in further study (captured as 'positive outcomes'). Further, **83.0%** were able to secure graduate level employment or were undertaking further study at graduate level.

Figure 2 Overview of employment prospects of CU alumni, based on DLHE 2011-12 and 2012-13



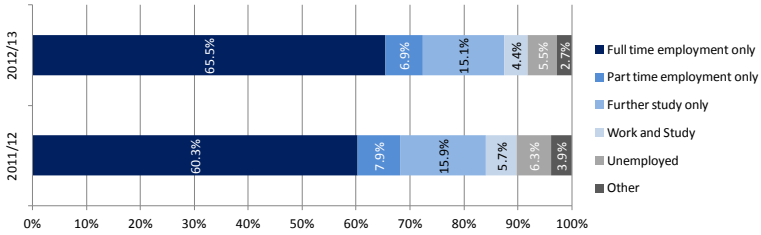
Note: The DLHE is a national annual survey carried out sixth months after graduation to provide a snapshot of graduates' employment circumstances, capturing both UK and non-UK graduates. Positive outcomes capture the proportion of graduates who were available for employment and had secured employment or further study. Graduate prospects capture the proportion of graduates who were available for employment and had secured graduate-level employment or graduate-level further study.

Based on 5,511 respondents (out of a total population of 7,910) in 2011-12 and 4,810 respondents (out of a total of 7,580) in 2012-13.

Source: London Economics' analysis of CU Destinations of Leavers of Higher Education (DLHE).

Figure 3 provides more detail on the particular employment circumstances of CU graduates six months after graduation (based on the DLHE). Again, the results evidence a high percentage of graduates in employment, with **65.5%** and **6.9%** of survey respondents in 2012-13 undertaking full-time or part-time work (respectively), and a further **4.4%** combining work and study.

Figure 3 Labour market outcomes and prospects of CU alumni, based on DLHE 2011-12 and 2012-13



Note: Based on total respondents with known destinations of 5,462 (2011-12) and 4,772 (2012-13).

Source: London Economics' analysis of CU Destinations of Leavers of Higher Education (DLHE).

Supplementing the above DLHE statistics, data on the connections of alumni with Cardiff University's LinkedIn account indicate that CU students are highly employable throughout the UK and all over the world; for example, LinkedIn indicates that approximately 1,700 CU alumni now live in the United States, 1,500 in Australia, 1,400 in India and 1,200 in China.

Note: LinkedIn information is based on a snapshot of summary information on students and alumni connected with Cardiff University's LinkedIn account as of 19th May 2015. The information provided on LinkedIn covers a total of 52,058 individuals, out of a total of 58,558 students linked to the account.

Source: Cardiff University

2.2 Defining the returns to qualifications

The fundamental objective of the analysis is to generate the **net graduate premium** to the individual associated with higher education qualification attainment and the **net public purse benefit**. These are defined in Box 2.

Box 2 Definition of gross and net graduate premiums and benefits to the public purse

The ***gross* graduate premium** associated with qualification attainment is defined as the **present value** of **enhanced after-tax earnings** (i.e. after income tax, National Insurance and VAT are removed) relative to an individual in possession of the counterfactual qualification.

The ***gross* benefit to the public purse** associated with qualification attainment is defined as the **present value** of **enhanced taxation** (i.e. income tax, National Insurance and VAT) relative to an individual in possession of the counterfactual qualification.

The ***net* graduate premium** is defined as the gross graduate premium *minus* the present value of the **direct costs** and **opportunity costs** (i.e. the cost of foregone earnings) associated with qualification attainment. Similarly, the ***net* benefit to the public purse** is defined as the gross benefit minus the **direct** costs of provision and **foregone taxation** during the period of attainment.

Box 3 Student Volunteering Cardiff

Student Volunteering Cardiff (SVC) is a charity run by the students at Cardiff University. SVC's volunteering projects assist a range of individuals in Cardiff and the Vale of Glamorgan, including the elderly, homeless, adults with learning disabilities and/or mental health difficulties, children and young adults with disabilities, local residents and young carers.

Over **1,200 volunteering opportunities** were filled in 2012-13, including both long-term and short-term opportunities. It is estimated that SVC's volunteers contributed approximately **50,000 hours** of volunteering activity in 2012-13.

In addition to working with a range of national partners (Headway, Age Concern, NHS, Communities First), SVC has developed a range of new projects to further assist those in greatest need across the entire age spectrum. These include:

- **Confident Futures**: Supporting young people living in care to develop skills, confidence and aspirations about Higher Education.
- **5 Party Planners** and **Make & Bake**: Clubs aimed at organising events and activities for older people.
- **Innovate Trust**: Working with our partner organisation, SVC volunteers were matched to adults with learning, physical and /or mental health disabilities living in Supported Housing.
- **LOL Fridays**: A club that provides young people with Down's syndrome the opportunity to build social and life skills.

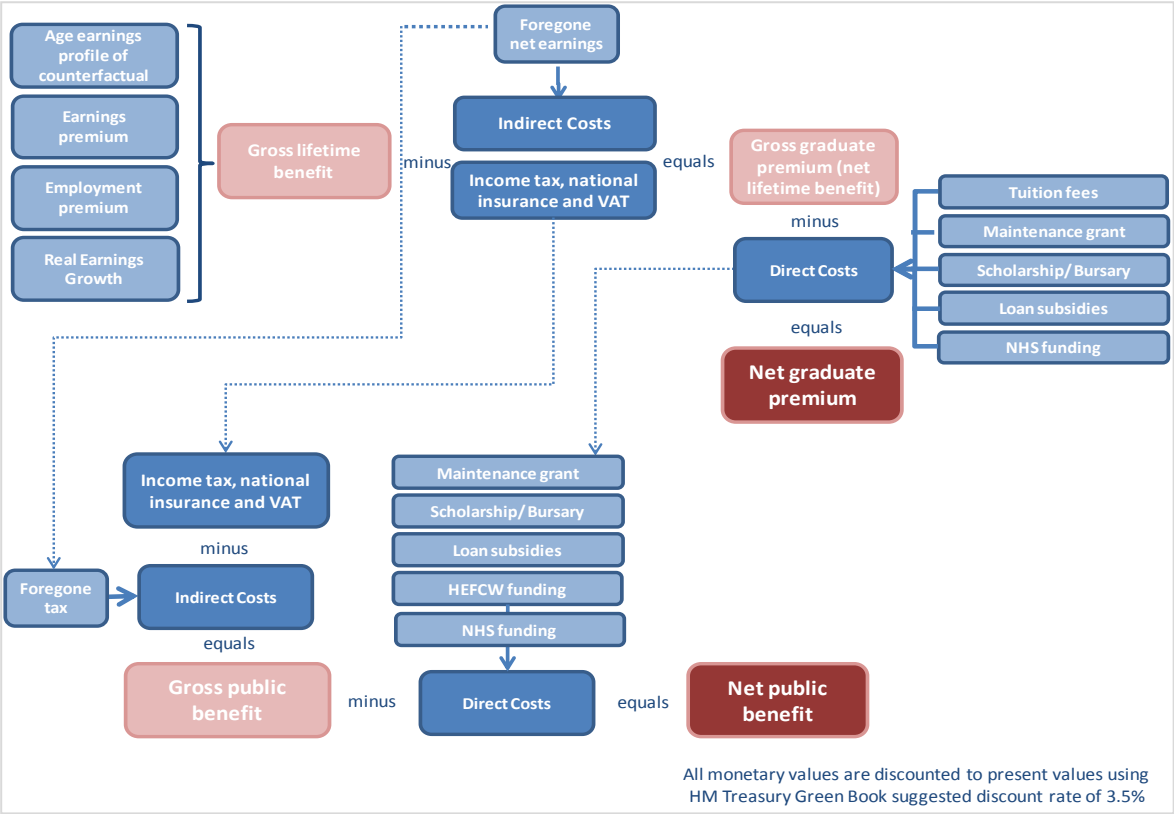
In 2012/13, SVC was re-accredited with the Investing in Volunteers Award.

Credit: Cardiff University.

Source: Cardiff University

In Figure 4, we provide an illustration of some of these concepts, as well as how the various components feeding into the costs and benefits associated with qualification provision and acquisition, tie together. We discuss the approach for establishing the **net graduate premium** and the **net public purse benefit** in the next sections.

Figure 4 Combining costs and benefits to the individual and the public purse



Source: London Economics' analysis of Department for Business Innovation and Skills (2011)

2.3 Scope of the analysis: what cohort of students was considered?

The analysis of the economic impact of Cardiff University's teaching and learning activities is based on the **2012-13 cohort** of Cardiff University students. In other words, instead of considering the University's entire student body (irrespective of when these individuals may have commenced their studies), we focus on determining the economic impact generated by those **undertaking a new stand-alone credit-bearing module or starting a formally recognised qualification in the 2012-13 academic year**.

Note that the analysis of the impact of teaching and learning in this section focuses on those students included in the 2012-13 Cardiff University cohort that are **UK-domiciled only** (i.e. with a known domicile in any of the UK's Home Nations). However, it is likely that a proportion of EU and non-EU domiciled students undertaking their studies at Cardiff University will remain in the UK to work following completion of their studies; similarly, UK-domiciled students might decide to leave the UK to pursue their careers in other countries. Given the uncertainty in predicting the extent to which this is the case, and the difficulty in assessing the net labour market returns for non-UK students (e.g. when considering the earnings which these students forego during their studies at Cardiff University), the analysis of teaching and learning focuses on UK-domiciled students only. In other words, we implicitly assert that all UK students studying with Cardiff University will enter the UK labour market upon graduation, and that non-UK students will leave the UK upon qualification

completion. Non-UK domiciled students in the 2012-13 Cardiff University cohort are instead considered as part of the analysis of the University's impact on **exports**, based on the tuition fee and non-tuition fee income associated with these students (**Section 4**).

2.4 Estimating the benefits to higher education qualifications

2.4.1 Assessing the gross graduate premium

To measure the **economic benefits to higher education qualifications**, it is necessary to estimate the labour market value associated with particular education qualifications, rather than simply assessing the labour market outcomes achieved by individuals *in possession* of a higher education qualification. To achieve this, the standard approach is to undertake an **econometric analysis** (see Box 4 and Box 5) where the 'treatment' group consists of those individuals in possession of the qualification of interest, and the 'counterfactual' group consists of those individuals with comparable personal and socioeconomic characteristics but with the next highest or 'adjacent' level of qualification[4].

Box 4 Estimating the wage returns to higher education qualifications

To undertake the impact of qualification attainment on earnings, using information from the Labour Force Survey, we estimated a standard **Ordinary Least Squares** linear regression model, where the dependent variable is the natural logarithm of hourly earnings and the independent variables include the full range of qualifications held alongside a range of personal, regional and job-related characteristics that might be expected to influence earnings. In this model specification, we included individuals who were employed on either a full-time or a part-time basis. This approach has been used widely in the academic literature. The basic specification of the model was as follows:

$$\ln(\omega_i) = \alpha + \beta' X_i + \varepsilon_i \qquad \text{for } i = 1 \text{ to n}$$

where $ln(\omega_i)$ represents the natural logarithm of hourly earnings, ε_i represents an error term, and X_i provides the independent variables included in the analysis as follows:

- Gender
- Age
- Age squared
- Ethnic origin
- Region of usual residence
- Qualifications
- Marital Status
- Number of dependent children under the age of 16
- Full-time/ part-time employment
- Temporary or permanent contract
- Public or private sector employment
- Workplace size
- Interaction terms, and
- Yearly Dummies

Using the above specification, we estimated earnings returns in aggregate and for men and women separately. Further, to analyse the benefits associated with different education qualifications over the lifetime of individuals holding these qualifications, the regressions were estimated separately across a range of specific age bands for the working age population, depending on the gender and qualification considered. The analysis of earnings premiums was undertaken at a national (UK-wide) level. However, to adjust for

[4] The 'treatment' and 'counterfactual' groups used throughout the econometric analysis are outlined in A2.1.1.

differences across the Home Nations, these UK-wide earnings premiums were then combined with the relevant differential direct costs facing the individual and/or the public purse for students domiciled in the different Home Nations.

To estimate the impact of higher education qualifications on labour market outcomes using this methodology, we used information from pooled Quarterly UK Labour Force Surveys between 1996 and 2013. The selection of information over this period is the longest time for which information on education and earnings is available on a relatively consistent basis. The resulting estimates of marginal wage returns to higher education qualifications are presented in A2.1.2.

Box 5 Estimating the employment returns to higher education qualifications

We adopted a **probit model** to estimate the likelihood of different qualification holders being in employment or otherwise. The basic specification defines an individual's labour market outcome to be either in employment (working for payment or profit for more than 1 hour in the reference week (using the standard International Labour Organisation definition) or not in employment (being either unemployed or economically inactive)). The specification of the probit model was as follows:

$$probit(EMPNOT_i) = \alpha + \gamma' Z_i + \varepsilon_i$$

The dependent variable adopted represents the binary variable *EMPNOT*, which is coded 1 if the individual is in employment and 0 otherwise. We specified the model to contain a constant term as well as a number of standard independent variables including the qualifications held by an individual (represented by Z_i in the above equation) as follows:

- Gender
- Age
- Age squared
- Ethnic origin
- Region of usual residence
- Qualifications
- Marital Status
- Number of dependent children under the age of 16, and
- Yearly Dummies

Again, ε_i represents an error term. Similar to the methodology for estimating earnings returns, the described probit model was estimated in aggregate and separately for men and women, with the analysis split by respective age bands. Further, and again similar to the analysis of earnings returns, employment returns were estimated at the national (i.e. UK-wide) level. The resulting estimates of marginal wage returns to higher education qualifications are presented in A2.1.2.

Comparing the earnings and employment outcomes of the treatment group and the counterfactual groups 'strips away' those other personal and socioeconomic characteristics that might affect the labour market earnings and employment (such as gender, sector or region of employment), leaving just the labour market gains attributable to the qualification itself. This is presented in Figure 5.

Throughout the analysis, the assessment of earnings and employment outcomes associated with higher education qualification attainment (at all levels) is undertaken separately by gender, reflecting the different labour market outcomes between men and women. However, in addition, given the fact that part-time students undertake and complete higher education qualifications later in life than full-time students, the analysis of part-time students applies a '**decay function**' to

the returns associated with qualification attainment to reflect the shorter period of time in the labour market[5].

Box 6 Changing the world, one bag at a time - Claire Morsman & Morsbags

Claire Morsman graduated from Cardiff University in 1998 with a degree in modern languages. She has since attained a Masters in linguistics and has just started a PhD in sociolinguistics. She has worked all over the world as a teacher, writer and examiner. Claire lived on a barge in London and became increasingly concerned about the quantities of plastic bags floating by on the canal.

With a simple concept, Morsbags was created. By setting up a website to share a pattern for making a bag, the project self-perpetuated and tens of thousands of people joined in. Morsbags is now a multinational creative non-profit community based on recycling waste fabric and goodwill. The results have been incredible. To date, more than 150,000 reusable Morsbags have been sewn around the world, with people from Prince Charles to prisoners, mums to members of the Women's Institute taking part.

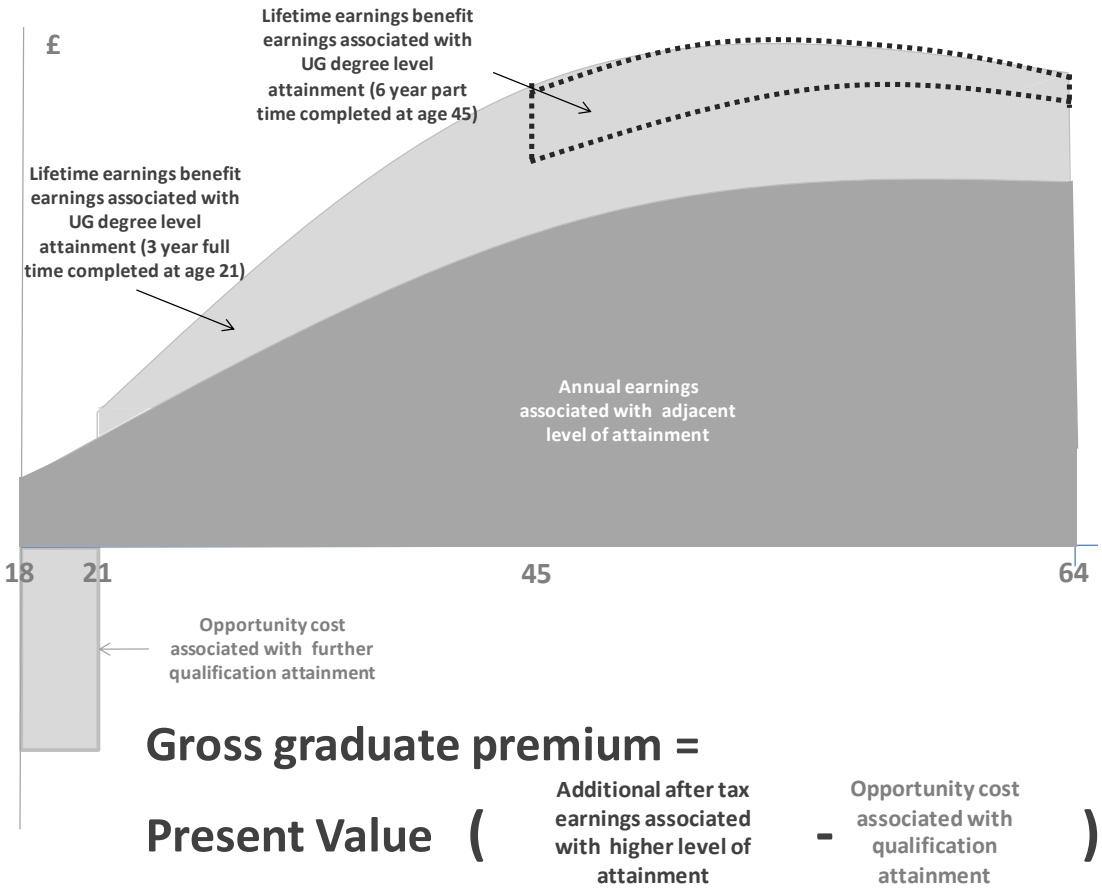
Credit: Cardiff University

Claire estimates that 150,000 reusable shopping bags have helped to take more than 80 million plastic carrier bags out of circulation, a figure that will have a huge impact on landfill sites and litter.

Source: Cardiff University

[5] For further details on the assumptions underlying the 'decay function' for part-time students, please refer to A2.1.3.

Figure 5 Estimating the gross graduate premium



Note: The analysis assumes that the opportunity costs of foregone earnings associated with further qualification attainment are applicable to full-time students only. For part-time students, we have assumed that these students are able to combine work with their academic studies and as such, do not incur any opportunity costs in the form of foregone earnings.

Source: London Economics' analysis

2.4.2 Gross benefits to the public purse

The potential benefits accruing to the public purse from the provision of higher education qualification attainment are derived from the enhanced taxation receipts that are associated with a higher likelihood of being employed, as well as the enhanced earnings associated with more highly skilled and productive employees. Based on the analysis of the lifetime earnings and employment benefits associated with higher education qualification attainment (generated through the econometric analysis), and combined with administrative information on the relevant taxation rates and bands (from HM Revenue and Customs), we estimated the present value additional income tax, National Insurance and VAT associated with higher education qualification attainment (by gender, level of study, mode of study, and origin of student)[6].

[6] More detail on the calculation of gross graduate premiums and gross public purse benefits is provided in technical annex A2.1.4.

Box 7 Cardiff University - Santander Partnerships

Paid internships in local organisations (subsidised by Santander) are available to final year Cardiff University students, recent graduates and postgraduates. Recognising the close links between Cardiff University and local businesses, the internship placements are provided by small to medium sized local businesses that pay a minimum of £1,000 a month for three months, who can then claim £1,500 back via the Cardiff University Work Experience Team at the end of the internship.

Credit: Cardiff University

The result of the sponsorship agreement is that finalists and recent graduates gain a paid internship, developing employability skills, while employers gain highly educated and eager graduates to help improve their businesses.

Credit: Cardiff University

For example, Celtic Recycling are leading specialists in heavy electrical plant recycling and recovery, live site dismantling, hazardous waste, abnormal load movement, oil recycling and high pressure cleaning.

Celtic Recycling provide a 'total package' approach, competently managing all health, safety and environmental risks associated with plant dismantling. The organisation used the Santander scheme to recruit a lab technician to set up and run a new, on-site laboratory to test recycled oils at their Newport plant.

Jack Haffenden completed his MChem Chemistry 2013 and was struggling to find work. He applied for the internships after seeing the Santander internship advertised on the University Target Connect database, with outstanding results.

"I got to set up and run my own lab which was very exciting – making decisions on equipment purchases and starting with a blank room was a great internship and experience for me. I highly recommend the scheme to other graduates – it has kick stared my career and has now led to my first graduate job!"

Source: Cardiff University

2.4.3 Costs to the individual

For full-time students, we assumed that there are **direct costs** (i.e. the proportion of the tuition fee and maintenance loan paid by the student minus any maintenance grant or Access Bursary received). In addition, we also estimated the **opportunity cost** associated with qualification attainment, which are represented by the foregone earnings of the next highest level of qualification whilst undertaking the higher education qualification (i.e. in the case of undergraduate degrees, this would consist of individuals in possession of GCE 'A' Levels). In contrast, although the comparable assumptions were made in relation to student support for part-time students, we assumed that there were no opportunity costs associated with this mode of study.

2.4.4 Costs to the public purse

The direct costs to the public purse include **teaching funding (administered through HEFCW)**, and any **student support** in the form of maintenance/fee grants, as well as subsidies associated with

maintenance and tuition fee loans (known as the **Resource Accounting and Budgeting charge** (**RAB charge**)) that are specific to the different Home Nations where students originate. We have further included the funding provided by the National Health Service for particular medical and Dentistry study programmes, providing maintenance and tuition fee support to students undertaking certain healthcare and nursing programmes, as well as teaching funding to compensate for the higher costs of clinical training for students on given dentistry courses. In turn, indirect costs to the public purse capture the **foregone income-tax, National Insurance and VAT receipts** during the period of qualification attainment (applicable to full-time students only). Given the differing approach to the funding of full-time and part-time students in each of the Home Nations, these costs incurred to the public purse were assessed separately for students originating from Wales, England, Scotland and Northern Ireland.

The direct and indirect costs of associated with qualification attainment to both students and the public purse (by qualification level, previous education, Home Nation and gender) were calculated from start to completion of a student's learning aim. Throughout the analysis, to ensure that the values of the economic benefits and costs presented were done so in **present value** terms (i.e. in 2012-13 money terms), all benefits and costs occurring at points in the future were discounted using the standard HM Treasury Green Book discount rate of **3.5%**[7]**.**

2.5 What are the estimates of the net graduate premium?

The net graduate premiums achieved by students undertaking undergraduate degrees (depending on the student domicile, and further disaggregated by gender and mode of study) are presented in Table 5. The analysis indicates that the **net graduate premium** achieved by a representative[8] male student from Wales completing a full-time undergraduate degree at Cardiff University with GCE 'A' Levels as their highest level of prior attainment stands at approximately **£121,000** in 2012-13 money terms. The comparable estimate for a female undergraduate student stands at approximately **£89,000**.

In comparison, and reflecting the different tuition fee and student support arrangements across the Home Nations, the respective net graduate premiums for undergraduates in **England, Scotland and Northern Ireland** are noticeably *lower*, ranging between approximately **£112,000** and **£114,000** for men and between approximately **£80,000** and **£82,000** for female undergraduate students.

It is important to note that the economic benefits associated with higher education qualification - expressed in monetary terms - are generally lower for women than men - predominantly as a result of the increased likelihood of spending time out of the active labour force. However, as with the majority of the wider economic literature, it is often the case that the benefit associated with higher education qualification attainment - expressed as either the percentage increase in hourly earnings or enhanced probability of employment - are greater for women than for men.

The net graduate premium associated with a full-time undergraduate degree for a representative CU student from Wales stands at approximately £121,000 for men and £89,000 for women.

[7] See HM Treasury (2011).
[8] The analysis is based on an average age at graduation of 22 for full-time students undertaking undergraduate degrees at Cardiff University.

Table 5 Estimates of the net graduate premium to a full-time undergraduate degree (relative to GCE 'A' Levels)

Domicile	Men		Women	
	Net graduate premium	Net public purse benefit	Net graduate premium	Net public purse benefit
Wales	£121,058	£113,692	£89,180	£60,377
England	£114,020	£120,729	£82,143	£67,414
Scotland	£111,937	£122,813	£80,059	£69,498
Northern Ireland	£111,641	£123,109	£79,763	£69,793

Note: Estimates are based on an average age at graduation of 22 for students undertaking undergraduate degrees at Cardiff University on a full-time basis.

Source: London Economics' analysis

2.6 What are the estimates of the net benefit to the public purse?

The net benefit to the public purse for a representative full-time male Cardiff University undergraduate from **Wales** with GCE 'A' levels as their highest level of prior attainment stands at approximately **£114,000** in 2012-13 money terms (also presented in Table 5). The comparable estimate for a female undergraduate stands at approximately **£60,000**. In comparison, reflecting the lower levels of student support provided to students from other Home Nations, the respective net public benefits for undergraduates from **England, Scotland and Northern Ireland are higher** - ranging between approximately **£121,000** and **£123,000** for men and between approximately **£67,000** and **£70,000** for women.

The net public purse benefit associated with a full-time undergraduate degree for a representative CU student from Wales stands at approximately £114,000 for men and £60,000 for women.

2.7 Differences by study mode

Despite the fact that students undertaking qualifications at Cardiff University on a part-time basis generally complete their qualifications later in life, there are also substantial benefits to both the individual and the public purse associated with the acquisition of higher education qualification attainment on a part-time basis. Specifically, the results of the analysis presented in Table 6 illustrate that the average net graduate premium achieved by a representative[9] male student domiciled in Wales undertaking an undergraduate degree (relative to the possession of GCE 'A' Levels) stands at approximately **£44,500**, while the corresponding estimate for a woman stands at approximately **£26,000**.

In spite of the late attainment of qualifications and the 'age decay' function applied to part-time students, the relatively small amount of funding available to part-time students implies positive returns to the public purse associated with part-time undergraduate level qualifications. In particular, the net public purse benefit associated with a representative male student undertaking

[9] The analysis is based on an average age at graduation of 45 for part-time students undertaking undergraduate degrees at Cardiff University

a part-time undergraduate degree stands at approximately **£26,000**, while the corresponding public purse benefit generated by women stands at **£3,500**.

Table 6 Estimates of the net graduate premium to a part-time undergraduate degree (relative to GCE 'A' Levels)

Domicile	Men		Women	
	Net graduate premium	Net public purse benefit	Net graduate premium	Net public purse benefit
Wales	£44,546	£26,228	£26,062	£3,540
England	£31,464	£39,311	£12,980	£16,623
Scotland	-	-	-	-
Northern Ireland	-	-	-	-

Note: Estimates are based on an average age at graduation of 45 for students undertaking undergraduate degrees at Cardiff University on a part-time basis. There are no students from Scotland and Northern Ireland recorded as having an intention to complete an undergraduate degree on a part-time basis in the 2012-13 cohort of Cardiff University students.

Source: London Economics' analysis

2.8 Other qualification levels

Although the focus has been on undergraduate degrees, the analysis was replicated for a range of different qualifications offered by Cardiff University. In particular, focusing on just those net graduate premiums and net public benefits generated by students/graduates who were Welsh domiciled prior to commencing their course of study, the analysis indicates that the **net (post)graduate premium** associated with a representative[10] Welsh-domiciled Cardiff University **Doctoral** student (relative to a Masters qualification) stands at approximately **£39,000** for men and **£24,000** for women. Reflecting the limited public funding associated with these degrees, the **net public purse benefit** associated with these Doctorate degree students stands at approximately **£59,000** for a man and **£33,000** for a woman.

A similar impact is identified for individuals undertaking postgraduate Masters qualifications. Specifically, the analysis suggests that the **net (post)graduate premium** associated with a representative[11] Welsh CU Masters degree student stands at approximately **£53,000** for a man and **£47,000** for a woman (relative to an undergraduate degree). The corresponding **net public purse benefits** stand at approximately **£76,000** and **£50,000**, respectively.

In relation to sub-degree higher education qualifications, the modelling suggests that there is a small net graduate premium associated with undertaking 'other' forms of higher education (i.e. stand-alone credit-bearing modules and Certificates of Higher Education[12]). For representative[13] male students from Wales undertaking such learning at Cardiff University, the net benefit stands at approximately **£17,000** compared to **£11,000** for a woman (relative to 2 or more GCE A Levels). The corresponding net public purse benefits stand at approximately **£15,000** and **£700** for men and women, respectively[14].

[10] This is based on an average age at enrolment of 26, and an average study duration for full-time Doctorate students of 3 years. The average age at enrolment is based on Cardiff University's 2012/13 HESA return, capturing all students (irrespective of subject of study) who started Doctorate degrees (or equivalent qualifications) in the 2012/13 academic year.

[11] This is based on an average age at enrolment of 25, and an average study duration for full-time Masters students of one year. The average age at enrolment is based on Cardiff University's 2012/13 HESA return, capturing all students (irrespective of subject of study) who started Masters degrees (or equivalent qualifications) in the 2012/13 academic year.

[12] For further detail on the qualification categorisations employed throughout the analysis, please refer to A2.1.6.

[13] Based on an average age at graduation for CU full-time students at 'other HE' level of 24 using Cardiff University 2012/13 HESA return.

[14] Note the low net graduate premium and net public purse benefit associated with male representative students from Wales undertaking HE Diplomas at Cardiff University. The values are caused by the fact that, on average, HE Diploma students in the 2012-13

For comprehensive tables of net graduate premiums and net public purse benefits estimated for full-time and part-time students across all qualifications offered by Cardiff University and all four Home Nation domiciles, please refer to A2.1.5.

Table 7 Estimates of the net graduate premium and net public purse benefit associated with qualifications offered by Cardiff University (full-time students from Wales only)

Level of study at CU	Men		Women	
	Net graduate premium	Net public purse benefit	Net graduate premium	Net public purse benefit
Other HE [1]	£17,055	£14,708	£10,560	£672
UG Degree	£121,058	£113,692	£89,180	£60,377
Masters Degree [2]	£53,403	£75,673	£46,742	£50,038
Doctorate Degree [3]	£39,431	£58,587	£24,175	£33,415

Note:

[1] Net graduate premiums and net public purse benefits associated with qualifications at Other HE level, and undergraduate degree level are estimated relative to possession of GCE 'A' Levels. Given the relatively low incidence of students undertaking HE Diplomas at Cardiff University, these have not been presented here, but full estimates are available in the Annex.

[2] Net graduate premiums and net public purse benefits associated with qualifications at Masters degree level are estimated relative to possession of an undergraduate degree.

[3] Net graduate premiums and net public purse benefits associated with qualifications at Doctorate degree level are estimated relative to possession of a Masters degree.

Source: London Economics' analysis

2.9 Aggregating the individual-level returns to teaching and learning

Having assessed the net individual and public purse benefits **per student** associated with different levels of higher education qualifications (by gender, prior attainment and domicile), the next stage of the analysis involves the assessment of the student cohort (in terms of the number of students starting and completing CU qualifications) in order to generate an aggregate economic impact.

2.9.1 The 2012-13 cohort of UK domiciled Cardiff University students

79% of undergraduate students say that the reputation of the course was important or very important in choosing their degree course at Cardiff University.

Based on CU's 'Welcome to Cardiff' Survey for undergraduate students

As outlined above, the analysis focuses on the **2012-13 cohort of students** (i.e. students undertaking a new stand-alone credit-bearing module or starting a formally recognised qualification at Cardiff University in 2012-13). Out of the total of **28,540** (new and continuing) students undertaking learning with Cardiff University in 2012-13, based on our definition of the cohort, **14,053** students (both UK and non-UK domiciled) started *new* standalone credit-bearing modules or qualifications at Cardiff University. Based on this, the analysis of the University's teaching and learning activities focuses on a total of **10,310 UK domiciled students starting qualifications or standalone modules in the 2012-13 academic year**. Table 8 presents a breakdown of these UK domiciled starters by domicile, qualification level and study mode[15].

cohort started these qualifications at age 27. This relatively high age at attainment implies large foregone income which these students would earn if they stayed in the labour market instead of attending university, as well as relatively low employment and wage returns to HE Diplomas as compared to GCE 'A' Levels (due to the assumption that these returns decay with age). Given the relatively low incidence of students undertaking HE Diplomas at Cardiff University, these have not been presented here, but full estimates are available in the Annex.

[15] Further detailed breakdowns of the 2012-13 cohort of CU students, including information on the number of full-time equivalent (FTE) students, are presented in A2.1.7.

Table 8 UK domiciled students (headcount) in 2012-13 cohort, by Home Nation, study mode and level of study at Cardiff University

Level of study at CU	Domicile				
	Wales	England	Scotland	Northern Ireland	Total UK
Full-time	**2,494**	**3,149**	**14**	**45**	**5,702**
Other HE	55	17	0	1	**73**
HE Diploma	58	26	0	0	**84**
UG Degree	1,767	2,706	4	41	**4,518**
Masters	475	300	5	0	**780**
Doctorate	139	100	5	3	**247**
Part-time	**3,797**	**749**	**41**	**21**	**4,608**
Other HE	2,851	203	7	8	**3,069**
HE Diploma	19	0	0	0	**19**
UG Degree	62	6	0	0	**68**
Masters	804	522	34	13	**1,373**
Doctorate	61	18	0	0	**79**
Total	**6,291**	**3,898**	**55**	**66**	**10,310**
Other HE	2,906	220	7	9	**3,142**
HE Diploma	77	26	0	0	**103**
UG Degree	1,829	2,712	4	41	**4,586**
Masters	1,279	822	39	13	**2,153**
Doctorate	200	118	5	3	**326**

Note: 'Other HE' includes Certificates of Higher Education, taught work for institutional credits or with an unspecified qualification aim, and credits at HE level. We received Cardiff University HESA data on a total of **16,216** students. From those, we excluded (in subsequent steps) a total of **3,782** students who were not UK-domiciled or for whom no Home Nation was indicated; **1** student who was studying in the second year; **69** students whose age was indicated at 99 (the default HESA age for students whose birth date is not known); and **2,054** students who were following courses at Further Education level. For a total of **934** students out of the resulting cohort, previous attainment levels were specified as either 'Mature student admitted on basis of previous experience and/or admissions test ', 'Other qualification level not known' or 'Not known'. For those students, we imputed their prior attainment level per student using a group-wise imputation approach; in particular, previous education levels for students with missing information were replaced with the mode of previous education of students undertaking similar qualifications at CU on the same basis (i.e. full-time or part-time).

Source: London Economics' analysis based on Cardiff University data

While Table 8 provides an overview of the number of students *starting* qualifications at Cardiff University in 2012-13, to aggregate the above-presented individual level impacts to a total level impact of the University's teaching and learning activity, it is necessary to adjust the cohort of 'starters' to account for non-completion rates. To generate these estimates, we make use of information provided by Cardiff University on qualification and module completion rates[16].

77% of undergraduate students say that the quality of the teaching was important or very important in choosing their degree course at Cardiff University

Based on CU's 'Welcome to Cardiff' Survey for undergraduate students

This information is presented in Table 9, and suggests that of those individuals starting an undergraduate degree at Cardiff University in 2012-13, approximately **95.1%** will complete the qualification, while the remaining **4.9%** either complete a different (usually lower) qualification (e.g. it could be the case that instead of finishing a full three year undergraduate degree, students

[16] The information is based on progression outcomes for Cardiff University students in the 2013/14 academic year (i.e. the most recent year for which the relevant information was available). While it is expected that a large proportion of the 2012/13 cohort of CU students would graduate in 2014/15 (i.e. completing a three year full-time undergraduate degree), progression outcomes for the 2014/15 academic year are not yet available.

instead only complete a two year HE Diploma), or instead only undertake one or more of the modules required for their degree before discontinuing their studies. Note that the completion rates indicated for students at 'other HE' level stands at **100.0%**, based on the inclusion of standalone credit-bearing modules in this qualification category throughout the analysis[17]. Further note that we apply the same completion rate assumptions to both part-time and full-time students starting qualifications or standalone credit-bearing modules with Cardiff University in 2012-13.

Table 9 Completion rates of Cardiff University students by level of intended attainment

Completion outcome	Qualification level /study intention				
	Other HE	HE Diploma	UG Degree	Masters	Doctorate
Complete as intended	100.0%	96.3%	95.1%	98.2%	91.4%
Other outcome	0.0%	3.7%	4.9%	1.8%	8.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Note: Based on Cardiff University completion information for the 2013-14 academic year. Students are included in the 'other outcome' category if they do not complete the qualification which they started, but instead either complete a different (usually lower) qualification, or only undertake one or more modules required as part of their programme before discontinuing their studies.

Source: London Economics' analysis based on Cardiff University data

2.9.2 Aggregate results of economic impact of teaching and learning

Combining the information on completion rates with the number of students starting qualifications at CU in 2012-13 (by gender, domicile, level of qualification attained, previous qualification and mode of study) and the individual and public purse benefits associated with the various levels of qualification attainment (relative to a student's specific level of prior attainment), the analysis indicates that the aggregate economic benefit of teaching and learning by Cardiff University associated with the 2012-13 cohort of CU students in the UK stands at approximately **£967.9 million**.

The economic benefit of teaching and learning generated by the 2012-13 cohort of Cardiff University students stands at £967.9 million.

Table 10 Aggregate economic impact of CU teaching and learning (£m), by students' domicile and type of impact

Type of impact	Wales	England	Scotland	NI	UK
Students/Graduates	**215.4**	**277.8**	**2.0**	**4.1**	**499.3**
Full-time	188.3	260.3	0.8	3.6	**453.0**
Part-time	27.1	17.5	1.2	0.5	**46.3**
Public purse	**190.5**	**271.8**	**2.3**	**4.0**	**468.6**
Full-time	164.5	251.5	0.9	3.5	**420.4**
Part-time	26.0	20.3	1.4	0.5	**48.2**
Total	**405.9**	**549.6**	**4.3**	**8.1**	**967.9**
Full-time	352.8	511.8	1.7	7.1	**873.4**
Part-time	53.1	37.8	2.6	1.0	**94.5**

Source: London Economics' analysis

Of the total economic impact, **52%** is accrued by the individuals undertaking qualifications at Cardiff University (**£499.3m**), while the remaining **48%** is accrued by the public purse (**£468.6m**).

[17] For instance, a student starting a Higher Education Certificate with Cardiff University in 2012-13 (categorised as starting a qualification at other HE level) who does not complete the intended qualification but instead only undertakes one or more of the modules associated with the intended qualification will be categorised as both starting and completing learning at 'other' HE level.

Reflecting the profile of the student cohort, **£873.4m** is associated with full-time students with the remaining **£94.5m** is generated by part-time students.

The analysis of Cardiff University's student profile (Table 8) illustrates the large inflow of English domiciled students undertaking their studies at CU, especially at undergraduate level. Clearly, amongst both Welsh and English domiciled Cardiff University students, there is a significant degree of labour market mobility, with many Welsh domiciled students working elsewhere in the United Kingdom post-graduation, as well as many English domiciled students remaining in Wales. However, without detailed information on the destination of Cardiff University graduates, it is very difficult to accurately assign the economic impact to the different Home Nations of the United Kingdom.

The expected economic benefit of teaching and learning generated by the 2012-13 cohort of Cardiff University students in Wales stands at £406 million.

In spite of this, using domicile prior to starting as a proxy, the analysis suggests that the economic benefit accrued to Wales associated with Cardiff University's teaching and learning provision stands at **£405.9 million.** This compares to **£549.6 million** in England, **£4.3 million** in Scotland and **£8.1 million** in Northern Ireland.

It is important to note that the economic impact estimated here is associated with the 2012-13 cohort of students only. Depending on the size and composition of the subsequent cohorts of Cardiff University students, a comparable assessment of the economic impact associated with teaching and learning activities would be estimated on an annual ongoing basis.

Box 8 Improving employability through internships and work placements - Cardiff University internships and *Insights*

Cardiff University undertakes significant activities aimed at improving the experience and employability of its student body. With a number of paid internships within the University suitable for final year students, graduates and postgraduates, the internship scheme is based on the success of previous years' "CUPID Scheme" (Cardiff University Professional Internship and Development Skills). Students gain a behind the scenes look at the working of the University in a range of internships from 4 to 12 weeks.

For example, the Law department ran an internship through this scheme in the summer of 2014 for four weeks with the aim of creating an assessed undergraduate Law Clinic module. This involved creating a course outline, lesson plan, draft assessments and teaching materials for a new Law Clinic final year 30 credit undergraduate law module.

Credit: Your Design /Shutterstock

In addition to these internships, Cardiff University also facilitates a range of paid and unpaid work experience opportunities suitable for 1st and 2nd year undergraduates in term time - flexibly set up around the student's timetable with a maximum of 35 hours of work experience. **Insights** take place in local organisations with a contribution to travel expenses paid by the University. Students gain hands on experience in structured working environments alongside experienced members of staff.

Source: Cardiff University

Box 9 Cardiff University's Step Up Scheme

The **Step-Up Scheme** aims to raise aspirations, attainment and provide support for secondary school students. Step-Up develops a three-year relationship with pupils in schools from which there have traditionally been low rates of progression to university.

Credit: Cardiff University

University staff visit priority schools and work with Year 11 pupils to promote the benefits of joining Step-Up. Once enrolled on the Scheme, pupils receive newsletters, access e-mentoring and attend general and subject specific events during Years 11/12. More than **150** participants a year attend the residential Step Up Summer School. In Year 13, pupils receive specialist information, advice and guidance during their university application process. Those applying for healthcare courses are also guaranteed interviews, subject to their academic ability. In addition, all Step-Up members have reserved places for other university events such as public lectures, MedWales and Open Days.

Pupils' progress is monitored and tracked throughout the three-year period. Typically, there are around **3,000** pupils (in Years 11, 12 and 13) on the Scheme at any one time and all of the University's academic schools contribute to the Scheme which is primarily focused on ***Communities First*** areas of South East Wales, but health elements of the Scheme are also available in parts of Mid and North Wales.

The Scheme brings together pupils, student mentors and academic staff at a variety of events. Current undergraduate students give talks about their experiences at University and information is available on routes into higher education, university accommodation, costs of being a student and much more.

Source: Cardiff University

3 The impact of Cardiff University's research and knowledge transfer activities

3.1 Methodological approach

3.1.1 Direct research impact

In order to estimate the economic impact of Cardiff University's research and knowledge transfer activities, we undertook a modified input-output analysis, based on the assumption that the **direct economic impact** of Cardiff University's research is equal to the amount which the University invests in its research activities each year. Hence, the direct economic impact of the research undertaken by Cardiff University is estimated based on the total research-related income accrued in the 2012-13 academic year, in terms of:

- Research grants and contracts provided by:
  - The UK Research Councils and charities;
  - Public corporations, Local Authorities and UK Government;
  - UK Industry and Commerce;
  - EU and overseas sources (e.g. charities, industry and commerce, public corporations, and EU government bodies);
  - Other sources;
- Research-related funding body grants, in terms of Quality Research Funding provided by the Higher Education Funding Council for Wales; and
- Other research-related income, in terms of revenue from intellectual property rights.

Aggregating income streams from these sources, the analysis suggests that the total direct research-related income accrued by Cardiff University in 2012-13 stands at **£129.8 million**. As outlined in Table 11, the funding granted by the UK Research Councils and UK charities constitutes the largest funding source for Cardiff University research, contributing **£41.3 million** (**32%**) to Cardiff University's research income, followed by the Quality Research Funding grant allocated by HEFCW (**£40.0 million** or **31%**).

Table 11 Cardiff University research-related income, £m in 2012-13

Type of income	Income, £m in 2012-13	% of total
Research grants and contracts		
Research Councils/ Charities	41.3	32%
Public corporations, Local Authorities, UK Government	26.8	21%
Industry & Commerce	5.0	4%
EU and overseas	15.0	12%
Other	0.2	<1%
Funding body grants		
HEFCW Quality Research Funding	40.0	31%
Other income		
Income from intellectual property rights	1.5	1%
Total	**129.8**	**100%**

Percentages may not add up to 100% due to rounding.

Source: London Economics' analysis of Cardiff University (2013) and other CU financial information

To calculate the net impact on the economy (similar to the analysis undertaken to estimate the impact of teaching and learning), it is necessary to deduct the costs to the public purse of funding the research activities undertaken by CU. Hence, to arrive at the net impact of CU's research activities, we deduct from total research-related income the public purse costs of funding CU research through direct block grants allocated by HEFCW (in terms of Quality Research Funding) as well as the UK Research Councils. Together, these public costs amount to **£62.9 million**, implying a **total direct research output** of **£66.9 million** generated by Cardiff University in 2012-13.

Box 10 Making bridges safer

Bridges which develop faults in construction materials over time can face major repairs and, in extreme cases, are shut down, resulting in safety problems, traffic disruption and road closures. To avoid these costs and risks, research in acoustic emission (AE) monitoring and refined data analysis, conducted by Cardiff University's School of Engineering in close partnership with Mistras Group Ltd., has transformed the inspection and monitoring of concrete and steel bridges worldwide.

Credit: pjhpix/Shutterstock

Cardiff University researchers and Mistras have developed a technology to replace the need for manual inspection of bridges, thus providing an early warning system to prevent major structural repairs, possible bridge shutdowns, safety issues and traffic disruptions. The technology relies on acoustic emission (AE) techniques, placing passive high frequency sensors on the surface of the structure under test. The sensors are able to detect energy released from growing defects, and to monitor the structure in question in its entirety, including internal details and inaccessible structure components. This system allows defects to be identified early, thus providing an effective strategic planning tool which can be used to manage assets, provide information that enables life extension, and reduce the need for road closures, therefore reducing whole-life costs of bridges.

The technology has been commercialised by Mistras through Knowledge Transfer Partnerships with Cardiff University, allowing Mistras to embed the outputs of the research collaboration within the company. The research outputs have enabled the company to provide safer, more reliable means of bridge monitoring, and to become a market leader in using AE for structural testing. **Mistras' turnover has increased significantly, from £0.3 million in 2005 to £7.5 million in the 2013/14 financial year, with £5 million of this turnover relating to Cardiff's research**. Mistras now claims more than 85% of the global market share in AE sensors and equipment sales, and the technique supports subsidiary companies in Northern Europe, the Middle East and Asia. As part of this global success, Mistras has been able to secure major international contracts including the San Francisco Oakland Bay Bridge, the Anthony Wayne Suspension Bridge (Ohio) and the Manhattan and Ben Franklin Suspension Bridges (Pennsylvania/New Jersey). The company also benefits from continued extensions, improvements and testing of acoustic emission technique for other purposes and sectors, such as the aerospace industry.

In addition to the direct benefits to the company itself, CU's research in this area has enhanced industrial practices and standards through world-wide dissemination of the outputs to engineering professionals. Further, the use of acoustic emission technologies is able to prevent serious safety risks to society, and to reduce CO2 emissions caused by lengthy road closures and traffic congestion.

Source: Cardiff University

3.1.2 Estimating productivity spillovers

In addition to the direct economic value of the innovations and knowledge generated by Cardiff University's research to the organisations funding these research activities, it is expected that the

research undertaken by Cardiff University results in considerable **productivity spillovers** for the private sector. For example, these spillovers might arise if firms can benefit from technologies developed at Cardiff University by employing them in their own production processes, thus reducing costs (see Box 10). These productivity spillovers are facilitated, for example, through direct R&D collaborations between firms and Cardiff University, the publication and dissemination of Cardiff University's research findings, or through the flow of Cardiff University graduates into the labour market and subsequent knowledge transfer within the organisations employing them. Box 13 outlines Cardiff University's Open Access policy, highlighting the University's successful efforts towards disseminating its research outputs to the wider public.

Box 11 Healthcare and Social Innovation – Llamau Limited

A Knowledge Transfer Partnership between **Llamau Limited** and **Cardiff University** has led to the improvement of the charity's service provision for vulnerable and homeless young people in Wales. The project has also received the highest possible rating by the UK's innovation agency, the Technology Strategy Board. Awarded to only a small percentage of KTP projects nationwide, the 'outstanding' rating signifies the highest quality of collaboration between Llamau Limited and Cardiff University.

Credit: Cardiff University

Llamau has been providing housing, education, training and support services to homeless young people and vulnerable women in Wales for more than 20 years following the research undertaken by **Dr Katherine Shelton** and **Dr Marianne Van den Bree** of Cardiff University into the underlying risk factors for homelessness experiences among young people. .The three year Knowledge Transfer Partnership project put this research into practice with the aim of improving Llamau's service provision in this area by:

- Enhancing the detection of mental health problems among service users;
- Developing specialist services with the aim of more positive outcomes for service users; and
- Achieving increased competitiveness when bidding for contracts to deliver new services.

Llamau

A step in the right direction for homeless young people and vulnerable women in Wales

Credit: Llamau.org.uk

Part-funded by the **Technology Strategy Board**, **Welsh Government** and the **Economic and Social Research Council**, the project has achieved significant success, with outputs including the development of a mental health bespoke screening tool that helps staff in the early identification of mental health issues amongst service users. The tool also enables the charity to fast track access to support and make meaningful and informed referrals.

Source: Cardiff University

Literature estimates of productivity spillovers from Higher Education research

There is a considerable volume of literature indicating that investments in intangible assets[18] (such as Research & Development and Intellectual Property) may generate **externalities** for the private sector. Externalities or spillovers refer to situations in which the activities of one agent in the market induce external effects (of either positive or negative nature) on other agents in that market. Put differently, "*an externality is present whenever the well-being of a consumer or the production possibilities of a firm are directly affected by the actions of another agent in the economy*" (Mas-Collell et al., 1995). More specifically, the economic literature analyses the existence of productivity and knowledge spillovers, where knowledge developed with the help of R&D efforts by one agent (e.g. a university) spills over to other firms' stocks of knowledge and

[18] In contrast to tangible assets (mainly land, capital and machinery), intangible assets are not physical in nature, such as scientific and creative property and knowledge embedded in computer software. For a more detailed definition of intangible assets which is frequently used across the literature, please refer to Corrado et al. (2005).

productivity levels, without the beneficiary firms contributing to the costs incurred in producing the scientific results.

Of particular interest in the context of research conducted by universities, a relatively recent study by Haskel and Wallis (2010)[19] investigates evidence of **spillovers from public funding of Research & Development** through a number of channels. Specifically, the authors analyse productivity spillovers to the private sector from public spending on R&D by the UK Research Councils, and public spending on civil and defence-related R&D. They also investigate the relative effectiveness of these channels of public spending in terms of their impact on the market sector.

Using data on government expenditure published by the Department for Business, Innovation and Skills for the financial years between 1986-87 and 2005-06, Haskel and Wallis find strong evidence of the existence of market sector productivity spillovers from public R&D expenditure on UK Research Councils[20] [21]. Based on their estimates, the findings imply that although there is no spillover effect associated with public funding of civil and defence R&D, the marginal spillover effect of public spend on research through the **Research Councils** amounts to **12.7, i.e. £1 million spent on university research through the Research Councils results in an additional annual output of £12.7 million in UK companies**. The analysis also suggests that the spillover benefits of public spending on research in higher education are greater than those from other R&D areas supported by government.

Another recent study by Haskel et al. (2014) provides additional insight into the size of potential productivity spillovers from university research. In contrast to Haskel and Wallis (2010, who estimate effects on the economy as a whole), Haskel et al. (2014) analyse the size of spillover effects from **public research** across different UK industries. Using data on 7 industries in the United Kingdom for the years 1995 to 2007, the authors investigate the correlation between the combined research conducted by the Research Councils, the higher education sector, and central government itself (e.g. through public research laboratories)[22], interacted with measures of industry research activity, and total factor productivity within the different market sectors[23]. Their findings imply a total rate of return on public sector research of **0.2, i.e. every £1 spent on public R&D results in an additional annual output of £0.20 within the UK private sector.**

[19] For a summary of Haskel and Wallis' (2010) findings, please refer to Imperial College London (2010).
[20] This is undertaken by regressing total factor productivity growth in the UK on various measures of public sector R&D spending
[21] Note that the authors' regressions only test for correlation, so that their results could be subject to the problem of reverse causation (i.e. it might be the case that increased market sector productivity induced the government to raise public sector spending on R&D). To address this issue, the authors not only test for 1 year lags, but for lags of 2 and 3 years respectively, and receive similar estimates. These time lags imply that if there was a reverse causation issue, it would have to be the government's *anticipation* of increased total factor productivity growth in 2 or 3 years which would induce the government to raise its spending on research; as this seems an unlikely relationship, Haskel and Walls argue that their results appear robust in relation to reverse causation.
[22] A key difference to the large multiplier estimate for the multiplier on Research Council spending provided by Haskel and Wallis (2010) lies in the distinction between performed and funded research, as outlined by Haskel et al. (2014). In particular, whereas Haskel and Wallis estimated the impact of research funding by the Research Councils on private sector productivity, Haskel et al. Instead focus on the performance of R&D. Hence, they use measures of the research undertaken by the Research Councils and the government, rather than the research funding which they provide for external research, e.g. by higher education institutions. The distinction is less relevant in the higher education sector: to measure the research performed in higher education, the authors use Higher Education Funding Council funding (where research is both funded by and performed in higher education).
[23] In particular, the authors regress the three year natural log difference of total factor productivity on the three-year and six-year lagged ratio of total research performed by the Research Councils, government and the Higher Education Funding Councils over real gross output per industry. To arrive at the relevant multiplier, this ratio is then interacted with a measure of co-operation of private sector firms with universities and public research institutes, capturing the fraction of firms in each industry co-operating with government or universities. The lagged independent variables are adjusted to ensure that the resulting coefficients can be interpreted as annual elasticities and rates of return.

Box 12 Life saving research: Treating locally advanced prostate cancer

Credit: Piotr_Pabijan/Shutterstock

Locally advanced prostate cancer (where a tumour has extended outside the prostate gland to surrounding tissues, but not to other parts of the body) affects around 4,000 men per year in the United Kingdom, and 20,000 men per year in the United States. In spite of these numbers, prior to essential research conducted by Cardiff University researchers, there was no consensus regarding the standard of care or the best way to treat locally advanced prostate cancer. Previous research on radiotherapy alone, and combined radiotherapy and hormone therapy, had been able to establish a role for hormone therapy, but had left uncertainty regarding the precise contribution of radiotherapy to patients' outcomes. As a result, patients were often treated with hormone therapy alone.

Against this background, led by researchers at Cardiff University, an international randomised clinical trial was implemented to investigate whether combining hormone therapy and radiotherapy improves outcomes for sufferers. The final results of the trial, presented in 2012, indicated that treating locally advanced disease with a combination of both types of therapy **reduced the risk of dying of prostate cancer by 54%**, thus highlighting the importance of radiation in the treatment of high-risk prostate cancer patients.

The results of this research have induced a change in the standard of care for these patients in the UK and internationally. Specifically, it has now become a standard of care in European and North American guidelines that all patients fit enough to receive it shall be offered combined modality radiotherapy and hormone therapy. In terms of ongoing impact, these recommendations are being extended to Asia. Based on the researchers' estimates, it is expected that the implementation of the study's results will prevent up to around 1,000 deaths from prostate cancer per year in the UK, around 5,000 such fatalities per year in the US, and in the order of 50,000 deaths per year worldwide.

Source: Cardiff University

Estimating productivity spillovers from CU research

To estimate the productivity spillovers associated with Cardiff University's research activity, we applied the above-described productivity spillover multipliers estimated in the relevant literature to the different items of research-related income presented in Table 11. Based on the results estimated by Haskel and Wallis (2010), the analysis implies a weighted average spillover multiplier of approximately **4.2** associated with Cardiff University research income (based on the 2012-13 academic year). In other words, **every £1m invested in research at Cardiff University results in an additional economic output of £4.2 million for UK companies**.

Table 12 Productivity spillover multipliers, by research income category

Type of income	Income, £m in 2012-13	Multiplier
Research grants and contracts		
Research Councils and charities	41.3	12.7
Public corporations, Local Authorities, UK Government	26.8	0.2
Industry & Commerce	5.0	0.2
EU and overseas	15.0	0.2
Other	0.2	0.2
Funding body grants		
Quality-related Research Funding	40.0	0.2
Other income		
Income from intellectual property rights	1.5	0.2
Weighted average productivity spillovers	**4.2**	

Source: London Economics' analysis based on Cardiff University (2013) and other CU financial data, Haskel and Wallis (2010) and Haskel et al. (2014)

3.2 The total impact of Cardiff University's research activities

Combining the **direct economic value** of Cardiff University's research activities (**£66.9 million**) with the **productivity spillovers** estimated for private companies in the UK (**£542.2 million**), the total economic impact of research conducted by Cardiff University in the 2012-13 academic year was estimated to be **£609.1 million** (see Table 13).

Cardiff University is ranked 5th in UK for quality of research and 2nd nationally for research impact

Table 13 Total impact of Cardiff University's research activities, in £m

Type of impact	£m in 2012-13
Direct research impact	66.9
Productivity spillovers	542.2
Total	**609.1**

Note: Values are presented in 2012-13 prices.

Source: London Economics' analysis

Box 13 Cardiff University and Open Access publishing

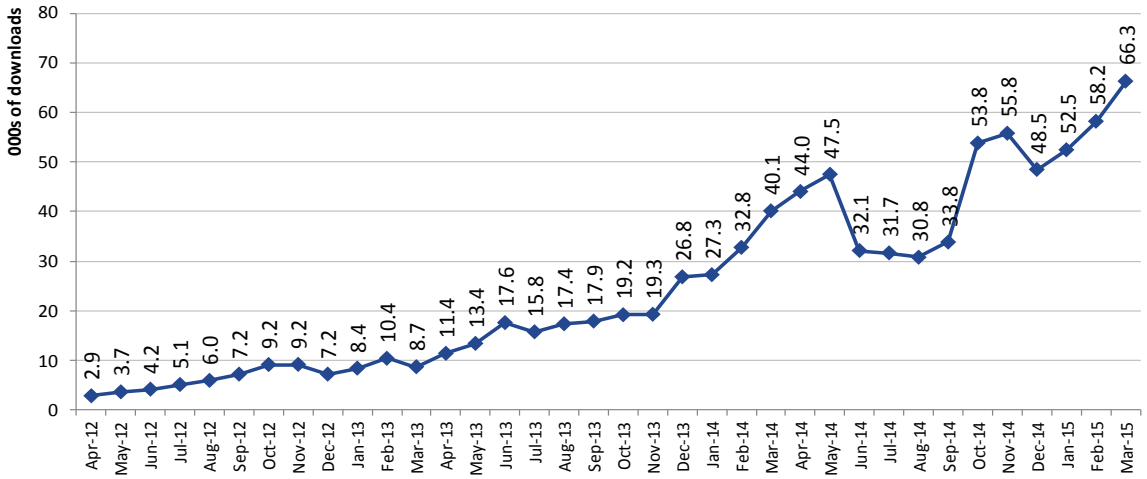
Based on the University's policy towards Open Access publishing and extensive dissemination of research outputs, CU generates productivity spillovers from its research across the UK economy. **Open Access publishing models** enable full-text peer reviewed articles to be freely available for anyone with access to the internet. Recognising the economic benefits associated with free and open access to publicly funded research, Cardiff University encourages its researchers to make their academic papers available via Open Access, in order to increase readership and citations, accelerate research and increase impacts, maximise the scope for innovation and growth of publicly funded research, and comply with funder mandates[24].

Gold Open Access publishing involves the author paying a fee (an Article Processing Charge) to the publisher of an Open Access journal. This allows the author to make their final published paper freely available to the public without any further charge. In contrast, **Green Open Access** occurs when researchers publish their research paper in a conventional journal (i.e. non-Open Access), but deposit the final pre-viewed accepted draft of their research paper in an institutional repository, without incurring any charge. In this case, it is likely that the publisher will not allow the author to deposit the final, published version of the paper, and will impose an embargo period prior to allowing the author to place the paper in the repository.

Cardiff University's Open Access Support Team encourages the deposit of the full text of all Cardiff University research publications, i.e. including research papers published through either the Green *or* Gold model, into its **Online Research @ Cardiff** (ORCA) repository. Based on the number of full texts available for download in ORCA by publication date, there are currently **6,548** full text items available on ORCA dating between 1995 and 2014. Of those, **5,309** full texts were published between 2006 and 2014, while the remainder (**1,239**) were published before 2006. Figure 6 presents monthly downloads from ORCA between April 2012 and March 2015, outlining the increasing interest in the academic research outputs produced by Cardiff University researchers via ORCA. Over the three years depicted, downloads per month increased by a factor of more than 23, from **2,865** in April 2012 to **66,275** in March 2015.

[24] Open Access is acknowledged and supported by UK Government as a driver for economic growth. Accordingly, it is compulsory for recipients of UK Research Council grants to make their research output Open Access. Similarly, as part of the post-2014 Research Excellence Framework, HEFCE requires journal articles and published conference proceedings used in submissions to be Open Access.

Figure 6 Number of full text downloads from ORCA, April 2012 to March 2015



Source: London Economics' analysis of Cardiff University data

The public interest in CU's research outputs is not limited to the United Kingdom. Based on the distribution of downloads from ORCA between March 2014 and February 2015, while **12.6%** of downloads originated in the UK, **29.7%** of downloads originated from within rest of the EU, and **40.1%** from outside of the EU (with the remaining **17.6%** of downloads unable to be determined).

Source: Cardiff University

Box 14 Improving support for victims of violence

Over the last decade, research led by Dr Amanda Robinson, a Reader in Criminology at Cardiff University, has been changing the services provided to victims of domestic and sexual violence, both nationally and internationally. The research consists of a series of inter-related research projects using both qualitative and quantitative approaches to identify effective working practices in, and measure outcomes of, interventions in cases of domestic and sexual violence. The outputs of these research projects provided a range of key insights into best practice responses, including:

- **The importance of multi-agency partnerships**, in particular Specialist Domestic Violence Courts (SDVCs) to improve service provision to victims of domestic and sexual violence, providing a multi-agency framework designed with the safety and support needs of victims and children in mind.
- **The value of independent support from specialist providers** such as Independent Domestic Violence Advisors (IDVAs) and Independent Sexual Violence Advisors (ISVAs), to support victims and to facilitate the work of partner agencies such as the police.
- Finally, **the need for distinctive forms of multi-agency support** (in the form of Multi-Agency Risk Assessment Conferences, or MARACs) to provide more targeted responses for individuals most at risk of serious abuse or homicide.

Credit: Vadim Kozlowski/Shutterstock

The new evidence base has had identifiable impacts on national and international policies, resulting in improvements in service provision for domestic and sexual violence victims, as organisations and governments are using findings from Dr Robinson's work to inform the development, implementation and funding of services for domestic and sexual violence victims.

Considering impacts on national policy, where they did not exist prior to the research work, the interventions analysed are now fully embedded in the British response to domestic and sexual violence. The research provided key evidence underpinning three of the seven policy objectives set out in the UK Government Report '**Saving Lives, Reducing Harm, Protecting the Public**'. In particular, the report sets out the Government's commitment to support the national use of IDVAs, ISVAs and MARACs, and to increase the number of SDVCs, with explicit reference to the research performed by Dr Robinson. There are now more than 280 MARACs held within the four Home Nations each year, responding to more than 74,000 high-risk cases of domestic violence, with an associated 94,000 children involved. In addition to the above, Dr Robinson has been asked to serve as an expert advisor on several national committees and working groups to shape professional practice on service provision to victims of violence in both the public and voluntary sector.

At the European level, most importantly, the research informed the 2008 Council of Europe **Task Force on Violence Against Women** and 2011 **Convention for Preventing and Combating Violence Against Women and Domestic Violence**, setting out obligations for Member States. As a result of this international interest in Dr Robinson's research insights, there has been a change in the response to victims of violence across Europe, with MARACs now operational in several European countries, and additional governments considering their implementation.

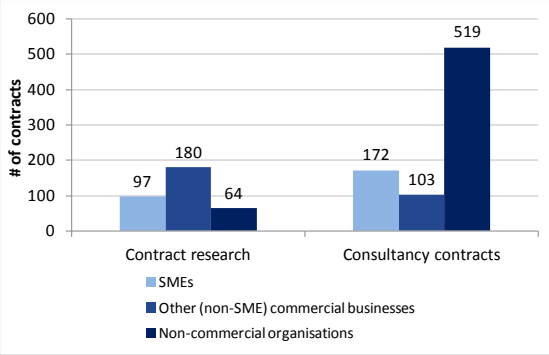
Source: Cardiff University

3.3 Research and knowledge transfer activities – summary statistics

In addition to the extensive direct and indirect economic impact associated with Cardiff University's research activity, information from the Higher Education Business and Community Interaction (HE-BCI) survey 2012-13 also demonstrates a number of tangible research outcomes.

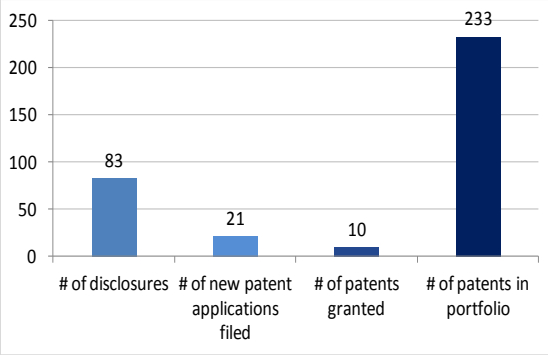
Specifically, the analysis of Cardiff University's HE-BCI responses indicates that the number of invention disclosures[25], patents applied for and granted stood at **83**, **21** and **10** respectively, while the number of active or live patents currently registered (under license to an external party or yet to be licensed) stood at **233** (see Figure 8).

Figure 7 Number of contracts for contract research or consultancy, 2012-13



Source: London Economics' analysis based on Cardiff University HE-BCI results 2012-13

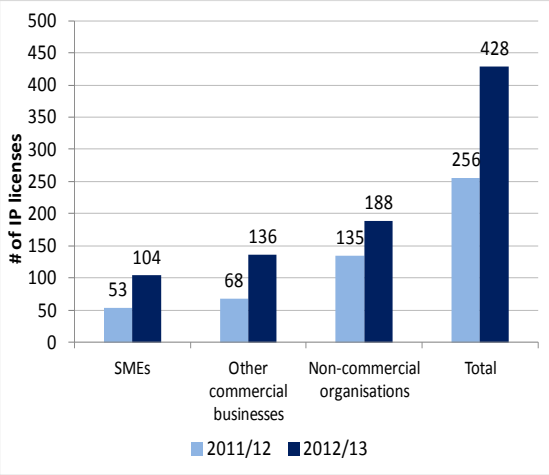
Figure 8 Disclosures and patents filed by or on behalf of CU, 2012-13



Note: Number of patents in portfolio refers to number in cumulative patent portfolio.

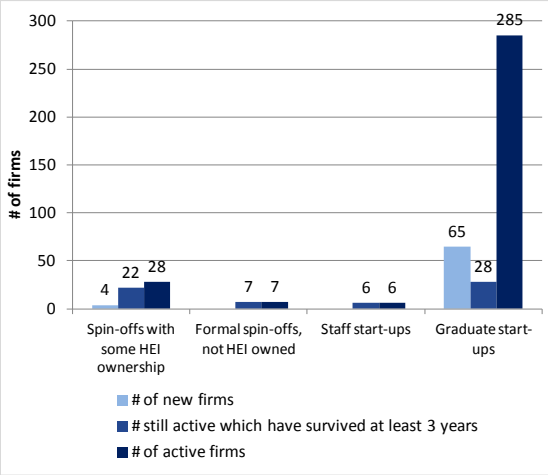
Source: London Economics' analysis based on Cardiff University HE-BCI results 2012-13

Figure 9 IP licenses granted by CU, 2011-12 and 2012-13



Source: London Economics' analysis based on Cardiff University HE-BCI results 2012-13

Figure 10CU spin-off activity, 2012-13



Source: London Economics' analysis based on Cardiff University HE-BCI results 2012-13

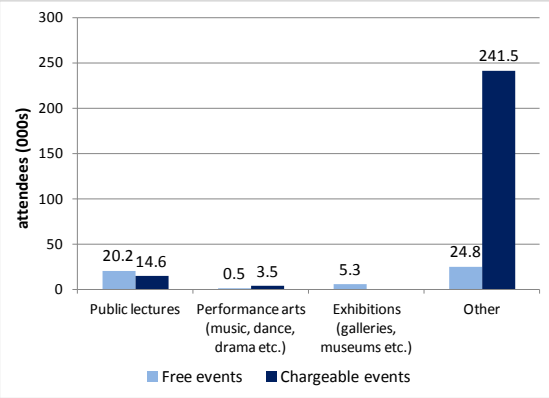
Furthermore, in relation to IP licenses (Figure 9), the analysis of HE-BCI data indicates that the number of IP licenses increased significantly between 2011-12 and 2012-13. Specifically, the number of IP licenses granted to SMEs almost doubled (from **53** to **104**), compared to an increase from **60** to **136** for other commercial businesses, and between **135** and **188** for non-commercial organisations. In aggregate, the total number of IP licenses granted by Cardiff University increased from **256** to **428** between 2011-12 and 2012-13.

The research impact of Cardiff University is not limited to Intellectual Property. Cardiff University has a recognised track record in relation to the successful development of spin-off companies. In

[25] An invention **disclosure**, or invention **disclosure** report, is a confidential document written by a scientist or engineer for use by a company's **patent** department, or by an external **patent** attorney, to determine whether **patent** protection should be sought for the described invention

2012-13, there were **4** spin off companies with some Cardiff University ownership, while there were an additional **65** graduate start-up firms (resulting in a cumulative total of **285**). However, importantly, many of these start-up firms have managed to remain sustainable over a period of time, with **22** Cardiff University part-owned or wholly-owned spin offs still in existence three years after being set up (with **28** in existence overall). Furthermore, of the **13** formal spin-offs or staff start ups, all **13** were still in existence three years post-initiation.

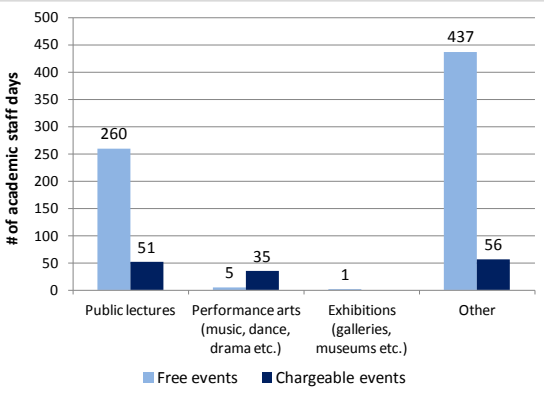
Figure 11 Attendance (in 000s) at designated CU public events run in 2012-13



Note: Other free events include a range of activities including discussion rounds, interactive workshops, teacher training days, and non-lecture events. Other chargeable events additionally include archaeological dig tours and exhibitions at museums not owned by CU.

Source: London Economics' analysis based on Cardiff University HE-BCI results 2012-13

Figure 12 Academic staff time (in days) dedicated to CU public events in 2012-13



Note: Other free events include a range of activities including discussion rounds, interactive workshops, teacher training days, and non-lecture events. Other chargeable events additionally include archaeological dig tours and exhibitions at museums not owned by CU.

Source: London Economics' analysis based on Cardiff University HE-BCI results 2012-13

Box 15 Community engagement through Brain Games

Created by neuroscientists at **Cardiff University** and funded by the **Wellcome Trust**, **Brain Games** featured a series of interactive challenges aimed at children aged between 8 and 11 to find out more about how their brain works.

The annual event has been held as part of **Brain Awareness Week**, which aims to increase public awareness of the progress and benefits of brain research. Children are given the chance to collect points and win prizes with educational and fun challenges like seeing how well you can shoot when your world is turned upside down and using brain waves to make a ball float.

Credit: Cardiff University

More than 2,500 children have attended the event held at Cardiff's National Museum annually. Brain Games is part of a sustainable project, organised by Cardiff University neuroscience researchers with engagement and outreach taking place in local communities and schools. Brain Assemblies have been run for Key Stage 2 children in various south Wales schools, as well as a teacher training programme to exchange information about the Brain Games to identify what worked well and what children gained from the event. This aim is for teachers to become 'Brain Champions' for their schools and to teach the school pupils more about the brain.

Source: Cardiff University

Cardiff University's external research impact is not limited to either the academic community or the world of business. In particular, a particular goal of the University is to bring its research and teaching activities to the general public. Through the commitment of almost **850** days of academic staff time to public events (see Figure 12), more than **310,000** members of the general public attended Cardiff University designated public events in 2012-13 (see Figure 11).

Box 16 Graduate start-ups: SuperStars

After studying for a degree in child psychology at Cardiff University and spending a summer coaching different sports in America and Africa, **James Taylor** returned to the UK and founded **SuperStars**.

Cashing in an I.O.U for £1,000 from his parents to buy a ticket to go travelling, James invested the money on sports equipment to get his business moving. A month of free trials led to five initial paid contracts. During this time, James lived on friends' sofas, using the library as an office and working every night as an unappreciated waiter.

However, SuperStars soon took off. Word of mouth spread, the contracts grew in number and so did the subject range. Over the last nine years he has grown and led the business to where it is today – an award-winning child development organisation, employing 240 staff, working with 80,000 children a week. **The business is a commercial success but, as importantly, it is a success socially, helping to raise the standards of learning in over 400 schools and developing bright futures for children by giving them outstanding experiences and opportunities**.

James and SuperStars have been recognised in a string of national awards including Startups.co.uk Young Guns, Shell Livewire Entrepreneur of the Year, HSBC Start-up Stars, and the Daily Mail's Enterprising Young Brits. Most recently, James was appointed to Chair the Welsh Government's Entrepreneurship Panel for Wales and in November 2014, he was crowned the overall Director of the Year at the national IoD awards in London.

Credit: Cardiff University

Source: Cardiff University

Box 17 CAER Heritage Project

Credit: © Crown, Royal Commission on the Ancient and Historical Monuments of Wales

Funded by the Arts and Humanities Research Council, the Caerau and Ely Rediscovering (CAER) Heritage Project is a collaborative project between **Cardiff University, Action in Caerau and Ely** (ACE), **local schools** and **local residents**. The project is based around one of Cardiff's most important, but little-known, archaeological sites, **Caerau Iron Age Hillfort**, and seeks to engage local people and school children in their shared history and help challenge marginalisation.

Ely and Caerau are places with strong communities, but today they are only suburbs of Cardiff. These communities face significant social and economic problems. Yet, before the advent of the Roman invasions in AD74, Caerau Hillfort was the major power centre for the entire Cardiff region and is one of the largest and most impressive hillforts in south-east Wales. During the Medieval period a ringwork and church (St Mary's) were built within the ancient Iron Age boundaries and their impressive remains can still be seen today.

Largely unexplored, this historical gem is now revealing its rich past from Iron age roundhouses to Roman settlement. The project has had a magical effect both on the landscape – creating beautiful linked heritage trails revealing the area's heritage – and on the people in the locality. In a journey of discovery, local schools and members of the community from all backgrounds helped unearth five large Iron age roundhouses, a roadway, extensive evidence of past communities from Iron age and Roman pottery and a beautiful Iron Age glass bead. **120** local people were actively involved in the 2013 excavation under the direction of archaeologists from Cardiff University, with **1,000** people visiting the excavations during the month-long dig.

The project won the overall and history category of the UK-wide NCCPE (**National Co-ordinating Centre for Public Engagement**) awards in 2014.

The project is one living example that the ivory tower is a myth. Far from being disengaged with society, researchers are engaging with the public in a host of innovative and effective ways. From inspiring young people with new advances in knowledge, to encouraging members of the public to contribute to research, university public engagement is thriving.

Source: Cardiff University

Box 18 Continuing Professional Development

Serving the professions, Cardiff University offers a range of stand-alone modules and courses contributing to the Continuing Professional Development (CPD) of local businesses and stakeholders. Covering a range of topics including Communication, Management, Marketing and Online Communication and Project Management, these courses draw on the experience and expertise of academics across the University.

A wide range of faculties were involved in the delivery of this CPD including the Centre for Continuing Learning, the School of Medicine, School of Healthcare Sciences, School of Biosciences and Cardiff Business School. In 2012-13, approximately **187** CPD recognised courses were delivered (consisting of almost **3,500** hours worth of taught content), with more than **2,800** learners.

Table 14 Cardiff University Continuing Professional Development short courses, 2012-13

Cardiff University school / division	# of courses	Total duration in hours	Estimated # of delegates
School of Welsh	1	6	15
School of Medicine	30	392	529
Cardiff Business School	20	931	35
Centre for Lifelong Learning	103	1,369	810
Lean University	1	35	15
School of Mathematics	7	91	107
School of Biosciences	10	97	652
School of Healthcare Sciences	8	133	169
School of Journalism, Media and Cultural Studies	1	35	10
School of Nursing and Midwifery Studies	2	56	44
School of Architecture	1	19	30
Information Services division	1	35	16
School of English, Communication and Philosophy	1	21	10
Welsh for Adults Centre	1	280	92
Total	**187**	**3,499**	**2,850**

Note: Based on short course costing forms for non-credit bearing short courses activated in the 2012-13 academic year. Where several schools were named as the initiator, the information presented focuses on the first school in the list. Estimates of the number of delegates per course were not available for a total of 32 courses across a total of 8 schools; for these, we have estimated the number of delegates based on the average number of delegates across all courses (amounting to 15 delegates) where available. The resulting estimates are indicated in brackets. Similarly, there was one course for which no course duration was indicated; in this instance, we estimated course duration based on the average course duration across all other courses (19 hours), and indicated this in brackets.

Source: London Economics' analysis of Cardiff University data

4 Impact on exports

Overseas trade (or international trade) is the sale of goods and/or services across international borders. With the United Kingdom being a destination for many overseas students wishing to undertake their advanced studies, higher education is a tradable sector with imports and exports like any other tradable sector, such as manufacturing or financial services. This section of the analysis focuses solely on **educational exports**, which contribute to the UK economy as an injection of income from an overseas source (i.e. non-UK origin). The guiding definition for export income in our valuation is that the income is derived from an overseas source[26]. In particular, we focus on export income in terms of the tuition fee income from overseas students (net of any public purse costs of provision), as well as the income associated with the non-tuition fee (off-campus) expenditure of overseas students during their studies at Cardiff University[27].

4.1 Methodological approach

4.1.1 The 2012-13 cohort of non-UK domiciled students

In the 2012-13 academic year, out of a total of **14,053** students starting new qualifications or standalone modules with Cardiff University, **3,743** (i.e.**27%** of the total), were non UK domiciled prior to starting their qualification.

Table 15 Non-UK domiciled students (headcount) in 2012-13 cohort, by domicile, study mode and level of study at Cardiff University

Level of study at CU	Domicile		
	EU (outside UK)	Non-EU	Total
Full-time	**407**	**2,781**	**3,188**
Other HE	47	646	693
HE Diploma	3	2	5
UG Degree	168	649	817
Masters	148	1,377	1,525
Doctorate	41	107	148
Part-time	**97**	**458**	**555**
Other HE	11	7	18
HE Diploma	0	0	0
UG Degree	0	1	1
Masters	81	435	516
Doctorate	5	15	20
Total	**504**	**3,239**	**3,743**
Other HE	58	653	711
HE Diploma	3	2	5
UG Degree	168	650	818
Masters	229	1,812	2,041
Doctorate	46	122	168

Note: 'Other HE' includes Certificates of Higher Education, taught work for institutional credits or with an unspecified qualification aim, and credits at HE level. We received HESA data on a total of **16,216** students from CU Registry & Academic Services, out of which **3,746** were non-UK domiciled. From those, we excluded (in subsequent steps) **one** student whose domicile was not known; **2** students who were following courses at Further Education level. For a total of **400** students out of the resulting cohort, previous attainment levels were specified as either 'Mature student admitted on basis of previous experience and/or admissions test ', 'Other qualification level not known' or 'Not known'. For those students, similar to the analysis conducted for UK domiciled CU students, we imputed their prior attainment level per student using a group-wise imputation approach; in particular, previous education levels for students with missing information were replaced with the mode of previous education of students undertaking similar qualifications at CU on the same basis (i.e. full-time or part-time). ***Source: London Economics' analysis based on Cardiff University data***

26 See Department for Business, Innovation and Skills (2011).

[27] Note that other types of export income accrued directly by Cardiff University (such as research income from international sources, or any other income received from non-UK sources) are taken account of in our analysis of the impact of CU's research activity (section 3) and the direct, indirect and induced impacts (section 5), and are thus excluded from the analysis of exports to avoid double-counting.

Of these **3,743** students, **3,239** were (non-EU) international students (**87%**), with the remaining **504** (**13%**) originating from the European Union. Across both EU and non-EU students, approximately **55%** of students (**2,041**) were enrolled on postgraduate Masters qualifications; **4%** of students (**168**) were enrolled on Doctorate degrees; and **22%** were enrolled on undergraduate degrees (**818**). The majority of the remaining students were enrolled on 'other' sub-degree higher education (incorporating credit bearing stand-alone modules and Certificates of Higher Education)[28]. This is presented in Table 15.

Again, in accordance with the analysis of the impact of CU's teaching and learning activities, it is necessary to apply estimated non-completion rates to the above number of non-UK students starting qualifications at Cardiff University in 2012-13. To arrive at the distribution of export students expected to *complete* qualifications (and modules) at Cardiff University (by gender, learning completed, previous attainment, mode of study and domicile), we apply the same assumptions on completion outcomes as in the impact of teaching and learning (see section 2.9.1).

Box 19 Opening the gateway to Cancer Research with China

While Cardiff University's links with China began as personal contacts between individual Chinese researchers, the mutual demand for close research collaborations has become much stronger in recent years. Following initial formal agreements to form cancer research partnerships with Peking University and Beijing's Capital Medical University (winning the International Collaboration Category at the annual Times Higher Education awards in 2011), CU then went on to establish multi-million pound joint research initiatives to strengthen these international connections.

Cardiff University-Peking University Joint Cancer Institute at Peking University in Beijing, China.

Specifically, in 2012, Cardiff University welcomed a delegation from Peking University to sign an agreement to create the **Cardiff University – Peking University Joint Cancer Institute**; CU invested £5.4 million in the Institute later in that year. Similarly in 2012, CU signed an agreement with Beijing's Capital Medical University to create the **Cardiff University – Capital Medical University Joint Centre for Biomedical research**, which would subsequently receive £2.6 million of funding from Cardiff.

Based on the success of these joint initiatives, CU was subsequently approached by the Chinese private sector, namely the Yiling Group (a large pharmaceutical firm in China) to enter a similar collaboration. CU's co-operation with the Yiling Group had begun in 2011, when the two organisations jointly investigated the potential mechanisms of some anti-cancer traditional Chinese medicines. In 2013, CU and the Yiling Group thus established the **Cardiff University – Yiling Joint Centre for Medical Research**.

To strengthen the collaboration with China even further, in 2014, the three initiatives were combined and consolidated into the **Cardiff – China Medical Research Collaborative (CCMRC)**. The Collaborative has already generated impact beyond the scientific research. As one of its key innovations, the CCMRC has forged terms upon which medical business, research and collaboration can take place. Further, CU was instrumental in establishing a formal link between the National Health Service and its Chinese counterpart, the Beijing Health Bureau. The CCMRC has also been a strong channel for discussions of transferring intellectual property in medical innovations between the UK and China; for example, CU is beginning to license its cancer technologies to Chinese companies via the CCMRC.

Source: Cardiff University

[28] Again, for a more detailed description of the particular qualifications covered by each category, please refer to A2.1.6.

4.1.2 Tuition fee income associated with 'export students'

To assess the level of tuition fee income associated with EU and non-EU international students starting qualifications at Cardiff University in 2012-13, we made use of data on fee levels per year for Cardiff University students in the 2012-13 academic year (by qualification level and domicile[29]). This provided an estimate of the **gross tuition fee income per student** associated with non-UK students starting qualifications at Cardiff University in 2012-13. To estimate the **net tuition fee income** associated with these students, it is necessary to deduct the direct public purse costs associated with funding the education provision for non-UK students studying at Cardiff University. These public purse costs include the subsidies associated with the **tuition fee support** (in terms of non-repayable tuition fee grants and the RAB charge on tuition fee loan support provided to eligible EU domiciled students), as well as the **teaching funding (administered through HEFCW)** associated with EU domiciled students studying in Wales. Note that no such public purse costs apply to students from non-EU countries attending Welsh HEIs, so that gross tuition fee income equals net tuition fee income for this group of students.

Using similar assumptions on average study duration as in the analysis of teaching and learning, the resulting estimates of net tuition fee export income per student (by domicile, study mode and qualification level) were calculated from start to completion of a student's learning aim. Again, any net benefits per student occurring in future years were discounted using the standard HM Treasury Green Book discount rate of **3.5%**.

Taking the most common example, the analysis indicates that the net average tuition fee income associated with a representative CU student from the European Union undertaking a full-time Masters Degree stands at approximately **£1,743** over the duration of their studies, while the average tuition fee income associated with a corresponding non-EU international student stands at approximately **£13,450**. The difference between these estimates is driven by the fact that non-EU international students incur higher tuition fee costs and that there are no public purse costs (either in terms of any tuition fee costs or teaching funds) associated with non-EU students.

4.1.3 Non-tuition fee income associated with 'export students'

Additional export income from overseas students flowing into the UK economy originates from students' expenditures on other, non-fee related items incurred during their studies at Cardiff University. Such expenditures might include, but not be restricted to:

- Accommodation costs (e.g. rent costs, council tax, household bills etc.);
- Subsistence costs (e.g. food, entertainment, personal items, non-course travel etc.);
- Direct course costs (e.g. course-related books, journal or library subscriptions, computers and other equipment);
- Facilitation costs (e.g. course-related travel costs); and
- Spending on children (including childcare that is not related to students' course participation).

Previous studies assessing the value of education exports (e.g. Department for Business Innovation and Skills, 2011) have demonstrated that the level of non-tuition fee related expenditure by

[29] Where fee levels were broken down by programme subject, we took a simple average of fees across the different subject areas. As in the analysis of teaching and learning, minimum fee levels were provided separately for undergraduate, postgraduate Masters and postgraduate Doctorate students. To derive fee levels associated with students undertaking HE Diplomas or 'other' HE qualifications (including modules), we multiplied minimum fee levels for undergraduate degree students by the ratio of average study load (i.e. course intensity) for other HE / HE Diploma students in the cohort divided by the average study intensity for undergraduate degree students. This was calculated separately for students undertaking qualifications on a full-time or part-time basis.

overseas students is often greater than the corresponding tuition fee expenditure, making non-tuition fee income a significant component of the exports income associated with non-UK students flowing into the UK.

To analyse the level of non-tuition fee income associated with overseas students included in the 2012-13 Cardiff University cohort, we make use of estimates provided by the most recent wave of the Student Income and Expenditure Survey (SIES), undertaken for Welsh domiciled students during the 2011-12 academic year[30]. The survey provides estimates of the average spending on living costs, housing costs, participation costs (including tuition fees) and spending on children per Welsh undergraduate student during the 2011-12 academic year, separately for full-time and part-time students.

For the purpose of this analysis, we undertook a number of adjustments to the 2011-12 SIES expenditure estimates:

- To avoid double-counting with the analysis outlined in section 4.1.2, we exclude tuition fee expenditures from the SIES average expenditure estimates.
- Similarly, to avoid any double-counting with the impact of institutional expenditure by Cardiff University (as analysed in section 5), it is necessary to exclude any amounts that students might spend on campus (i.e. any amounts that would be counted as income by the University itself), thus focusing on international students' off-campus expenditures only[31].
- Since the SIES does not cover non-UK domiciled students, our analysis implicitly assumes that the level and pattern of expenditure of non-UK domiciled students in Wales is not significantly different to that of Welsh domiciled students. We do, however, adjust expenditure levels per student to reflect assumed longer average stay durations in the UK for non-UK students. Our adjustments are based on the approach outlined by the Department for Business, Innovation and Skills (2011) in estimating the value of education exports to the UK economy.[32]

The resulting estimates were then adjusted for inflation[33] to provide total (off-campus) non-tuition fee expenditure per student in 2012-13 prices, by domicile (i.e. EU versus non-EU), study mode and level of study. Again, all estimates per student were calculated over the total study duration and discounted to reflect present values.

Again taking an example, the analysis indicates that the average non-tuition fee income associated with a representative CU full-time Masters student stood at **£11,085** over their study duration; since we use the same assumption regarding average UK stay duration for all non-UK domiciled Masters students, this estimate applies to all both EU and non-EU Masters students in the 2012-13 cohort.

[30] For further details, please refer to Welsh Government (2014).
[31] Following the approach undertaken by Kelly and McNicoll (2013), who analyse the collective economic impact of Higher Education Institutions in Wales, we assume that **25%** of students' non-tuition fee expenditures are spent on campus (i.e. are accrued as income by Cardiff University itself).
[32] Further information on the adjustments for average stay durations is provided in A2.2.
[33] Inflation estimates are based on data provided by the Office for National Statistics (2015).

Box 20 Opportunity through partnership

In September 2014, Cardiff University signed an agreement with the University of Leuven designed to boost research activity, create new research collaborations and offer more opportunities for students and staff to study and teach abroad. The University of Leuven is the world's oldest surviving Catholic university, employing around 6,800 academic staff and teaching to more than 40,000 students on study programmes offered in Dutch and English. The new international agreement builds on existing academic collaborations between the two universities, and is part of Cardiff University's wider plans to form collaborations with other universities to promote research and teaching.

Credit: Cardiff University

"As a new central partner university, Cardiff shares in our internationalisation ambitions. That is why this cooperation agreement has real long-term potential and will benefit the education and research missions of both universities, at both institution and research group levels, and for both staff and students."

Professor Danny Pieters, Vice Rector for Internationalisation at KU Leuven.

Source: Cardiff University

4.2 Aggregate impact on exports

To estimate the aggregate export income associated with Cardiff University's 2012-13 cohort of non-UK students, using the same assumptions as in the analysis of the impact of teaching and learning (see section 2.9.1), we again assessed the number of non-UK students in the cohort expected to *complete* qualifications (and modules) at Cardiff University (by gender, domicile, study mode, prior attainment and level of study).

Combining the resulting number of students completing qualifications with our estimates of net tuition fee income and non-tuition fee income for non-UK students, the analysis indicates that the aggregate export income associated with Cardiff University's 2012-13 cohort of students stands at **£135.9 million** (see Table 16). Of this, approximately **9%** (**£12.9 million**) is generated by EU domiciled students undertaking learning at Cardiff University, while the remaining **£123.0 million** (**91%**) of impact is associated with non-EU international students attending the University. This is driven predominantly driven by the composition of the cohort of non-UK students (**87%** of non-UK students in the 2012-13 cohort are non-EU domiciled (see Table 15)), as well as the fact that non-EU students pay higher tuition fees than their EU domiciled counterparts.

The impact of Cardiff University on UK exports, based on the 2012-13 academic year, stands at

£136 million.

Table 16 Aggregate economic impact on exports (£m), by domicile and type of impact

Type of impact	Domicile		
	EU	Non-EU	Total
Net tuition fee income	1.9	65.5	**67.4**
Non-tuition fee income	11.0	57.5	**68.5**
Total	**12.9**	**123.0**	**135.9**

Note: Values are presented in 2012-13 prices. ***Source: London Economics' analysis***

It is important to note that the presented aggregate impact on exports associated with Cardiff University's 2012-13 cohort of students does not take account of any export revenues associated with the off-campus[34] expenditures generated by **international visitors** to Cardiff, including both leisure visitors (i.e. friends and relatives of international students studying at Cardiff University) as well as conference and academic business visitors. These visitors' expenditures are omitted from the analysis due to data limitations, particularly a lack of information on the number of such visitors attracted by universities. As a result, the assessment of Cardiff University's impact on UK export income constitutes relatively conservative estimates.

Box 21 Taking imaging into the therapeutic domain: Self-regulation of brain systems for mental disorders

Led by Professor David Linden at Cardiff University's School of Psychology, the project is based on the idea that **real-time functional neuro-imaging can be used to train patients to regulate their own brain activity via neuro-feedback training** and thus modulate the brain networks of mental disorder, restore function, improve symptoms and promote resilience.

As part of the European Commission's **7th Framework Programme for Research and Technological Development** (FP7), and valued at almost **€6 million** in total, Cardiff University has brought together a number of institutions that have been instrumental in the development of methods for real-time functional imaging and fMRI (functional magnetic resonance)-based neurofeedback and have led the initial clinical applications in neuropsychiatric disorders.

Credit: Cardiff University

The project has three main components:

- The development and refinement of **methods for the real-time analysis and feedback of fMRI data** and combination with other imaging modalities,
- The adaptation of fMRI mapping techniques to **localise disease-relevant networks and development of protocols for their self-regulation through neurofeedback**, and
- The assessment of **feasibility and clinical effects in several mental disorders** that are characterised by dysfunctional brain systems for motivation, emotion regulation and social communication and by important therapeutic gaps (autism spectrum disorders, alcohol addiction, post-traumatic stress disorder, childhood anxiety disorders, binge-eating disorder).

The project will also explore the **potential transfer of (laboratory-based) imaging feedback training into everyday settings** through ambulatory and assistive technologies such as electro-encephalography (EEG) and gaming. The project will **engage with potential users of these technologies** (healthcare professionals and providers, medical instrument and software manufacturers, patient and carer associations) through several workshops, liaise with regulatory authorities and disseminate findings to the academic and user communities.

Source: Cardiff University

[34] Any on-campus expenditures associated with international visitors are taken account of as part of the analysis of the direct, indirect and induced impacts associated with the institutional expenditures of Cardiff University itself (as outlined in section 5).

5 Direct, indirect and induced impact of Cardiff University

5.1 Definitions and methodological approach

Traditional analyses of the economic impact of universities focus (almost exclusively) on the **direct, indirect and induced** impact of higher education institutions on their local, regional or national economies. An assessment of such effects considers a university as an economic unit creating output within its local economy, through the purchasing of products and services from different suppliers and hiring employees. In addition to the direct, indirect and induced impacts associated with the university itself, a number of analyses further consider the impact of the non-tuition fee expenditures of university students on the businesses within the local communities in which the university is located.

5.1.1 Economic impact associated with CU institutional expenditure

The direct, indirect and induced impacts of a university's output on the economy are defined as follows:

- The **direct effect** considers the economic output generated by a university itself, by purchasing goods and services, including labour, from the economy in which it operates.
- The **indirect effect** arises from a university's purchases of goods and services from other sectors in the economy to support its activities. These purchases generate income for the supplying industries, which are in turn spent on purchases from their own suppliers to meet the university's demands. This results in a chain of reaction of subsequent rounds of spending across industries, typically referred to as the 'ripple effect'[35].
- The **induced effect** is based on a university's status as an employer; specifically, in return for their services, a university pays salaries to its employees, who use this income to purchase consumer goods and services within the economy. This generates wage income for employees within the industries producing these goods and services, who in turn spend their own wages on goods and services. Again, this leads to subsequent rounds of wage income spending throughout the economy as a whole, i.e. a 'ripple effect'.

An analysis of the net impact of these effects on a university's local, regional or national economy needs to consider two additional factors potentially reducing the size of any of the above effects:

- **Leakage** into other geographical areas, by taking account how much of the additional economic activity actually occurs in the area under consideration. For example, it might be the case that the university sources some of its inputs from areas outside of its local economy, thus reducing the economic impact which it has on its local surroundings.
- **Displacement** of economic activity within the region of analysis, i.e. taking account of the possibility that the economic activity generated might result in the reduction of activity elsewhere within the region.

The total of these direct, indirect and induced impacts (net of any leakage and displacement effects, as applicable) of a university on the economy is commonly measured both in terms of monetary output[36] and employment.

[35] E.g. Kelly et al. (2014).

[36] In this respect, the monetary economic output associated with universities is typically measured either in terms of institutional revenue or institutional expenditure. As outlined in Kelly and McNicoll (2013), the use of different output measures should, in theory, not influence output multipliers to a large extent, since the status of universities as not-for-profit organisations implies that their expenditure is closely aligned with institutional revenue.

Box 22 A clearer view: Ultravision removes smoke during keyhole surgery

Ultravision™ is a ground-breaking invention that clears smoke created by cutting instruments during laparoscopic surgery. The concept was conceived by **Dr Neil Warren**, a specialist at the forefront of minimally invasive surgery training at Cardiff University, and is the first product to be launched by **Asalus**, the company established to commercialise the inventions of the **Welsh Institute of Minimal Access Therapy** (WIMAT). Alongside the many prestigious international awards, the result has been to generate significant economic and societal benefits for the six million patients worldwide.

Credit: Shutterstock

The product is based around the proven technology of '**electrostatic precipitation**', which is already widely used in industrial applications for the removal of airborne particles from waste gases. Asalus worked closely with academics at Cardiff University and laparoscopic surgeons from University Hospital Wales throughout the development process.

The Ultravision story has been an excellent example of best practice collaborative IP commercialisation. **Cardiff University** immediately recognised the potential value, rapidly filed IP and provided translational funding to create prototypes. Working with funding from the University's own seed fund (**Cardiff Partnership Fund**), followed by subsequent equity investment, resulted in the formation of the spinout Asalus Medical Instruments Limited. The continued interaction between the University, the technology transfer team and Asalus along with essential interactions with NHS surgeons has led to the development of technology that offers a radically new way of safely handling laparoscopic surgical smoke. The product obtained its CE (Conformité Européenne) mark in January 2014 and is now being launched across Europe.

Source: Cardiff University

Direct impact of CU expenditure and employment

To measure the direct economic impact of Cardiff University's purchases of labour, goods and services within the UK economy, we used data on CU's total direct economic output (captured by total staff and non-staff expenditure), as well as the number of staff employed by Cardiff University itself (measured in terms of full-time equivalent employees). For consistency with the analysis of CU's other sources of impact outlined above, we focus on the 2012-13 academic year.

Based on these definitions, the total **direct impact** of Cardiff University (in terms of monetary output) is estimated at **£410.6 million**, based on approximately **£249.1 million** of CU staff costs and **£161.5 million** spent on other operating expenses in the 2012-13 academic year[37]. In terms of employment, Cardiff University directly employed full-time equivalent **5,473** staff, of which approximately **5,425** were contractual staff, and **48** were atypical staff (i.e. casual academic employees). In terms of employee headcount, this is equivalent to a total of **7,233 staff** (**6,051** contractual and **1,182** atypical).

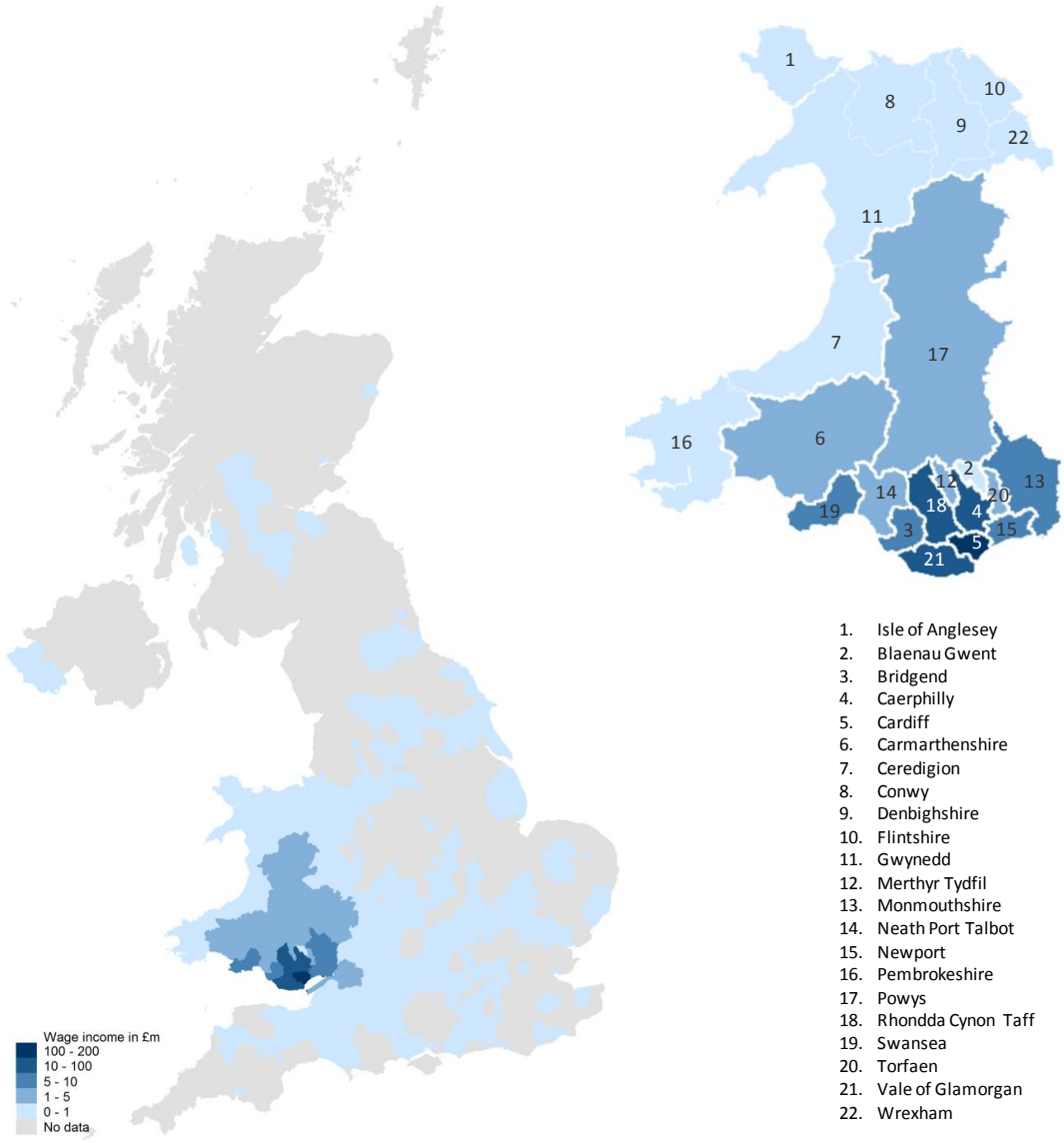
To analyse the geographical destination of some of Cardiff University's expenditures, Figure 13 presents information on the salary income of contractual staff employed by CU in 2012-13, by Local Authority in which the respective employees reside[38]. As expected, CU's expenditures on

[37] Note that we exclude from aggregate expenditure a total of **£16.2 million** in depreciation costs, as it is assumed that these are not relevant from a procurement perspective, i.e. these costs are not accounted for as income by other organisations).

[38] We received HESA data on salary bands and postcode prefixes for a total of **7,700** contractual staff employed with CU in the 2012-13 academic year. From those, we excluded a total of **116** employees for whom the postcode prefix information could not be linked to a given Local Authority; hence, the map is based on information for a total of **7,584** staff. To arrive at individual salary estimates (rather than salary bands) per individual, we calculated band midpoints (and the lower bound of the highest salary band indicated) for each employee. Note that information is cumulative and based on appointment rather than specific employee headcount (i.e. multiple appointments are counted separately), resulting in differences between the number of staff underlying the geographical analysis (**7,700**), and the **7,233** staff employed by CU. Salary band and postcode prefix information was not available for atypical (casual) staff.

(contractual) staff salaries are significantly concentrated in the Cardiff Local Authority. However, there were relatively large levels of wage income flowing into some surrounding Local Authorities, particularly the Vale of Glamorgan, Rhondda Cynon Taff and Caerphilly, with the subsequent generation of economic impacts to businesses in these areas.

Figure 13 Salary income for CU contractual staff, £m in 2012-13, by Local Authority



We received HESA data on salary bands and postcode prefixes for a total of **7,700** contractual staff employed with Cardiff University in the 2012-13 academic year. From those, we excluded a total of **116** employees for whom the postcode prefix information could not be linked to a given Local Authority area; hence, the map is based on information for a total of **7,584** staff. To arrive at individual salary estimates (rather than salary bands) per individual, we calculated band midpoints (and the lower bound of the highest salary band indicated) for each employee. Please note that information is cumulative and based on appointment rather than specific employee headcount (i.e. multiple appointments are counted separately), resulting in differences between the number of staff underlying the geographical analysis (**7,700**), and the **7,233** staff employed by CU in 2012-13 on which the remainder of the analysis is based. Further note that the salary band and postcode prefix information was not available for atypical (casual) staff.

Source: London Economics' analysis based on Cardiff University data and ONS (2013). Contains National Statistics data © Crown copyright and database right 2013; NISRA data © Crown copyright and database right 2013; NRS data © Crown copyright and database right 2013; Ordnance Survey data © Crown copyright and database right 2013

Indirect and induced impacts of CU expenditure

Across the existing literature, the indirect and induced effects of higher education institutions on the economy are (in general) estimated with the help of Input-Output models. Such models develop a series of **multipliers** to estimate the extent to which the direct output produced by a university generates additional activity throughout the rest of the economy. As with the direct impact presented above, these knock-on multipliers are commonly measured in terms of both economic output (e.g. total turnover or expenditure by the university) and employment. These multipliers are commonly calculated as:

$$\textbf{Output multiplier} = \frac{\text{Direct output} + \text{indirect output} + \text{induced output}}{\text{Direct output}}$$

$$\textbf{Employment multiplier} = \frac{\text{Direct employment} + \text{indirect employment} + \text{induced employment}}{\text{Direct employment}}$$

To interpret the resulting estimates, for example, an output multiplier of 1.5 implies that each £1 million of (direct) expenditure by a university on goods and services (including labour services) generates an additional £500,000 throughout the economy. Similarly, an employment multiplier of 1.25 implies that for every 1,000 employees hired directly by a university, another 250 jobs are created in other industries.

For the purpose of our analysis, we applied relevant output and employment multipliers to Cardiff University's total direct expenditure (i.e. both staff and non-staff costs) and employment, respectively, over the 2012-13 academic year. To arrive at best estimates, we made use of recent multiplier estimates provided by Kelly and McNicoll (2013) in assessing the combined economic impact of Higher Education institutions in Wales on the Welsh and UK economies. These are presented in Table 17. Based on Kelly and McNicoll's estimates, we assume that every **£1 million** of CU expenditure will generate an *additional* **£1.03 million** of impact throughout the Welsh economy, and a further **£0.35 million** in other parts of the UK. Similarly, it is asserted that for every **1,000** (FTE) staff employed by Cardiff University itself, an *additional* **1,080** jobs will be generated throughout the whole of the UK, of which **840** are generated in Wales itself, and **240** will be created elsewhere in the UK.

Table 17 Economic multipliers applied to CU expenditure and employment

Multiplier type	Location of impact		
	Wales	Rest of UK	Total UK
Expenditure	2.03	0.35	**2.38**
Employment	1.84	0.24	**2.08**

Note: While we apply multiplier effects to CU's expenditure, the analysis by Kelly and McNicoll instead focuses on institutional revenue as a measure of universities' output; as noted above, the use of different measures of output should, in theory, not influence output measures to a large extent, based on the assumption that institutional revenue roughly equals expenditure of universities.

Source: London Economics' analysis of Kelly and McNicoll (2013).

5.1.2 Economic impact associated with CU student expenditure

In addition to the direct, indirect and induced impacts of institutional expenditure by universities, traditional HEI impact analyses further consider the economic output associated with the personal expenditures of university students throughout their studies. This includes the (non-tuition fee) expenditure associated with *both* UK and non-UK domiciled students.

Our methodology behind estimating the non-tuition fee spending associated with *non-UK domicile* students is outlined in section 4.1.3. We employed a similar methodological approach to estimate

the level of non-fee spending of *UK domiciled* students starting qualifications or modules with Cardiff University in 2012-13.

As in the analysis of the impact on exports, we make use of the 2011-12 Student Income and Expenditure Survey for Welsh domiciled students, adjusting the Survey's estimates to exclude any tuition fee income as well as other on-campus expenditure that students might incur[39], and inflated the estimates to reflect 2012-13 prices. Further, we assume that the level and pattern of expenditure by non-Welsh domiciled students is (in general) similar to that of Welsh domiciled students studying in Wales; we do however make an additional adjustment for part-time students from Wales.

While our estimates for full-time students from all Home Nations are based on all types of non-tuition fee off-campus expenditure (i.e. including the costs of living, housing, course participation, spending on children etc), it is likely that Welsh domiciled part-time students would have lived (and worked) in Wales regardless of their study at CU. This implies that not all of these students' non-tuition fee spending should be considered *additional* to the Welsh economy. Our estimate of Welsh domiciled part-time students' additional non-tuition fee expenditure thus only includes the costs which these students incur directly in relation to their studies (such as course material costs or course-related travel costs), and excludes any other expenditures.

Again, the resulting estimates of the off-campus non-tuition fee spending per student per year (by domicile, study mode and level of study) were calculated over the total study duration and discounted to reflect present values. We then aggregated the level of expenditure per student across the total 2012-13 cohort, combined with information on completion rates, to achieve the total (off-campus) non-tuition fee expenditure associated with students of all UK and non-UK domiciles[40], estimated at a total of approximately **£217.5 million** in 2012-13 money terms.

Indirect and induced impacts of CU student expenditure

In line with Cardiff University's own institutional expenditure creating 'ripple effects' of spending through the economy and generating additional impact, the personal expenditure of Cardiff University's students is expected to create similar knock-on impacts over and above the level of this expenditure. These knock-on effects again arise from indirect impacts of students' expenditure (generating revenue for businesses which these companies in turn use to purchase goods and services from other suppliers), as well as induced effects (as businesses also use the additional revenue to pay wages to their staff).

Similar to the analysis of the indirect and induced effects associated with the expenditures of CU itself, we applied relevant multipliers to the total values of student expenditure, based on estimates provided by Kelly and McNicoll (2013). Outlined in Table 18, their estimates indicate that every **£1 million** of expenditure by non-UK students generates a total of **£1.05 million** throughout the Welsh economy, and a total of **£1.41 million** throughout the entire UK economy. In terms of employment, the estimates suggest that every **£1 million** of international student expenditure supports a total of **11.9** full-time equivalent jobs in the UK, of which **8.8** are located in Wales.

Note that while Kelly and McNicoll (2013) argue that the personal expenditure of non-UK domiciled students in Wales is an injection into the UK economy (as assumed throughout our

[39] This is again based on the assumption that 25% of students' non-tuition fee expenditures are incurred on campus (see Kelly and McNicoll, 2013).
[40] Again, the aggregation is based on similar assumptions on total study duration, average wage growth, discount rates and completion information as the analyses of the impact of CU's teaching and learning activities as well as the University's impact on exports.

analysis of CU's impact on exports in section 4.1.3), their multipliers are adjusted to reflect different assumptions on *additionality* for UK domiciled students. In particular, it is argued that the personal expenditure of UK students from Home Nations outside Wales, while not additional to the UK economy, constitute an injection into the Welsh economy. Further, they presume that the expenditures of Welsh domiciled students are not an injection into the Welsh or UK economies; however, they argue that HEIs in Wales ensure that this expenditure is instead *retained* within the Welsh region (assuming that students would otherwise leave Wales to study elsewhere within the UK). In consequence, this is reflected in the expenditure and employment multipliers for UK domiciled students outlined in Table 18, where the effects on the UK economy are identical to the effects on the Welsh economy, with no additional impact on the rest of the UK due to displacement.

Table 18 Economic multipliers applied to CU student expenditure

	Output multipliers (£m impact per £m expenditure)			Employment multipliers (FTE employees per £m expenditure)		
Domicile	**Wales**	**Rest of UK**	**Total UK**	**Wales**	**Rest of UK**	**Total UK**
UK	1.05	- *	1.05	8.81	- *	8.81
Outside UK	1.05	0.36	1.41	8.81	3.09	11.90

Note: These multipliers are based on London Economics' calculations derived from Kelly and McNicoll (2013).

*As outlined by Kelly and McNicoll, 'because of the wider displacement effects of domestic student expenditure [...] the 'knock-on' impact of domestic student expenditure only on the UK is defined to be identically equal to the estimated impact on Wales'. Hence, for UK domiciled students, multipliers for Wales equal those indicated for the UK. ***Source: London Economics' analysis of Kelly and McNicoll (2013).***

Box 23 Medaphor Group Plc: ScanTrainer Ultrasound Training Solutions

Training methods for sonographers have always been expensive, time consuming and dependent on the availability of patients and resources.

Credit: Shutterstock

Medaphor was established in 2004 as a result of Cardiff University's School of Medicine **Professor Nazar Amso** identifying the need to train highly skilled individuals to perform ultrasound procedures using **simulation technology** with **educational excellence** at its core.

ScanTrainer provides a solution which is fast, effective and does not require a clinical setting. The system utilises a hand-held device that is manipulated to produce ultrasound images from specific parts of the body in a virtual environment. This enables trainees to undertake tasks that closely resemble those carried out during live ultrasound sessions and which provide immediate feedback on performance. The first ScanTrainer was launched in 2010 and is now recognised in the UK as one of the gold standard simulators for teaching ultrasound.

Medaphor was initially supported with funding from the University's seed investment fund (**Cardiff Partnership Fund**) and has doubled its sales in each of the last four years. In terms of direct employment, the company has increased ten-fold in terms of the number of employees and is now based in both the United Kingdom and United States. With more than 120 hospitals now using the system in 11 countries, more than 50% of sales come from the export market.

Source: Cardiff University

5.1.3 Adjusting for double counting with other strands of impact

In aggregating the total impact of CU student expenditure and CU institutional expenditure, it is necessary to adjust the estimates to avoid double-counting with the other sources of impact included in our analysis. Specifically, to avoid double-counting of the impact of CU's research activities and the impact of the University on exports, we deducted from the total impact of **CU institutional expenditure** the value of total research income net of public purse research funding estimated in section 3 (**£66.9 million**) and the level of net tuition fee income (after public purse costs) from non-UK domiciled students estimated in section 4 (**£67.4 million**). Similarly, to prevent double-counting with the impact on exports, we excluded from the total direct, indirect and induced impacts of **CU student expenditure** the level of non-tuition fee expenditure associated with non-UK students (**£68.5 million**; see section 4)[41].

Box 24 MEDOW (Multi-terminal DC Grid for Offshore Wind)

Based on a **newly emerging technology** (multi-terminal DC grids), which is particularly suitable for transporting power from offshore wind farms, **MEDOW** is a partnership of five universities and six industrial organisations across the globe, each with unique expertise in the manufacturing, design, and operation of multi-terminal DC grids.

The findings of the project will inform the way in which offshore wind power is integrated into the onshore AC grids in European countries and ultimately support the creation of the European Super Grid.

In addition to fostering greater ties between industry and academia, MEDOW offers a career development path to an international cohort of 17 researchers.

Credit: Credit: Aleksey Stemmer/ Shutterstock

By extending the traditional academic research training to a truly international and inter-sectoral setting, MEDOW is leading the way in creating a new generation of creative, entrepreneurial and innovative researchers and shaping the way in which researchers are trained across Europe. MEDOW is a Marie Curie Initial Training Network funded by the European Commission and is coordinated by Cardiff University's School of Engineering.

Source: Cardiff University

5.2 Aggregate direct, indirect and induced impact of Cardiff University

Following these adjustments, Table 19 presents the resulting aggregate estimates of the total direct, indirect and induced impacts associated with expenditures incurred by Cardiff University (in the 2012-13 academic year) and its students (based on 2012-13 cohort). The analysis suggests that the total direct, indirect and induced impacts associated with CU expenditure and CU student expenditure stands at **£1,027.5 million** in the UK, of which **£885.8 million** (**86%**) is estimated to accrue within Wales. Of the total UK impact, **£842.9 million** (**82%**) is associated with the expenditures of CU on purchases of goods and services from within the economy, while **£184.6**

The total direct, indirect and induced impact of Cardiff University's staff and non-staff expenditure, and the personal expenditure of its students stands at £1.03 billion in the UK. Of this total, £886 million is accrued in Wales.

[41] For further methodological details on the adjustment for double counting, please refer to A2.3.

million (**18%**) is generated from the off-campus personal expenditures of domestic and non-domestic students undertaking their studies at Cardiff University.

In addition to these monetary measures of impact, the analysis also estimates the direct, indirect and induced impact of Cardiff University in terms of supported employment. The analysis suggests that in addition to the **5,473** full-time equivalent jobs provided directly by the University, there are a further **5,898** supported by the expenditure of Cardiff University through its supply chain and the personal expenditures of its students.

Cardiff University's activities support a total of almost 11,400 jobs throughout the UK, of which 10,100 are in Wales.

Table 19 Direct, indirect and induced impact associated with CU expenditure and CU student expenditure (£m and number of FTE jobs supported)

Type of impact	£m		# of FTE jobs	
	Wales	UK	Wales	UK
Impact of CU expenditure	718.9	842.9	8,685	9,819
Impact of CU student expenditure	166.9	184.6	1,398	1,552
Total	**885.8**	**1,027.5**	**10,083**	**11,371**

Note: Estimates have been adjusted to avoid double-counting with other sources of economic impact as analysed in previous sections. For each type of impact separately, the impacts which would be double-counted were deducted from the total UK impact in £m of expenditure. We then calculated the revised Welsh impact by multiplying the new UK total by the ratio of Welsh to UK impacts (in terms of expenditure) based on the 'raw' results before adjusting for double-counting. The revised expenditure impacts were then combined with the ratios of FTE employees per £m of expenditure impact (based on the 'raw' results before double-counting adjustments), separately for Wales and the UK and by type of impact.

Source: London Economics' analysis

In addition to CU's staff and non-staff operational expenditures outlined above, the University is currently involved in several major capital developments to transform its facilities to support its research, innovation, translational and educational activities. As the first milestone of these capital developments, work is being undertaken to build a new state-of-the-art brain research imaging centre (the Cardiff University Brain Research Imaging Centre (CUBRIC)). The University has further planned and earmarked an additional **£300 million** investment in four new buildings for Cardiff's Maindy Road site, transforming the area from a disused former industrial space into a range of modern facilities.

In 2012-13, Cardiff University incurred a total of **£20.1 million** in capital expenditures[42] to develop its facilities, constituting exceptional expenditure items in the sense that these are large amounts incurred over a relatively short period of time. In contrast, the above-presented values of impact of CU's expenditure on the Welsh and UK economies capture estimates of the *annual* impact of CU's physical footprint in Wales and the UK (i.e. they are based on the University's expenditures typically incurred *each year*), and thus exclude capital expenditures from the impact[43].

Nevertheless, it is expected that during the years of construction, the University's capital projects will significantly boost the economic impact of the University, temporarily generating high income for the suppliers involved in planning and constructing the new campus facilities and supporting local jobs.

[42] Where capital expenditure is defined in terms of payments to acquire tangible assets during the 2012-13 academic year.
[43] This is in line with existing analyses of the economic impact of higher education institutions focusing on either total institutional revenue or expenditure, both of which do not take into account institutions' capital expenditures.

Box 25 DECIPHer-ASSIST: maximising population impact of an effective schools-based intervention to prevent smoking uptake in adolescence

DECIPHer-ASSIST is an intervention that reduces the uptake of smoking among adolescents. It was developed and evaluated by Cardiff University in collaboration with the University of Bristol, culminating in a large scale randomised control trial funded by the Medical Research Council. The intervention was found to be effective, with the results published in *The Lancet* (2008). Decipher Impact Limited, a wholly owned partnership between Cardiff University and the University of Bristol, was set up in March 2010, in order to provide support knowledge translation of evidence-based interventions that have an impact on public health.

Credit: Cardiff University

The ASSIST programme was exclusively licensed to the company by the universities, and with the right to grant sub-licences. The company now provides licences to the DECIPHer-ASSIST programme methodology to the NHS and local authorities across England and Wales accompanied by intensive 'training of the trainers' and on-going support to ensure professional roll-out of the ASSIST programme.

By July 2014 the ASSIST programme had been introduced to over **60,000** year eight pupils in 350 schools across England and Wales and if successful is thought will prevent approximately **1,650** of these young people from the uptake of smoking. DECIPHer ASSIST has been recommended by **the National Institute for Health and Care Excellence (**NICE) guidance in 2010, and if implemented throughout the UK, it is estimated that it would prevent **40,000** young people taking up smoking each year, thereby reducing the financial burden on the NHS from smoking-related diseases.

Source: Cardiff University

6 Total economic impact

Table 20 and Figure 14 present aggregate estimates of the economic impact of Cardiff University in the United Kingdom. In terms of the components of economic impact, the value of the teaching and learning activities of Cardiff University stands at approximately **£967.9 million** (**35%** of total), while research activity contributes **£609.1 million** (**22%** of total). A further **£135.9 million** (**5%**) is associated with Cardiff University's contribution to educational exports. The economic impact resulting from Cardiff University's physical footprint, in terms of its own expenditure on goods and services as well as its students' personal expenditures throughout their studies, constitutes the largest individual source of impact, standing at **£1,027.5 million** (**38%** of total). Combining these strands of impact, we have estimated the total economic impact associated with the activities of Cardiff University in the UK to be approximately **£2,740.4 million** in 2012-13[44].

The total economic impact associated with Cardiff University was estimated to be approximately £2,740 million in 2012-13.

Based on a number of assumptions on the location of the different strands of impact, we estimated that the total economic impact of Cardiff University on the Welsh economy stood at approximately **£2,036.7 million**, corresponding to approximately **74%** of the total attributable economic benefit generated by Cardiff University, with the remaining **£703.7 million** (**26%**) accrued elsewhere across the United Kingdom.

To place these estimates in context, the analysis suggests that compared to Cardiff University's total operational cost of approximately **£427 million** in 2012-13, the total economic contribution or benefit to the UK economy associated with the 2012-13 cohort of students is estimated to be approximately **£2,740.4 million** in 2012-13 money terms. This corresponds to a benefit to cost ratio of almost **6½:1**.

[44] For an analysis of the sensitivity of these results to our key assumption on the average real annual earnings growth rate (assumed at **2%** in the above estimates), please refer to Annex 3.

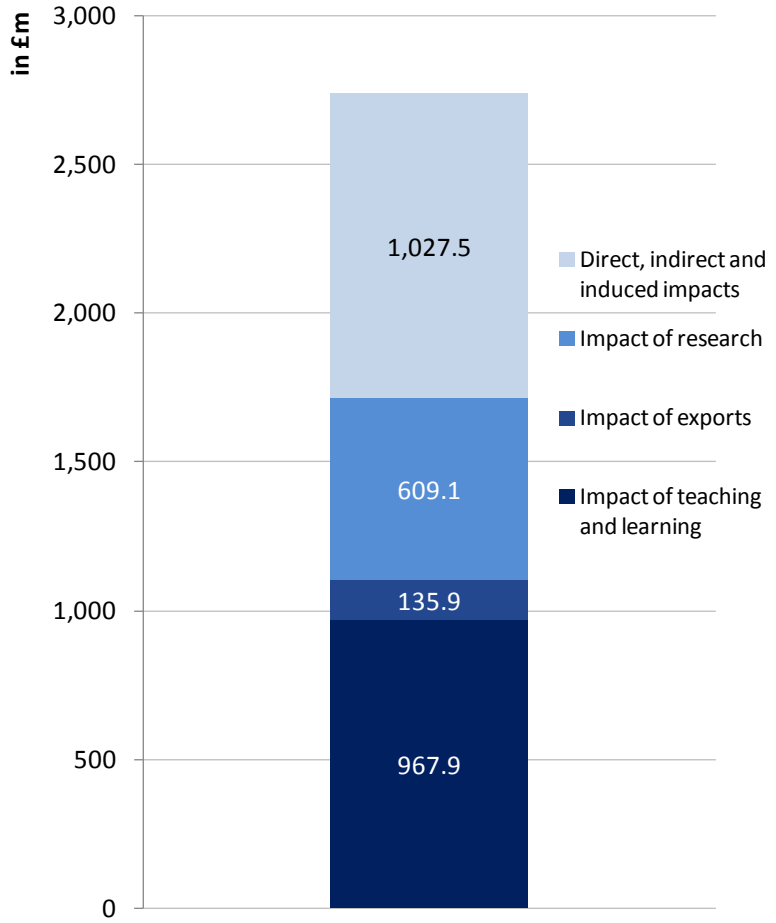
Table 20 Aggregate economic impact of Cardiff University in the UK (£m and % of total)

Type of impact (£m in 2012-13)	£m	%
Impact of teaching and learning	**967.9**	**35%**
Students	499.3	18%
Public purse	468.6	17%
Impact of research	**609.1**	**22%**
Net direct research income	66.9	2%
Spillover impact	542.2	20%
Impact on exports	**135.9**	**5%**
Net tuition fee income	67.4	2%
Non-tuition fee income	68.5	3%
Direct, indirect and induced impacts	**1,027.5**	**38%**
Impact of CU expenditure	842.9	31%
Impact of CU student expenditure	184.6	7%
Total economic impact	**2,740.4**	**100%**

Note: Values are presented in 2012-13 prices. Percentages are rounded up to the nearest 4 decimal points.

Source: London Economics' analysis

Figure 14 Aggregate economic impact of Cardiff University in the UK (£m)



Note: Values are presented in 2012-13 prices

Source: London Economics' analysis

Index of Tables, Figures and Boxes

Tables

Figures

Boxes

ANNEXES

Annex 1 References

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Annex 2 Methodological details / technical annex

A2.1 The impact of Cardiff University's teaching and learning activities

A2.1.1 Qualifications considered and counterfactuals in the econometric analysis

In total, our regression analyses considered seven different higher education qualification groups (i.e. six 'treatment' groups) within the National Qualifications Framework: two at postgraduate level (Masters and Doctorate degrees) and five at undergraduate level or sub-degree level (Undergraduate degrees; Foundation degrees; Higher Education Diplomas[45]; Higher National Certificates (HNCs), Higher National Diplomas (HNDs) and BTECs at level 4[46]; and 'other' higher education qualifications[47]).

Table 21 presents the different postgraduate and undergraduate level qualifications considered in the analysis, along with the associated **counterfactual** group used for the marginal returns analysis in each case. We compare the earnings of the group of individuals in possession of the qualification to a counterfactual group to ensure that we assess the economic benefit associated with the qualification itself, rather than the economic returns generated by the specific characteristics of the individual in possession of the qualification. This is a common approach in the literature and allows for the removal of other personal, regional or socioeconomic characteristics that might influence both the determinants of qualification attainment as well as earnings.

Table 21 Treatment and comparison groups – marginal returns

Treatment – highest academic qualification	Comparison - highest academic qualification	Treatment and comparison groups – highest possible vocational/professional qualification
Doctorate degree	Undergraduate degree	Level 3 vocational
Masters degree	Undergraduate degree	Level 3 vocational
Undergraduate degree	2 or more GCE 'A' Levels	Level 3 vocational
Foundation degree	2 or more GCE 'A' Levels	Level 3 vocational
HE Diploma	2 or more GCE 'A' Levels	Level 3 vocational
HNCs/HNDs/Level 4 BTECs	2 or more GCE 'A' Levels	Level 3 vocational*
Other higher education	2 or more GCE 'A' Levels	Level 3 vocational
2 or more GCE 'A' Levels	5 or more GCSEs at A*-C	Level 3 vocational

Note: * excluding HNCs/HNDs/Level 4 BTEC qualifications themselves; ***Source: London Economics***

For the analysis of marginal returns, postgraduate degree holders are compared to undergraduate degree holders, while for individuals holding undergraduate or sub-degree level higher education

[45] Labour Force Survey variable QUALS6 value label 2 (Diploma in higher education). Diplomas in higher education are similar to HNDs though more academic in orientation as they generally relate to accredited professional qualifications. HE Diplomas usually take two years to complete and it is normally possible to convert a higher education diploma to a degree with an extra year of study.

[46] Note that while Foundation Degrees, HNCs and HNDs are not part of Cardiff University's teaching curriculum, the returns to these qualifications were estimated in order to assess the returns to other qualifications for individuals who are *in possession of* HNCs/HNDs/BTECs or Foundation Degrees, using a 'stepwise' calculation of additional lifetime earnings. For example, to calculate the earnings and employment returns for a student in possession of a HE Diploma undertaking an undergraduate degree, we deducted the returns to undertaking a HE Diploma (relative to the possession of 2 or more GCE 'A' Levels) from the returns to undertaking an undergraduate degree (again relative to the possession of 2 or more GCE 'A' Levels).

[47] Labour Force Survey variable QUALS6 value label 9 ('Other higher education qualification below degree level'). Interviewers are instructed to use label 9 'only if the respondent states that they have 'something from higher education but they do not know what it is'. It is therefore not possible to provide examples of typical qualifications that would normally fall under this category. The response option serves the purpose of confirming that higher education qualifications have been achieved but that the respondent is unaware of the actual qualification title itself.

qualifications, the counterfactual group consists of individuals holding 2 or more GCE 'A' Levels as their highest qualification. For the purposes of estimating the returns to all higher education qualifications, the highest level of professional or vocational qualification that an individual may be in possession of is level 3 (for both those in possession of higher education qualifications (the treatment group) and those individuals not in possession of higher education qualifications (the control group)).

In addition to the analysis of higher education outcomes, we also included a separate specification comparing the earnings associated with GCE 'A' Levels to possession of 5 or more GCSEs at grades A*-C. This additional analysis was undertaken to provide an indication of the fact that the academic 'distance travelled' by a (small) proportion of Cardiff University students is greater than might be the case compared to those in possession of levels of prior attainment 'traditionally' associated with higher education entry.

A2.1.2 Estimated marginal earnings and employment returns

Throughout the analysis, we present detailed findings of the **marginal** earnings and employment returns associated with different types of higher education qualifications[48] [49]. In the earnings regressions, the coefficients relating to the higher education qualifications provide an indication of the additional effect on hourly earnings associated with possession of the respective qualification in addition to those in the reference category. For instance, the coefficient assessing the earnings premium to an undergraduate degree level qualification relative to 2 or more GCE 'A' Levels should be interpreted as the wage return achieved by an individual in possession of *both* an undergraduate degree and 2 or more GCE 'A' Levels compared to the possession of 2 or more GCE 'A' Levels *alone*.

Table 22 presents the marginal percentage earnings returns estimated using the above methodology, separately for men and women and across a range of age bands. Taking an example, in the row labelled 'undergraduate degree', the analysis suggests that a male aged between 31 and 35 years old in possession of an undergraduate degree is estimated to achieve a **23.6%** hourly earnings premium compared to a comparable male holding only 2 or more GCSE 'A' levels as his highest level of attainment. The comparable estimate for a woman aged between 31 and 35 stands at **33.1%**.

In the employment regressions, the relevant coefficients (displayed in Table 23) provide similar estimates of the impact of the qualification on the probability of being in employment (expressed in percentage points). Taking an example in relation to employment, a man aged between 36 and 40 in possession of an undergraduate degree is **2.7 percentage points** more likely to be in employment than a man of similar age holding only 2 or more GCE 'A' levels as his highest level of education.

[48] The coefficients in the model (represented by β) provide information on the extent to which a particular independent variable (e.g. qualification attainment) influences the dependent variable (earnings or employment outcomes). For the earnings returns, because the coefficients from the regression refer to the impact of qualification on the natural logarithm of hourly earnings, these coefficients need to be converted into percentages through exponentiation (using the transformation e^{β} -1). In general terms, for small coefficients (less than 0.10), the coefficient in the regression model will give a reasonable approximation of the actual percentage change; however, for coefficients greater than this, the correction is necessary. This transformation is required only when considering earning returns, as we are estimating the impact of qualification attainment on the logarithm of hourly earnings. No exponential transformation is necessary when considering the employment outcomes of learners, as in the employment regressions, the relevant coefficient provides an automatic estimate of the impact of the qualification on the probability of being in employment, in percentage terms.

[49] Note that in cases where the estimated coefficients are not statistically significantly different from zero (at the 10% level), the coefficient is assumed to be zero.

Table 22 Marginal earnings returns to higher education qualifications, in %, by gender and age band

Qualification level	Male										Female								
	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
2 or more GCE A-levels[1]	3.0%	5.8%	12.0%	23.7%	25.5%	17.6%	23.0%	22.8%	18.3%	20.3%	2.8%	5.7%	11.7%	16.6%	20.0%	20.7%	11.9%	14.8%	12.6%
HNC/HND/ Level 4 BTECS[2]			10.6%		6.2%	7.0%	7.1%	8.8%					6.9%	5.7%	9.4%	14.6%	6.2%	7.5%	16.0%
Other HE						23.9%	14.6%			-32.6%		12.0%		11.7%	14.7%		12.2%	16.1%	
HE Diploma						21.0%				-27.6%		6.2%	9.5%	14.8%	32.8%	44.5%	24.6%	31.0%	33.5%
Foundation Degree				18.8%				26.9%					10.8%			45.1%			
Undergraduate Degree		8.7%	20.9%	23.6%	24.6%	26.9%	22.3%	27.3%	29.4%	25.2%		9.9%	21.4%	33.1%	41.2%	39.9%	40.8%	36.3%	31.7%
Masters Degree[3]		5.3%	7.4%	5.5%	11.7%	13.7%	10.2%	11.6%	9.0%			3.7%	3.8%	9.4%	11.6%	16.3%	16.5%	12.3%	21.0%
Doctorate Degree		31.4%	12.6%	11.0%	13.9%	18.8%	12.6%	21.4%	14.8%	37.0%		14.8%	9.3%	10.2%	25.6%	21.2%	26.0%	28.3%	23.7%

Note: Regression coefficients have been exponentiated to reflect percentage wage returns. In cases where the estimated coefficients are not statistically significantly different from zero (at the 10% level), the coefficient is assumed to be zero; these are displayed as gaps in the table.

[1] Returns to holding 2 or more GCE 'A' levels compared to 5 or more GCSEs at A*-C. ;

[2] Returns to HNCs/HNDs/Level 4 BTECs, 'other' higher education qualifications, higher education Diplomas, Foundation Degree and Undergraduate Degrees returns are estimated relative to individuals holding 2 or more GCE 'A' levels as their highest qualification;

[3] Masters Degree and Doctorate Degree returns are estimated relative to Undergraduate Degrees.

Source: London Economics' analysis of Labour Force Survey 1996-2013

Table 23 Marginal employment returns to higher education qualifications, in percentage points, by gender and age band

Qualification level	Male											Female							
	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
2 or more GCE A-levels[1]	-6.1%		1.5%	1.0%	1.9%								3.0%	1.9%		1.7%		2.6%	
HNC/HND/ Level 4 BTECS[2]			1.9%	3.4%	1.9%	3.2%		3.5%	4.5%			6.2%			4.6%		3.6%	7.8%	
Other HE				4.8%									-8.8%						
HE Diploma						4.5%								5.0%			5.3%		7.6%
Foundation Degree										37.2%									
Undergraduate Degree		-3.6%	1.7%	2.3%	2.7%	3.0%	2.6%	5.4%				1.8%	1.9%	3.4%	3.5%	4.8%	4.5%	4.5%	5.9%
Masters Degree[3]		-4.6%		0.7%	0.8%		1.4%		7.5%	7.3%		-3.9%				2.7%	5.7%	6.2%	12.3%
Doctorate Degree				1.2%	1.2%		1.6%	3.9%	9.6%	11.0%			-3.9%	3.7%		7.1%	8.0%		15.1%

Note: In cases where the estimated coefficients are not statistically significantly different from zero (at the 10% level), the coefficient is assumed to be zero; these are displayed as gaps in the table.

[1] Returns to holding 2 or more GCE 'A' levels compared to 5 or more GCSEs at A*-C. ;

[2] Returns to HNCs/HNDs/Level 4 BTECs, 'other' higher education qualifications, higher education Diplomas, Foundation Degree and Undergraduate Degrees returns are estimated relative to individuals holding 2 or more GCE 'A' levels as their highest qualification;

[3] Masters Degree and Doctorate Degree returns are estimated relative to Undergraduate Degrees.

Source: London Economics' analysis of Labour Force Survey 1996-2013

A2.1.3 Measuring the returns to education for full-time and part-time students

Many of the economic analyses (e.g. Walker and Zhu (2013)) considering the lifetime benefits associated with higher education qualifications to date have focused on the returns associated with the 'traditional path' of higher education qualification attainment – namely progression directly from secondary level education and completion of a three or four year undergraduate degree by the age of 22. These analyses assume that there are **direct costs** (tuition fees etc), as well as an **opportunity cost** (the foregone earnings whilst undertaking the qualification full-time) associated with qualification attainment. More importantly, these analyses make the implicit assumption that any and all of the estimated earnings and/or employment benefit achieved accrues to the individual.

However, the labour market outcomes associated with the attainment of higher education qualifications on a part-time basis are fundamentally different. In particular, part-time students typically undertake higher education qualifications several years later than the 'standard' full-time undergraduate (the average age at enrolment amongst students undertaking undergraduate degrees with Cardiff University on a part-time basis is approximately **39**); generally undertake their studies over an extended period of time (a Cardiff University part-time undergraduate degree normally lasts approximately **6 years**); and often combine their studies with full-time employment.

Given these participation differences, and reflecting the (relatively limited) wider economic literature on the returns to part-time study[50], some significant changes to the methodology need to be made when estimating the return to part-time education attainment.

The most important of these changes relates to the introduction of an **'age-decay' function**. This approach assumes that possession of a particular higher education qualification is associated with a certain earnings or employment premium, and that this entire labour market benefit accrues to the individual *if* the qualification is attained before the age of 25.

However, we assume that, as the age of attainment increases, a declining proportion of the potential value of the estimated earnings and employment benefit accrues to the individual[51] [52]. This calibration ensures that those individuals completing qualifications at a relatively high age will see relatively low earnings and employment benefits associated with higher education qualification attainment (and perhaps reflect potentially different motivations amongst this group of learners). In contrast, those individuals attaining qualifications earlier in their working life will see a greater economic benefit (potentially reflecting the investment nature of qualification acquisition).

Table 24 presents the assumed age-decay adjustment factors which we apply to the marginal earnings and employment returns to students undertaking qualifications with Cardiff University (presented in Table 22 and Table 23). For example, the age-decay function used as part of this analysis suggests that a male commencing their undergraduate degree (on a part-time basis) at

[50] In general, these studies suggest that the economic returns to studying part-time are lower than the economic returns associated with studying full-time. This is in part because part-time students are often already employed when undertaking their studies so the marginal (or additional) impact of the higher education qualification is lower. For instance, six months after graduation, graduates from part-time study were three percentage points more likely to be employed than graduates from full-time study, and less than half as likely (3% compared to 7%) to be unemployed. See Callender et al (2011).

[51] Callender et al. (2011) suggest that the evidence points to decreasing employment returns with age at qualification: older graduates are less likely to be employed than younger graduates three and a half years after graduation; however, there are no differences in the likelihood of graduates from part- and full-time study being employed according to their age or motivations to study.

[52] The salaries of graduates from part-time study grow at a slower pace compared with their full-time peers. Part-time graduates are less likely to see their salaries increase and are more likely to see their salaries stagnate between 6 months and 42 months after graduation: specifically, during this period, 78% of pat time graduates and 88% of full-time graduates saw their salaries rise, while 16% of part-time and 8% of full-time graduates experienced no change in salaries, and 6% of part-time and only 2% of former full-time students saw a drop in their salaries.

the age of 39 and completing that degree at the age of 45 will achieve approximately **50%** of the estimate of the full earnings return (**26.9%** from Table 22) and employment return (**3.0 percentage points** from Table 23). Given the fact that we assume that women have slightly different retirement ages compared to men, this implies that for a woman completing an undergraduate degree at the age of 45, she will achieve **43%** of the full earnings return (**39.9%** from Table 22) and employment return (**4.8 percentage points** from Table 23).

Note that the 'age-decay' function is also applied to *full-time* students undertaking Higher Education Diplomas with Cardiff University, based on a relatively high average age at graduation for these students (**29**, based on an average age at enrolment of **27** and average study duration of **2** years). Hence, it is assumed that men completing HE Diplomas with Cardiff University will achieve approximately **88%** of the estimate of the full earnings return; the comparable figure for women amounts to **86%**.

Table 24 Assumed age decay adjustment factors for students undertaking higher education qualifications at Cardiff University

Qualification level	Male									
	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65
2 or more A-levels	100%	100%	88%	75%	63%	50%	38%	25%	13%	0%
HNC/HND/BTECS	100%	100%	88%	75%	63%	50%	38%	25%	13%	0%
Other HE	100%	100%	88%	75%	63%	50%	38%	25%	13%	0%
HE Diploma	100%	100%	88%	75%	63%	50%	38%	25%	13%	0%
Foundation Degree	100%	100%	88%	75%	63%	50%	38%	25%	13%	0%
UG Degree	100%	100%	88%	75%	63%	50%	38%	25%	13%	0%
Masters Degree	100%	100%	100%	86%	71%	57%	43%	29%	14%	0%
Doctorate Degree	100%	100%	100%	86%	71%	57%	43%	29%	14%	0%

Qualification level	Female									
	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65
2 or more A-levels	100%	100%	86%	71%	57%	43%	29%	14%	0%	
HNC/HND/BTECS	100%	100%	86%	71%	57%	43%	29%	14%	0%	
Other HE	100%	100%	86%	71%	57%	43%	29%	14%	0%	
HE Diploma	100%	100%	86%	71%	57%	43%	29%	14%	0%	
Foundation Degree	100%	100%	86%	71%	57%	43%	29%	14%	0%	
UG Degree	100%	100%	86%	71%	57%	43%	29%	14%	0%	
Masters Degree	100%	100%	100%	83%	67%	50%	33%	17%	0%	
Doctorate Degree	100%	100%	100%	83%	67%	50%	33%	17%	0%	

Note: Note: Shaded areas indicate relevant average graduation age per full-time (dark blue) / part-time students (light blue) at each level of study with Cardiff University.

Source: London Economics

The second difference in the treatment of students studying part-time and full-time is that we assume that students undertaking higher education qualifications on a full-time equivalent basis are not in employment during their studies, and as such incur opportunity costs associated with studying (i.e. the foregone earnings associated with the adjacent level of qualification). For part-

time students, we have assumed that these students are able to combine work with their academic studies and as such, do not incur any opportunity costs in the form of foregone earnings.

A2.1.4 Estimating the gross graduate premium and gross public benefit

The gross graduate premium associated with qualification attainment is defined as the **present value** of **enhanced post-tax earnings** (i.e. after income tax, National Insurance and VAT are removed) relative to an individual in possession of the counterfactual qualification. To estimate the value of gross graduate premium, it is necessary to extend the econometric analysis presented in Box 4 and Box 5. In particular, the following elements of analysis were undertaken (for men and women separately):

1. We estimated the employment-adjusted **annual earnings** achieved by individuals in the counterfactual groups (i.e. 5 or more GCSEs at A*-C, 2 or more GCE 'A' Levels, or an undergraduate degree).
2. We inflated these baseline or counterfactual earnings using the earnings premiums and employment probabilities presented in section A2.1.2), adjusted to reflect late attainment (as outlined in section A2.1.3), to produce **annual age-earnings** profiles associated with the possession of each particular qualification.
3. We adjusted these generated age-earnings profiles to account for the fact that earnings would be expected to increase in real terms over time (at an assumed rate of **2%** per annum).
4. Based on the earnings profiles generated by qualification holders, and income tax and National Insurance rates and allowances for the relevant academic year[53], we computed the future stream of net earnings (i.e. post-tax)[54]. Using similar assumptions, we further calculated the future stream of (employment-adjusted) foregone earnings (based on earnings in the relevant counterfactual group) during the period of study (for full-time students only), again net of tax.
5. We calculated the discounted stream of additional (employment-adjusted) future earnings compared to the relevant counterfactual group (using a standard discount rate of **3.5%** as presented in HM Treasury Green Book (HM Treasury, 2011)), and the discounted stream of foregone earnings during qualification attainment (for full-time students), to generate a present value figure i.e. the **gross graduate premium** (or equivalent for other qualifications).
6. The discounted stream of enhanced taxation revenues minus the tax income foregone during students' qualification attainment (where relevant) derived in element 4 provides an estimate of the **gross public benefit** associated with the funding of higher education teaching and learning.

Note that the gross graduate premium and gross public benefit for students undertaking qualifications at a level equivalent to or higher than the highest qualification which they are already in possession of was assumed to be zero. For example, it is assumed that a student in possession of an undergraduate degree undertaking an additional undergraduate degree at Cardiff University will not incur any wage or employment benefits to this additional qualification attainment.

[53] For more information on relevant tax and National Insurance rates, please refer to: http://www.hmrc.gov.uk/ni/intro/basics.htm. Note that the analysis assumes fiscal neutrality, i.e. it is asserted that the earnings tax and National Insurance income bands grow at the same rate of annual earnings growth of **2%**.

[54] The tax adjustment also takes account of increased VAT revenues for HMG, by assuming that individuals spend **69%** of their annual income consuming goods and services within the economy (i.e. assuming a 69% propensity to consume), and a VAT rate of **20%**.

The resulting gross graduate premiums and gross public purse benefits per full-time student are presented in Table 25 and Table 26, respectively. Taking an example, the analysis suggests that the **gross lifetime benefit** (before the direct costs of study are taken into account) achieved by an average CU[55] male full-time undergraduate in possession of GCE 'A' Levels as their highest level of prior attainment stands at approximately **£117,000** (in 2012-13 money terms). The comparable estimate for a female undergraduate student stands at approximately **£85,000**. In terms of benefits to the public purse, the analysis indicates the **gross public benefit** associated with an average CU male full-time undergraduate student (again compared to GCE 'A' Levels as their highest level of prior attainment) stands at **£149,000**, while the comparable estimate for female undergraduate students stands at **£95,000**.

It is important to note that although the levels of higher education attainment are essentially monotonically increasing (i.e. a Masters degree is at a higher level within the National Qualifications Framework compared to an undergraduate degree, which in turn is at a higher level compared to a Foundation degree), this does not necessary 'translate' into monotonically increasing higher earnings by qualification level. Specifically, the econometric analysis is based on a (large) survey of individuals, but may not exactly capture all the characteristics of the learner or the rationale for undertaking the qualification. The absence of this information might result in a slightly 'distorted' pattern of the returns to higher education qualification attainment.

The corresponding estimates of gross graduate premiums and gross public benefit for part-time students are presented in Table 27 and Table 28.

[55] The estimates are based on average ages at graduation for Cardiff University students per qualification level at the University, estimated at 22 for full-time undergraduate degree students.

Table 25 Gross graduate premiums associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£104,806	£36,617	£14,337	£7,842	£0	£0	£0	£0					£0	£0	£0	£0		
HE Diploma	£37,369	£56,647	-£21,062	£45,495	-£11,407	£51,752		£0	£0				£0	£0		£0	£0	
Undergraduate	£186,384	£97,464	**£116,541**	**£84,663**	£117,019	£89,285	£98,897	£76,047	£128,484	£31,829	£95,137	£85,515	£0	£0	£0	£0		£0
Masters		£160,839	£178,007	£137,391	£168,667	£134,693	£151,415	£121,022		£79,403	£147,664		£58,504	£51,844	£0	£0	£0	£0
Doctorate									£180,011	£75,701			£65,711	£51,419	£50,749	£35,493		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 26 Gross public purse benefits associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£117,209	£45,019	£26,693	£12,656	£0	£0	£0	£0					£0	£0	£0	£0		
HE Diploma	£61,281	£74,271	-£4,200	£53,302	-£12,700	£48,722		£0	£0				£0	£0		£0	£0	
Undergraduate	£230,017	£122,933	**£148,604**	**£95,289**	£125,990	£84,058	£112,053	£71,595	£138,828	£29,966	£109,899	£80,508	£0	£0	£0	£0		£0
Masters		£167,242	£218,472	£139,893	£197,491	£132,080	£184,287	£119,209		£80,028	£182,226		£79,718	£54,082	£0	£0	£0	£0
Doctorate									£231,722	£86,861			£107,915	£64,001	£58,587	£33,415		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 27 Gross graduate premiums associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£44,602	£14,535	£12,252	£5,429	£0	£0	£0	£0	£0	£0		£0	£0	£0	£0	£0	£0	£0
HE Diploma		£30,984										£0	£0	£0	£0	£0		
Undergraduate		£30,190	**£42,144**	**£23,660**		£18,310				£4,892		£21,564	£0	£0		£0		£0
Masters		£148,969	£164,428	£126,687		£111,865	£134,346	£104,771	£151,638	£71,172	£129,309	£110,924	£62,601	£55,440	£0	£0	£0	£0
Doctorate													£52,772	£35,668	£24,082	£10,198		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 28 Gross public purse benefits associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£45,845	£13,684	£15,389	£5,111	£0	£0	£0	£0	£0	£0		£0	£0	£0	£0	£0	£0	£0
HE Diploma		£29,170										£0	£0	£0	£0	£0		
Undergraduate		£28,422	**£44,963**	**£22,275**		£17,238				£4,606		£20,301	£0	£0		£0		£0
Masters		£140,247	£190,510	£119,269		£105,315	£158,854	£98,636	£173,923	£67,004	£155,678	£104,429	£76,034	£52,194	£0	£0	£0	£0
Doctorate													£60,539	£33,580	£26,965	£9,601		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

A2.1.5 Net graduate premium and net public benefit

The below tables provide detailed information on the net graduate premium and net public benefit associated with all higher education qualifications offered by Cardiff University, based on the 2012-13 cohort. With separate tables provided for full-time and part-time students of different domiciles (information for full-time students is provided in Table 29 to Table 36, and information for part-time education is provided in Table 37 to Table 44), each table provides detailed information on net graduate premiums / net public purse benefits by qualification level at Cardiff University, previous education level, and gender.

Net graduate premiums associated with full-time students, by domicile

Table 29 Net graduate premiums associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Wales

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£107,524	£39,335	£17,055	£10,560		-£7,540	-£7,540	-£7,540					-£7,540	-£7,540	-£7,540	-£7,540		
HE Diploma	£43,166	£62,444	-£15,266	£51,292	-£5,610	£57,549			-£10,396				-£10,396	-£10,396		-£10,396	-£10,396	
Undergraduate	£190,901	£101,981	**£121,058**	**£89,180**	£121,536	£93,802	£103,414	£80,564		£36,346	£99,654	£90,032	-£23,850	-£23,850	-£23,850	-£23,850		-£23,850
Masters		£155,737	£172,905	£132,289		£129,591		£115,920		£74,301	£142,562		£53,403	£46,742	-£5,102	-£5,102	-£5,102	-£5,102
Doctorate										£64,383			£54,393	£40,101	£39,431	£24,175		-£11,318

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 30 Net graduate premiums associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from England

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£104,219		£13,751	£7,256	-£7,540	-£7,540	-£7,540	-£7,540					-£7,540	-£7,540	-£7,540	-£7,540		
HE Diploma		£57,974	-£19,735	£46,822		£53,079		-£10,396					-£10,396	-£10,396		-£10,396		
Undergraduate	£183,864	£94,944	**£114,020**	**£82,143**	£114,499	£86,765	£96,377	£73,527	£125,964	£29,309		£82,995	-£23,850	-£23,850	-£23,850	-£23,850		-£23,850
Masters			£172,905		£163,565	£129,591	£146,313			£74,301			£53,403	£46,742	-£5,102	-£5,102		
Doctorate									£168,693				£54,393	£40,101	£39,431	£24,175		

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 31 Net graduate premiums associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Scotland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE																		
HE Diploma																		
Undergraduate			**£111,937**	**£80,059**														
Masters													£53,403	£46,742				
Doctorate													£54,393		£39,431	£24,175		-£11,318

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 32 Net graduate premiums associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Northern Ireland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE			£13,026	£6,531														
HE Diploma																		
Undergraduate			**£111,641**	**£79,763**										-£23,850				
Masters																		
Doctorate													£54,393	£40,101	£39,431			

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Net public purse benefits associated with full-time students, by domicile

Table 33 Net public purse benefits associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Wales

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£105,224	£33,035	£14,708	£672		-£2,359	-£2,359	-£2,359					-£2,359	-£2,359	-£2,359	-£2,359		
HE Diploma	£36,304	£49,294	-£29,177	£28,325	-£37,677	£23,745			-£9,334				-£9,334	-£9,334		-£9,334	-£9,334	
Undergraduate	£195,105	£88,021	**£113,692**	**£60,377**	£91,078	£49,146	£77,141	£36,683		-£4,946	£74,987	£45,596	-£7,185	-£7,185	-£7,185	-£7,185		-£7,185
Masters		£163,197	£214,427	£135,849		£128,036		£115,165		£75,983	£178,181		£75,673	£50,038	-£4,045	-£4,045	-£4,045	-£4,045
Doctorate										£86,861			£107,915	£64,001	£58,587	£33,415		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 34 Net public purse benefits associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from England

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£108,529		£18,013	£3,977	-£2,359	-£2,359	-£2,359	-£2,359					-£2,359	-£2,359	-£2,359	-£2,359		
HE Diploma		£53,764	-£24,707	£32,795		£28,215		-£9,334					-£9,334	-£9,334		-£9,334		
Undergraduate	£202,142	£95,058	**£120,729**	**£67,414**	£98,115	£56,183	£84,178	£43,720	£110,953	£2,091		£52,633	-£7,185	-£7,185	-£7,185	-£7,185		-£7,185
Masters			£214,427		£193,446	£128,036	£180,242			£75,983			£75,673	£50,038	-£4,045	-£4,045		
Doctorate									£231,722				£107,915	£64,001	£58,587	£33,415		

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 35 Net public purse benefits associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Scotland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE																		
HE Diploma																		
Undergraduate			**£122,813**	**£69,498**														
Masters													£75,673	£50,038				
Doctorate													£107,915		£58,587	£33,415		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 36 Net public purse benefits associated with higher education qualification attainment for *full-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Northern Ireland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE			£18,738	£4,702														
HE Diploma																		
Undergraduate			**£123,109**	**£69,793**										-£7,185				
Masters																		
Doctorate													£107,915	£64,001	£58,587			

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Net graduate premiums associated with part-time students, by domicile

Table 37 Net graduate premiums associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Wales

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£46,845	£16,778	£14,495	£7,672	-£2,006	-£2,006	-£2,006	-£2,006	-£2,006	-£2,006		-£2,006	-£2,006	-£2,006	-£2,006	-£2,006	-£2,006	-£2,006
HE Diploma		£31,171										-£8,189	-£8,189	-£8,189	-£8,189	-£8,189		
Undergraduate		£32,591	**£44,546**	**£26,062**		£20,712				£7,294		£23,965	-£9,982	-£9,982		-£9,982		-£9,982
Masters		£143,564	£159,023	£121,281			£128,940			£65,766			£57,196	£50,035	-£5,406	-£5,406	-£5,406	-£5,406
Doctorate													£43,475	£26,371	£14,785	£901		-£9,297

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 38 Net graduate premiums associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from England

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£42,456	£12,389	£10,106	£3,283	-£2,006		-£2,006	-£2,006		-£2,006			-£2,006	-£2,006	-£2,006	-£2,006	-£2,006	-£2,006
HE Diploma																		
Undergraduate			**£31,464**	**£12,980**						-£5,789								
Masters				£121,281		£106,460	£128,940	£99,365	£146,233	£65,766	£123,904	£105,519	£57,196	£50,035	-£5,406	-£5,406	-£5,406	-£5,406
Doctorate													£43,475		£14,785	£901		-£9,297

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 39 Net graduate premiums associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Scotland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE							-£2,006						-£2,006	-£2,006		-£2,006		
HE Diploma																		
Undergraduate																		
Masters										£65,766			£57,196	£50,035	-£5,406	-£5,406		
Doctorate																		

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 40 Net graduate premiums associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Northern Ireland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE		£14,495												-£2,006		-£2,006		
HE Diploma																		
Undergraduate																		
Masters													£57,196	£50,035	-£5,406	-£5,406		
Doctorate																		

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Net public purse benefits associated with part-time students, by domicile

Table 41 Net public purse benefits associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Wales

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£40,208	£8,047	£9,752	-£525	-£1,387	-£1,387	-£1,387	-£1,387	-£1,387	-£1,387		-£1,387	-£1,387	-£1,387	-£1,387	-£1,387	-£1,387	-£1,387
HE Diploma		£15,568										-£5,227	-£5,227	-£5,227	-£5,227	-£5,227		
Undergraduate		£9,687	**£26,228**	**£3,540**		-£1,497				-£14,129		£1,566	-£6,351	-£6,351		-£6,351		-£6,351
Masters		£136,475	£186,738	£115,497			£155,083			£63,233			£72,262	£48,423	-£3,772	-£3,772	-£3,772	-£3,772
Doctorate													£60,539	£33,580	£26,965	£9,601		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 42 Net public purse benefits associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from England

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE	£44,598	£12,437	£14,142	£3,864	-£1,387		-£1,387	-£1,387		-£1,387			-£1,387	-£1,387	-£1,387	-£1,387	-£1,387	-£1,387
HE Diploma																		
Undergraduate			**£39,311**	**£16,623**						-£1,047								
Masters				£115,497		£101,544	£155,083	£94,865	£170,152	£63,233	£151,906	£100,658	£72,262	£48,423	-£3,772	-£3,772	-£3,772	-£3,772
Doctorate													£60,539		£26,965	£9,601		£0

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 43 Net public purse benefits associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Scotland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE							-£1,387						-£1,387	-£1,387		-£1,387		
HE Diploma																		
Undergraduate																		
Masters										£63,233			£72,262	£48,423	-£3,772	-£3,772		
Doctorate																		

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

Table 44 Net public purse benefits associated with higher education qualification attainment for *part-time students*, by level of study at Cardiff University, gender and prior attainment: Students from Northern Ireland

Level of study at CU	Previous qualification																	
	GCSE		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Other HE		£10,331												-£1,387		-£1,387		
HE Diploma																		
Undergraduate																		
Masters													£72,262	£48,423	-£3,772	-£3,772		
Doctorate																		

Note: Gaps may arise where there are no students in the 2012-13 cohort to complete the given qualification (of the given characteristics) at Cardiff University. Grey shading indicates instances where the level of study at CU is equal to or higher than the level of previous attainment.

Source: London Economics' analysis

A2.1.6 Categorisation of Cardiff University qualifications

To undertake the analysis of the impact of CU's teaching and learning activities, we were supplied with an extract of Cardiff University's HESA return for students starting formally recognised qualifications or standalone credit-bearing modules in the 2012-13 academic year. The data provides detailed information (separately for each student included in the 2012-13 cohort) on a range of variables, including HESA variables QUALENT3 (indicating the highest qualification that a student holds on entry) and COURSEAIM (indicating the general qualification aim of a student's course, intended to record the qualification that will be attained as a result of successful completion of studies). To combine these HESA data on the 2012-13 cohort with the results of the above-described econometric level, we categorised both HESA variables on previous education and qualification aim as recorded for the 2012-13 CU cohort into a range of overall qualification categories, thus generating a consistent grouping of education levels throughout the analysis. These categorisations are outlined in Table 45 (for qualification levels undertaken at CU) and Table 46 (for previous education levels).

Table 45 Categorisation of qualification aims

COURSEAIM	Label	Qualification aim category
C20	Certificate of Higher Education (CertHE)	Other HE
H99	Taught work at level H with an unspecified qualification aim	Other HE
I90	Credits at level I	Other HE
M90	Taught work at level M for institutional credit	Other HE
M99	Taught work at levels E or M with an unspecified qualification aim	Other HE
H61	Graduate diploma/certificate at level H but where a previous qualification at level H is a pre-requisite for course entry	HE Diploma
J20	Diploma of Higher Education (DipHE)	HE Diploma
J26	Diploma of Higher Education (DipHE) leading towards obtaining eligibility to register to practice with a health or social care or veterinary statutory regulatory body	HE Diploma
H00	First degree with honours	Undergraduate Degree
H16	Pre-registration first degree with honours leading towards obtaining eligibility to register to practice with a health or social care or veterinary statutory regulatory body	Undergraduate Degree
H71	Professional Graduate Certificate in Education	Undergraduate Degree
M22	Integrated undergraduate/postgraduate taught masters degree on the enhanced/extended pattern	Undergraduate Degree
L00	Masters degree that meets the criteria for a research-based higher degree	Masters Degree
M00	Masters degree obtained typically by a combination of coursework and thesis/dissertation, that does not meet the criteria for a research-based higher degree	Masters Degree
M11	Master of Business Administration (MBA)	Masters Degree
M71	Postgraduate Certificate in Education or Professional Graduate Diploma in Education	Masters Degree
M80	Other taught qualification at level M	Masters Degree
D00	Doctorate degree that meets the criteria for a research-based higher degree	Doctorate Degree
X41	Welsh for Adults Entry level	-
X42	Welsh for Adults level 1	-
X43	Welsh for Adults level 2	-
X44	Welsh for Adults level 3	-
X45	Welsh for Adults level 4	-
X46	Welsh for Adults specialist/arbennig	-

Note: 'Welsh for Adults' programmes are courses at Further Education level; students undertaking these courses were therefore excluded from the 2012-13 cohort.

Source: London Economics' analysis based on Cardiff University HESA data

Table 46 Categorisation of prior attainment levels

QUALENT3	Label	Previous education category
Q80	Other qualification at level 2	GCSE
R51	14-19 Foundation Diploma (level 1)	GCSE
R80	Other qualification at level 1	GCSE
X05	Student has no formal qualification	GCSE
P47	AQA Baccalaureate (Bacc)	A-level
P50	A/AS level	A-level
P51	14-19 Advanced Diploma (level 3)	A-level
P62	International Baccalaureate (IB) Diploma	A-level
P80	Other qualification at level 3	A-level
P92	Level 3 qualifications of which none are subject to UCAS Tariff	A-level
P93	Level 3 qualifications of which all are subject to UCAS Tariff	A-level
P94	Level 3 qualifications of which some are subject to UCAS Tariff	A-level
X00	Higher education (HE) access course, Quality Assurance Agency (QAA) recognised	A-level
X01	Higher education (HE) access course, not Quality Assurance Agency (QAA) recognised	A-level
C30	Higher National Certificate (HNC)	HNC/HND/BTECs
J30	Higher National Diploma (HND)	HNC/HND/BTECs
J49	Foundation course at level J	HNC/HND/BTECs
J80	Other qualification at level J	HNC/HND/BTECs
C20	Certificate of Higher Education (CertHE)	Other HE
C80	Other qualification at level C	Other HE
C90	Undergraduate credits	Other HE
P41	Diploma at level 3	Other HE
P42	Certificate at level 3	Other HE
P46	Award at level 3	Other HE
J20	Diploma of Higher Education (DipHE)	HE Diploma
J48	Certificate in Education (CertEd) or Diploma in Education (DipEd) (i.e. non-graduate initial teacher training qualification)	HE Diploma
J10	Foundation degree	Foundation Degree
H11	First degree with honours leading to Qualified Teacher Status (QTS)/registration with a General Teaching Council (GTC)	Undergraduate Degree
H80	Other qualification at level H	Undergraduate Degree
HUK	UK first degree with honours	Undergraduate Degree
HZZ	Non-UK first degree	Undergraduate Degree
JUK	UK ordinary (non-honours) first degree	Undergraduate Degree
M41	Diploma at level M	Masters Degree
M71	Postgraduate Certificate in Education or Professional Graduate Diploma in Education	Masters Degree
M80	Other taught qualification at level M	Masters Degree
MUK	UK masters degree	Masters Degree
MZZ	Non-UK masters degree	Masters Degree
D80	Other qualification at level D	Doctorate Degree
DUK	UK doctorate degree	Doctorate Degree
X02	Mature student admitted on basis of previous experience and/or admissions test	-
X04	Other qualification level not known	-
X06	Not known	-

Source: London Economics' analysis based on Cardiff University HESA data

A2.1.7 Further information on the 2012-13 UK-domiciled cohort of Cardiff University students

To complement the breakdown of the number of students in terms of **headcount** included in the 2012-13 UK domiciled Cardiff University cohort presented in Table 8, Table 47 presents a similar breakdown of this cohort in terms of the number of **full-time equivalent students**.

Table 47 UK domiciled students (FTE) in 2012-13 cohort, by Home Nation, study mode and level of study at Cardiff University

Level of study at CU	Domicile				
	England	Wales	Scotland	Northern Ireland	Total UK
Full-time	**3,086**	**2,389**	**14**	**45**	**5,533**
Other HE	17	52	0	1	**70**
HE Diploma	26	55	0	0	**81**
UG Degree	2,669	1,730	4	41	**4,444**
Masters	285	433	5	0	**723**
Doctorate	90	118	5	3	**215**
Part-time	**321**	**1,100**	**20**	**8**	**1,449**
Other HE	45	685	2	2	**734**
HE Diploma	0	9	0	0	**9**
UG Degree	4	24	0	0	**28**
Masters	261	350	18	6	**636**
Doctorate	10	31	0	0	**42**
Total	**3,407**	**3,488**	**33**	**53**	**6,982**
Other HE	62	738	2	3	**805**
HE Diploma	26	65	0	0	**90**
UG Degree	2,673	1,754	4	41	**4,472**
Masters	546	783	23	6	**1,359**
Doctorate	101	149	5	3	**257**

Note: Based on HESA variable STULOAD, indicating the student FTE based on the institution's best academic judgement of the full-time equivalence of a student during the reporting year 1 August – 31 July.

Source: London Economics' analysis of Cardiff University data

Again adding to the information presented in Table 8, below, we present breakdowns of the number of students (in **headcount**) in the 2012-13 CU cohort by Home Nation domicile, gender, level of study at Cardiff University and prior attainment.

Table 48 Welsh students (headcount) in 2012-13 cohort, by study mode, level of study at Cardiff University, gender and prior attainment

Level of study at CU	Prior attainment																		
	GCSEs		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate		Total
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	ALL
Full-time	**20**	**41**	**667**	**914**	**12**	**23**	**18**	**27**	**1**	**9**	**4**	**5**	**249**	**339**	**62**	**95**	**2**	**6**	**2,494**
Other HE	0	9	13	27	0	0	0	0	0	0	0	0	2	3	0	1	0	0	**55**
HE Diploma	1	3	3	4	2	1	0	0	1	0	0	0	16	20	0	6	1	0	**58**
UG Degree	19	27	650	882	10	20	18	26	0	2	3	5	33	58	4	7	0	3	**1,767**
Masters	0	2	1	1	0	2	0	1	0	6	1	0	164	227	30	37	1	2	**475**
Doctorate	0	0	0	0	0	0	0	0	0	1	0	0	34	31	28	44	0	1	**139**
Part-time	**120**	**204**	**122**	**204**	**4**	**11**	**62**	**53**	**5**	**47**	**0**	**7**	**569**	**1,117**	**422**	**779**	**37**	**34**	**3,797**
Other HE	120	198	115	176	4	10	61	53	5	31	0	4	432	847	272	478	25	20	**2,851**
HE Diploma	0	1	0	0	0	0	0	0	0	0	0	2	1	12	1	2	0	0	**19**
UG Degree	0	4	6	25	0	1	0	0	0	8	0	1	2	10	0	4	0	1	**62**
Masters	0	1	1	3	0	0	1	0	0	8	0	0	127	242	126	271	12	12	**804**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	7	6	23	24	0	1	**61**
Total	**140**	**245**	**789**	**1,118**	**16**	**34**	**80**	**80**	**6**	**56**	**4**	**12**	**818**	**1,456**	**484**	**874**	**39**	**40**	**6,291**
Other HE	120	207	128	203	4	10	61	53	5	31	0	4	434	850	272	479	25	20	**2,906**
HE Diploma	1	4	3	4	2	1	0	0	1	0	0	2	17	32	1	8	1	0	**77**
UG Degree	19	31	656	907	10	21	18	26	0	10	3	6	35	68	4	11	0	4	**1,829**
Masters	0	3	2	4	0	2	1	1	0	14	1	0	291	469	156	308	13	14	**1,279**
Doctorate	0	0	0	0	0	0	0	0	0	1	0	0	41	37	51	68	0	2	**200**

Note: 'Other HE' includes Certificates of Higher Education, taught work for institutional credits or with an unspecified qualification aim, and credits at HE level. We received Cardiff University HESA data on a total of **16,216** students. From those, we excluded (in subsequent steps) a total of **3,782** students who were not UK-domiciled or for whom no Home Nation was indicated; **1** student who was studying in the second year; **69** students whose age was indicated at 99 (the default HESA age for students whose birth date is not known); and **2,054** students who were following courses at Further Education level. For a total of **934** students out of the resulting cohort, previous attainment levels were specified as either 'Mature student admitted on basis of previous experience and/or admissions test ', 'Other qualification level not known' or 'Not known'. For those students, we imputed their prior attainment level per student using a group-wise imputation approach; in particular, previous education levels for students with missing information were replaced with the mode of previous education of students undertaking similar qualifications at CU on the same basis (i.e. full-time or part-time).

Source: London Economics' analysis based on Cardiff University data

Table 49 English students (headcount) in 2012-13 cohort, by study mode, level of study at Cardiff University, gender and prior attainment

Level of study at CU	Prior attainment																		
	GCSEs		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate		Total
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	ALL
Full-time	**22**	**9**	**1,092**	**1,462**	**21**	**28**	**18**	**27**	**2**	**3**	**0**	**2**	**178**	**172**	**52**	**59**	**0**	**2**	**3,149**
Other HE	0	0	12	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**17**
HE Diploma	0	2	2	3	0	2	0	1	0	0	0	0	4	11	0	1	0	0	**26**
UG Degree	22	7	1,077	1,455	19	24	17	26	1	2	0	2	14	31	1	6	0	2	**2,706**
Masters	0	0	1	0	2	2	1	0	0	1	0	0	141	114	20	18	0	0	**300**
Doctorate	0	0	0	0	0	0	0	0	1	0	0	0	19	16	30	34	0	0	**100**
Part-time	**3**	**3**	**10**	**21**	**1**	**1**	**6**	**2**	**3**	**7**	**1**	**1**	**192**	**238**	**131**	**114**	**8**	**7**	**749**
Other HE	3	3	8	16	1	0	5	1	0	1	0	0	35	76	20	29	3	2	**203**
HE Diploma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
UG Degree	0	0	2	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	**6**
Masters	0	0	0	3	0	1	1	1	3	4	1	1	156	162	102	78	5	4	**522**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	1	0	9	7	0	1	**18**
Total	**25**	**12**	**1,102**	**1,483**	**22**	**29**	**24**	**29**	**5**	**10**	**1**	**3**	**370**	**410**	**183**	**173**	**8**	**9**	**3,898**
Other HE	3	3	20	20	1	0	5	1	0	1	0	0	35	76	21	29	3	2	**220**
HE Diploma	0	2	2	3	0	2	0	1	0	0	0	0	4	11	0	1	0	0	**26**
UG Degree	22	7	1,079	1,457	19	24	17	26	1	4	0	2	14	31	1	6	0	2	**2,712**
Masters	0	0	1	3	2	3	2	1	3	5	1	1	297	276	122	96	5	4	**822**
Doctorate	0	0	0	0	0	0	0	0	1	0	0	0	20	16	39	41	0	1	**118**

Note: 'Other HE' includes Certificates of Higher Education, taught work for institutional credits or with an unspecified qualification aim, and credits at HE level. We received Cardiff University HESA data on a total of **16,216** students. From those, we excluded (in subsequent steps) a total of **3,782** students who were not UK-domiciled or for whom no Home Nation was indicated; **1** student who was studying in the second year; **69** students whose age was indicated at 99 (the default HESA age for students whose birth date is not known); and **2,054** students who were following courses at Further Education level. For a total of **934** students out of the resulting cohort, previous attainment levels were specified as either 'Mature student admitted on basis of previous experience and/or admissions test ', 'Other qualification level not known' or 'Not known'. For those students, we imputed their prior attainment level per student using a group-wise imputation approach; in particular, previous education levels for students with missing information were replaced with the mode of previous education of students undertaking similar qualifications at CU on the same basis (i.e. full-time or part-time).

Source: London Economics' analysis based on Cardiff University data

Table 50 Scottish students (headcount) in 2012-13 cohort, by study mode, level of study at Cardiff University, gender and prior attainment

Level of study at CU	Prior attainment																		
	GCSEs		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate		Total
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	ALL
Full-time	**0**	**0**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**3**	**1**	**1**	**0**	**1**	**14**
Other HE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
HE Diploma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
UG Degree	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**
Masters	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	**5**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	1	**5**
Part-time	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**12**	**16**	**7**	**4**	**0**	**0**	**41**
Other HE	0	0	0	0	0	0	1	0	0	0	0	0	2	3	0	1	0	0	**7**
HE Diploma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
UG Degree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Masters	0	0	0	0	0	0	0	0	0	1	0	0	10	13	7	3	0	0	**34**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total	**0**	**0**	**1**	**3**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**16**	**19**	**8**	**5**	**0**	**1**	**55**
Other HE	0	0	0	0	0	0	1	0	0	0	0	0	2	3	0	1	0	0	**7**
HE Diploma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
UG Degree	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**
Masters	0	0	0	0	0	0	0	0	0	1	0	0	12	16	7	3	0	0	**39**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	1	**5**

Note: 'Other HE' includes Certificates of Higher Education, taught work for institutional credits or with an unspecified qualification aim, and credits at HE level. We received Cardiff University HESA data on a total of **16,216** students. From those, we excluded (in subsequent steps) a total of **3,782** students who were not UK-domiciled or for whom no Home Nation was indicated; **1** student who was studying in the second year; **69** students whose age was indicated at 99 (the default HESA age for students whose birth date is not known); and **2,054** students who were following courses at Further Education level. For a total of **934** students out of the resulting cohort, previous attainment levels were specified as either 'Mature student admitted on basis of previous experience and/or admissions test ', 'Other qualification level not known' or 'Not known'. For those students, we imputed their prior attainment level per student using a group-wise imputation approach; in particular, previous education levels for students with missing information were replaced with the mode of previous education of students undertaking similar qualifications at CU on the same basis (i.e. full-time or part-time).

Source: London Economics' analysis based on Cardiff University data

Table 51 Northern Irish students (headcount) in 2012-13 cohort, by study mode, level of study at Cardiff University, gender and prior attainment

Level of study at CU	Prior attainment																		
	GCSEs		A-level		Other HE		HNC/D, BTEC		HE Diploma		Foundation		Undergraduate		Masters		Doctorate		Total
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	ALL
Full-time	**0**	**0**	**11**	**30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	**45**
Other HE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
HE Diploma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
UG Degree	0	0	10	30	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**41**
Masters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	**3**
Part-time	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**9**	**3**	**4**	**0**	**0**	**21**
Other HE	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	3	0	0	**8**
HE Diploma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
UG Degree	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Masters	0	0	0	0	0	0	0	0	0	0	0	0	4	5	3	1	0	0	**13**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total	**0**	**1**	**11**	**30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**11**	**4**	**4**	**0**	**0**	**66**
Other HE	0	1	1	0	0	0	0	0	0	0	0	0	0	4	0	3	0	0	**9**
HE Diploma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
UG Degree	0	0	10	30	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**41**
Masters	0	0	0	0	0	0	0	0	0	0	0	0	4	5	3	1	0	0	**13**
Doctorate	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	**3**

Note: 'Other HE' includes Certificates of Higher Education, taught work for institutional credits or with an unspecified qualification aim, and credits at HE level. We received Cardiff University HESA data on a total of **16,216** students. From those, we excluded (in subsequent steps) a total of **3,782** students who were not UK-domiciled or for whom no Home Nation was indicated; **1** student who was studying in the second year; **69** students whose age was indicated at 99 (the default HESA age for students whose birth date is not known); and **2,054** students who were following courses at Further Education level. For a total of **934** students out of the resulting cohort, previous attainment levels were specified as either 'Mature student admitted on basis of previous experience and/or admissions test ', 'Other qualification level not known' or 'Not known'. For those students, we imputed their prior attainment level per student using a group-wise imputation approach; in particular, previous education levels for students with missing information were replaced with the mode of previous education of students undertaking similar qualifications at CU on the same basis (i.e. full-time or part-time).

Source: London Economics' analysis based on Cardiff University data

A2.2 Cardiff University's impact on exports: Assumptions on average stay duration

As outlined in section 4.1.3, to estimate the non-tuition fee income associated with EU and non-EU students studying with Cardiff University, we adjusted estimates of non-tuition fee expenditure per academic year provided by the Student Income and Expenditure Survey (based on Welsh students) to reflect longer stay durations for non-EU and EU students.

In particular, following a similar approach as outlined by the Department for Business, Innovation and Skills (2011), we assume that EU domiciled postgraduate, and non-EU undergraduate and postgraduate students spend a larger amount of time in the UK than prescribed by the duration of the academic year (39 weeks), on average[56]. Hence, we assume that all postgraduate students (both EU and non-EU domiciled) spend **52 weeks** per year in the UK, as they write their dissertations during the summer. Further, we assume that non-EU domiciled and EU domiciled undergraduate students spend an average of **42** and **39 weeks** per year in the UK (respectively), to reflect the fact that EU students, given the relative geographical proximity to their home countries and the resulting relative ease and low cost of transport, are more likely to return home during holidays. These assumptions are summarised in Table 52.

Table 52 Assumed average stay durations (in weeks) for non-UK domiciled students, by domicile and level of study

Level of study	Domicile	
	EU (outside UK)	Non-EU
Undergraduate	39 weeks	42 weeks
Postgraduate	52 weeks	52 weeks

Source: London Economics' analysis based on Department for Business, Innovation and Skills (2011)

A2.3 Direct, indirect and induced impacts: Adjusting for double-counting

As outlined in section Box 23, to aggregate the total impact of CU student expenditure and CU institutional expenditure, it is necessary to make adjustments to the respective 'raw' estimated impacts to avoid double-counting with the other sources of impact included in the analysis. The 'raw' impacts associated with CU expenditure and CU student expenditure, i.e. before any adjustments for double-counting, are presented in Table 53.

[56] There may be significant variation around these assumed average stay durations depending on individual students' circumstances, such as country of origin, parental income etc.

Table 53 'Raw' direct, indirect and induced impact associated with CU expenditure and CU student expenditure (£m and number of FTE jobs supported) – *before adjustments for double counting*

Type of impact	£m		# of FTE jobs	
	Wales	UK	Wales	UK
'Raw' impact of CU expenditure	833.5	977.2	10,070	11,383
Raw' impact of CU student expenditure	228.9	253.1	1,917	2,128
Total	**1,062.4**	**1,230.3**	**11,987**	**13,511**

Note: Estimates before adjustments to avoid double-counting with other sources of economic impact as analysed in previous sections.

Source: London Economics' analysis

To avoid double-counting of the impact of CU's research activities and the impact of the University on exports, we deducted from the total impact of **CU institutional expenditure** in the UK **(£977.2 million**) the value of total research income net of public purse research funding (**£66.9 million**) and the level of net tuition fee income (after public purse costs) from non-UK domiciled students (**£67.4 million**). Similarly, to prevent double-counting with the impact on exports, we excluded from the total direct, indirect and induced impacts of **CU student expenditure** in the UK (**£253.1 million**) the level of non-tuition fee expenditure associated with non-UK students (**£68.5 million**; see section 4).

We thus arrived at the adjusted total monetary impact for the UK as a whole. To calculate the monetary impact on Wales, we multiplied the adjusted UK impact by the ratio of Welsh to UK monetary impact based on the above 'raw' impact estimates indicated in Table 53 (separately for the impact of CU expenditure and CU student expenditure). To calculate the adjusted impact on jobs in Wales and the UK, we then multiplied the adjusted monetary impacts by the ratio of 'raw' FTE employment estimates to 'raw' monetary impact (separately for Wales and the UK). This provides the net adjusted estimates displayed in Table 19 (repeated in Table 54 for reference).

Table 54 Direct, indirect and induced impact associated with CU expenditure and CU student expenditure (£m and number of FTE jobs supported)

Type of impact	£m		# of FTE jobs	
	Wales	UK	Wales	UK
Impact of CU expenditure	718.9	842.9	8,685	9,819
Impact of CU student expenditure	166.9	184.6	1,398	1,552
Total	**885.9**	**1,027.5**	**10,083**	**11,371**

Note: Estimates have been adjusted to avoid double-counting with other sources of economic impact as analysed in previous sections.

Source: London Economics' analysis

Annex 3 Sensitivity analysis

Our estimates of the impact Cardiff University's teaching and learning activities (presented in section 2), CU's impact on exports (see section 4) and the economic associated with CU's operational expenditures and the personal expenditures of its students (see section 5) are based on an assumed rate of real annual earnings growth of **2%**. This growth rate constitutes a crucial assumption in the analysis of the net graduate premium and net public purse benefits over graduates' working lifetimes, as well as the tuition fee and non-tuition fee income associated with students over their total study period. Note that our estimate of the impact of CU's research activities is not affected by changes in the assumed annual earnings growth.

To test the sensitivity of our estimates, Table 55 presents resulting changes in the aggregate economic impact of Cardiff University in the UK in response to a decrease in the assumed real annual earnings growth rate to **1.5%** (i.e. a **lower bound estimate**) or an increase to **2.5%** (providing a **higher bound estimate**).

As displayed in the table, a decrease in the assumed earnings growth rate from **2.0%** to **1.5%** results in a decline in the estimated total economic impact of Cardiff University, from **£2,740.4 million** to **£2,607.9 million**, corresponding to a drop by **4.8%**. This decline is largely driven by a **13.6%** decrease in the impact of CU's teaching and learning activities from **£967.9 million** in the central estimate to **£836.7 million** in the lower bound estimate, with only relatively small decreases (of less than **1%**, respectively) in the estimated direct, indirect and induced impacts of CU's institutional and student expenditure and the impact of Cardiff University on UK exports.

Similarly, the strongest effect of an increase in earnings growth to **2.5%** is on the estimated impact of CU's teaching and learning activities – though, again, the aggregate effect is relatively small, resulting in an increase in the total economic impact of **5.5%** (from **£2,740.4 million** to **£2,890.1 million**) between the central and higher bound estimates. In this case, the impact of teaching and learning increases by **15.3%**, while the impact of CU on export and the direct, indirect and induced effects associated with CU increase by **0.4%** and **0.1%**, respectively.

Table 55 Sensitivity analysis: Change in aggregate economic impact of Cardiff University in the UK in response to changes in real annual earnings growth rate, £m and % change

Type of impact (£m in 2012-13)	Lower bound estimate: Earnings growth = 1.5%		Central estimate: Earnings growth = 2.0%	Higher bound estimate: Earnings growth = 2.5%	
	£m	% difference to baseline	£m	£m	% difference to baseline
Impact of teaching and learning	**836.7**	**-13.6%**	**967.9**	**1,116.2**	**+15.3%**
Students	434.5	-13.0%	499.3	572.4	+14.6%
Public purse	402.2	-14.2%	468.6	543.8	+16.0%
Impact of research	**609.1**	**0.0%**	**609.1**	**609.1**	**0.0%**
Net direct research income	66.9	0.0%	66.9	66.9	0.0%
Spillover impact	542.2	0.0%	542.2	542.2	0.0%
Impact on exports	**135.6**	**-0.2%**	**135.9**	**136.4**	**+0.4%**
Net tuition fee income	67.3	-0.1%	67.4	67.7	+0.4%
Non-tuition fee income	68.3	-0.3%	68.5	68.7	+0.3%
Direct, indirect and induced impacts	**1,026.5**	**-0.1%**	**1,027.5**	**1,028.4**	**+0.1%**
Impact of CU expenditure	842.9	0.0%	842.9	842.9	0.0%
Impact of CU student expenditure	183.6	-0.5%	184.6	185.5	+0.5%
Total economic impact	**2,607.9**	**-4.8%**	**2,740.4**	**2,890.1**	**+5.5%**

Note: Values are presented in 2012-13 prices.

Source: London Economics' analysis

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