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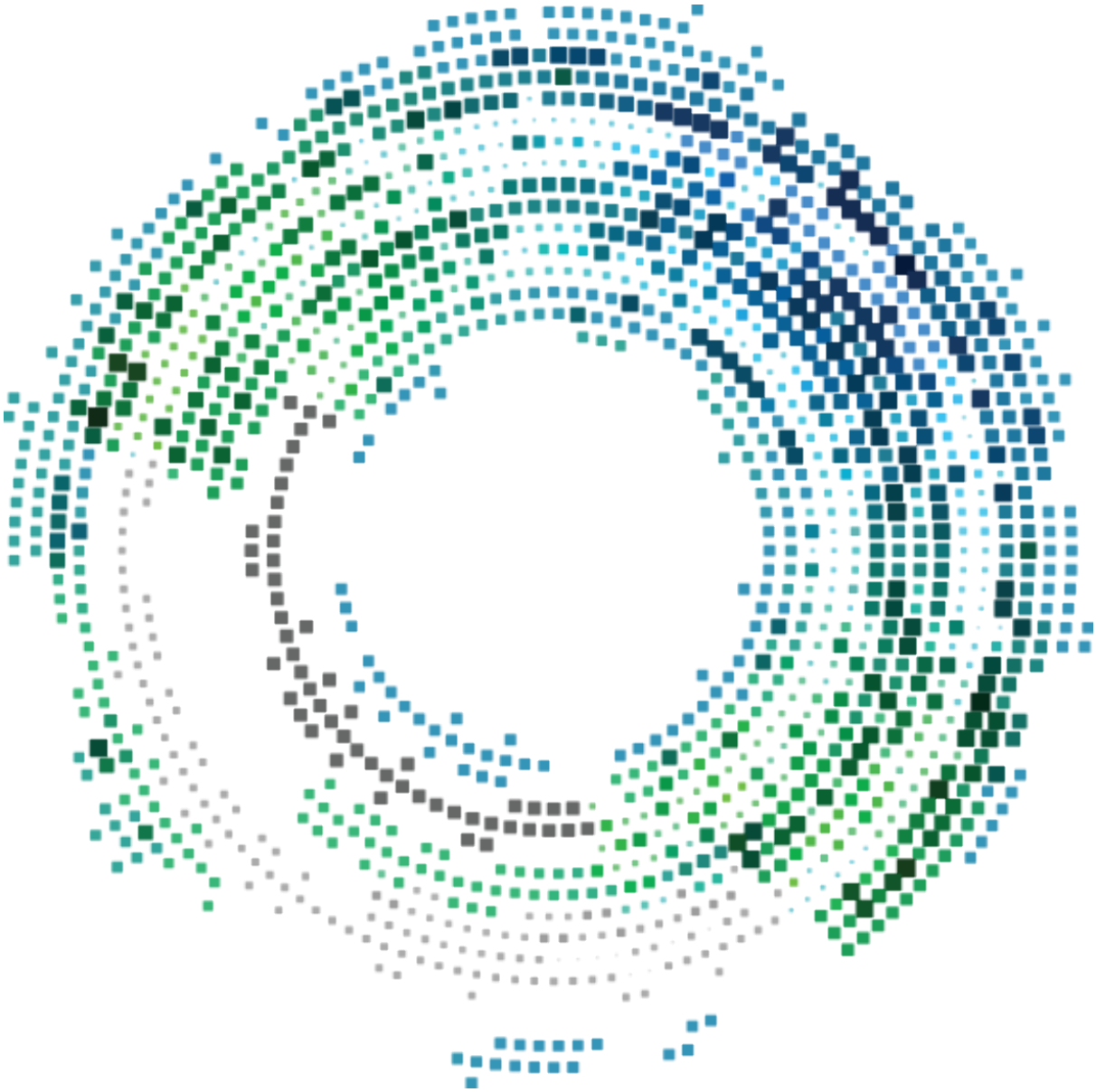

Regional variation in costs and benefits for higher education providers in England

Report to HEFCE by Deloitte LLP

December 2017

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Contents

Abbreviations

Abbreviation	Definition
AP	Alternative provider
ASHE	Annual Survey of Hours and Earnings, provided by the ONS
BCIS	Building Costs Information Service
BIC	Bayesian information criteria
DLHE	Destinations of Leavers in Higher Education
DCLG	Department for Communities and Local Government
Dfbeta	'Difference in Betas': A measure of how much impact an observation has on a particular predictor
EFA	Education Funding Agency
EMR	Estates Management Record
EU	European Union
FEC	Further education and sixth form colleges
FNRRMCT	Variable name for maintenance costs sourced from HESA
FNRRV	Variable name for the rateable value sourced from HESA
FTE	Full Time Equivalent
HEFCE	Higher Education Funding Council for England
HEI	Higher education institutions
HEP	Higher education provider
HESA	Higher Education Statistics Agency
HMRC	Her Majesty's Revenue and Customs office
ILR	Individualised Learner Record
IT	Information technology
Log	Refers to the natural logarithm
NHSE	NHS (National Health Service) England
NSS	National Student Survey
NUTS1	Nomenclature of Territorial Units for Statistics 1
OLS	Ordinary least squares
ONS	Office for National Statistics
Oxbridge	Abbreviation used to refer to the University of Cambridge and University of Oxford together
PAYE	Pay-As-You-Earn (referred to in the context of tax registration)
REF	Research Excellence Framework
RICS	Royal Institute of Chartered Surveyors
SFA	Skills Funding Agency
SIC	Standard Industrial Classifications

Abbreviation	Definition
SLC	Student Loans Company
SMNIANRT	Variable name for the total net internal area sourced from HESA
SOC	Sector Occupation Classification
STEM	Science, Technology, Engineering and Mathematics
TAS	Time Allocation Survey
TRAC	Transparent Approach to Costing
UCAS	Universities and Colleges Admissions Service
VOA	Valuation Office Agency

1 Executive Summary

The objective of this study is to gather evidence on the geographic variation in relative costs and benefits for higher education providers (HEPs) of operating in England.

HEPs in England receive funds for teaching and research from a number of sources, including tuition fees and the Higher Education Funding Council for England (HEFCE). In 2016/17 HEFCE provided £3.7 billion to HEPs. The proportion of a HEP's total income that a HEFCE grant constitutes depends on the level of income HEPs are able to raise through fees, their activities and the money they generate from other sources. However, not all HEPs receive funding from HEFCE. In 2016/17, 132 higher education institutions (HEIs) and 202 further education and sixth form colleges (FECs) received funds; HEFCE is not empowered to fund alternative providers (APs) directly.

HEFCE uses funding formulae to determine the allocation of funding for HEPs. The majority of funding for 2016/17 was allocated as recurrent grants for teaching (37%) and research (43%) based, broadly, on measures including the number and characteristics of students served and the subject studied, the quality of the research conducted and differences in HEPs' costs associated with their geographical location.

To account for the variation in costs associated with geography, the formulae apply a regional cost adjustment in the form of London weightings. Specifically, a 12 per cent uplift is applied to HEPs in Inner London and an 8 per cent uplift in Outer London, for both the student premium element of the teaching grant and research funding, recognising the higher cost of provision for HEPs in London. In addition, HEFCE provides a separate targeted allocation, within the teaching grant, to support providers with the additional costs of students attending courses in London. While the approach to account for the additional costs of operating in London has evolved since it was first established, the evidence underpinning it has not been updated.

In this context, HEFCE commissioned Deloitte to undertake a study to gather evidence on the regional differences in relative costs and benefits for HEPs of operating in England. The objectives of this study are to provide evidence on:

- The variation in relative costs for HEPs associated with operating in different geographic areas of England;
- The benefits derived by HEPs operating in different geographic areas of England. The motivation of the benefit analysis is that although specific providers might have higher costs due to their location, they might derive specific benefits that compensate them for these higher costs;
- The regional drivers of costs and benefits, including the extent to which any such variations differ according to the activities and characteristics of institutions; and
- The approaches taken by other public funders in determining and contributing to any additional costs associated with operating in London and other geographic areas.

Ultimately, the evidence provided could inform HEFCE's or its successor bodies' funding decisions specifically related to the allocation of funds across HEPs, as opposed to the determination of the total amount of funds provided to HEPs.

The evidence was gathered on the basis of qualitative and quantitative analysis:

- Qualitative analysis included both a review of regional adjustments used by other public funders as well as engagement with the sector, in the form of structured interviews and a workshop; and

- Quantitative analysis focused on using data and econometric techniques to estimate the impact of geographical location on costs and benefits for HEPs.

A summary of the findings is provided below.

1.1 Other public funders

Other public funders in England make regional cost adjustments in their allocation formulae, including NHS England (NHSE), the Department for Communities and Local Government (DCLG), the Education Funding Agency (EFA) and the Skills Funding Agency (SFA)[1]. NHSE and DCLG take account of geographical differences in staff and estates costs, whereas the EFA and SFA only consider differences in staff costs. Econometric techniques are typically applied to sector-specific and other economic data to estimate these costs. However, regionally driven benefits, such as greater income generation, are not considered.

1.2 Stakeholder engagement

Engagement with the sector suggested that staff and estates costs are the main costs expected to vary by geographical location. For staff costs, this was largely felt to be driven by a location's relative attractiveness and cost of living. For estates costs, different property prices and rents drive variation.

Stakeholders also indicated that location may play an important role in attracting students, especially international students attending HEIs. Specifically, it was suggested that London has an advantage due to better transport links, job opportunities for graduates and the location's general attractiveness. Stakeholders suggested that higher student enrolment is the main type of benefit associated with location: HEIs that are able to attract more students due to their location generate more income.

1.3 Quantitative analysis

The insights gained from the literature review and stakeholder engagement were used to develop a set of hypotheses around the types of costs and benefits that are expected to vary across geographies (see Section 3.2 for further details). In particular, seven hypotheses were developed around the following three areas:

- **Staff costs.** The underlying hypothesis is that wages are determined by employees' skills and job characteristics, including location;

- **Estates costs.** Estates costs are likely to vary across the country due to differences in property prices, rents and maintenance costs; and

- **Student enrolment (benefits).** Apart from provider reputation and quality, HEPs' geographic location may play an important factor in attracting students.

These hypotheses were tested using quantitative analysis of higher education sector-specific data and other economic data. For the cost analysis, various data sets were used.

[1] The Education Funding Agency and the Skills Funding Agency merged on 1 April 2017 and became a single funding agency, the Education and Skills Funding Agency.

- **Staff costs.** Data included both the average wages from the Annual Survey of Hours and Earnings (ASHE), compiled by the Office for National Statistics (ONS), and average staff costs from the Higher Education Statistics Agency (HESA).

- **Estates costs.** Primarily the rateable value from the Valuation Office Agency (VOA) and maintenance costs from the Building Costs Information Service (BCIS).

- **Student enrolment (benefits).** The student enrolment analysis was more constrained. Sufficient data to carry out the analysis was only available for HEIs. Furthermore, due to the historical student caps on Home and EU undergraduate student enrolment, the analysis focused on international and postgraduate student enrolment and aimed at quantifying the impact of location on HEIs' student numbers. Due to these limitations and lack of precedent in modelling student enrolment in higher education and incorporating benefits associated with income in public allocation formulae, this analysis is experimental.

The data and methodology used were broadly consistent to other public funders. Specifically, econometric analysis was employed to account for other factors beyond location, for instance, staff quality, which might drive variations in cost, and perceived reputation of HEPs, which might lead to differences in student enrolment. Notwithstanding this, it is recognised that fully controlling for these factors is, in practice, imperfect (see Section 3.3).

The results of the quantitative analysis suggested that:

- **Academic staff costs.** Average academic staff costs in HEPs vary significantly across English regions[2], in particular, between Inner London and the rest of the country. Analysis using the HESA data found average staff costs in Inner London for HEIs to be between 12 per cent and 14 per cent[3] higher than the national average. Outer London was found to have average staff costs which are between 6 and 8 per cent higher than the national average. The East of England, South East and South West have average staff costs that are generally close to the national average, whereas the other regions have average staff costs which are generally below the national average[4]. A similar pattern and magnitude of regional variation was found for FECs' and APs' academic staff costs with the main exception of Inner London. Using data from ONS ASHE, it was found that FECs' and APs' academic staff costs are 22 per cent and 28 per cent higher than the national average.

- **Non-academic staff costs.** HEPs' non-academic staff costs were also found to vary significantly across England. Using data from ONS ASHE, it was found that the regional variation of HEPs' non-academic staff costs exhibit a similar pattern as the regional variation in academic staff costs. Inner London was found to have average non-academic staff costs which are between 22 per cent and 28 per cent higher than the national average; Outer London was found to have average staff costs which are between 8 per cent and 10 per cent higher than the national average. The East of England, South East and South West have average staff costs that are

[2] As defined by the Nomenclature of Territorial Units for Statistics 1 (NUTS1) regional classification: North East, North West, Yorkshire and Humber, East Midlands, West Midlands, South West, East of England, South East, Outer London and Inner London (in NUTS1 London is not broken down into Inner and Outer London).
[3] The quantitative analysis utilised different modelling strategies which provided different estimates of the regional variation in staff costs. The ranges of the estimates reported reflect these different modelling strategies.
[4] Their magnitude depends on the precise model used to generate the estimates.

generally close to the national average, whereas the other regions have average staff costs which are generally below the national average.

- **Research vs. teaching staff costs.** No evidence was found of HEIs' research staff wages being more or less sensitive to regional factors than HEIs' teaching staff wages. However, this finding may be due to data limitations.

- **Estates costs.** Land and building costs vary significantly across England. Land and building costs in Inner London are more than three times the national average. Outer London and the South East also have land and building costs that are above the average, around 35 per cent and 9 per cent respectively. Other English regions were found to have costs that are between 7 per cent and 40 per cent lower than the national average. Maintenance costs were found to vary considerably less than land/building costs. Maintenance costs were found to be higher in London, around 17 per cent higher than the national average. The South East has approximately 7 per cent higher costs than the average whereas the other regions have between 2 per cent and 9 per cent lower costs than the average.

- **Student enrolment (benefits).** After controlling for perceived reputation and quality, it was found that the number of international and postgraduate students enrolled varies considerably across the country. Student enrolments for international and postgraduate students were found to be significantly higher than average in Inner London, and considerably lower in the North and Midlands.

The objective of this study is to gather evidence on the variation in relative costs and benefits for HEPs associated with operating in different geographic areas of England. This study is not intended to make recommendations on how the total quantum of HEFCE funding should be determined or allocated across providers, and further analysis may be required to incorporate the evidence presented into a funding formula.

Moreover, the results need to be interpreted carefully given the limitations associated with the underlying data and quantitative analysis. This is particularly the case for the student enrolment analysis, given the challenges with historical student caps and lack of precedence. The costs analyses are based on widely recognised datasets and modelling approaches used by other public funders and as such they are more robust than the student enrolment analysis.

2 Introduction

2.1 Background

The Higher Education Funding Council for England (HEFCE) was established by the Further and Higher Education Act 1992 to provide funding and support for teaching, research and related activities to higher education providers (HEPs). In 2016/17, HEFCE distributed £3.7 billion to 132 higher education institutions (HEIs) and 202 further education and sixth form colleges (FECs); HEFCE is not empowered to fund alternative providers (APs) directly.

HEFCE grants are intended only to make a contribution to the costs of providing teaching and undertaking research. As such, they cover only a proportion of HEPs' costs. Other sources of income include tuition fees and grants from other bodies. Following the increase in tuition fees and reduction in HEFCE's funding, associated with the 2012 higher education funding reforms, the proportion of income for teaching received by HEIs from HEFCE has dropped from an average of 66 per cent in 2011/12 to 17 per cent in 2015/16[5,6].

2.1.1 Allocation formula

The majority of HEFCE's funding is allocated as recurrent grants for teaching (37 per cent) and research (43 per cent) and is allocated on the basis of a formula that takes into account, among other things, the number of students and the quality of research[7].

- **Teaching funding**. The recurrent teaching funding is a function of the number of students within a subject area[8] and other factors related to the type of students (e.g. part-time students, students from disadvantaged backgrounds) and service provision (e.g. very high cost Science, Technology, Engineering and Mathematics (STEM) subjects, accelerated full-time undergraduate provision). Funding is generally prioritised towards areas where tuition fees on their own may be insufficient to meet institutions' full costs, which is primarily the case for high-cost subjects.

- **Research funding**. The main determinant of recurrent research funding is the research output based on the volume of research, relative costs of the subject area, and quality of research as measured by the Research Excellence Framework (REF). Additional grants are allocated on the basis of the number of postgraduate research students, the proportion of eligible research income from charities, and the proportion of income from industry and corporations.

[5] Student Funding Panel, 2015, 'An analysis of the design, impact and options for reform of the student fees and loans system in England', available at http://www.universitiesuk.ac.uk/policy-and-analysis/reports/Documents/2015/student-funding-panel.pdf

[6] More recently, a higher proportion of public funding is being channelled through the Student Loans Company (SLC).

[7] Other elements include knowledge exchange (4 per cent), funding for national initiatives (3 per cent) and capital grants (13 per cent). Further details can be found in HEFCE, 2016, 'Guide to funding 2016-2017', available at: http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/2016/201607/HEFCE2016_07.pdf

[8] Subject areas are classified in five price groups (A: medicine, dentistry and veterinary science, which are the most costly to provide; B: laboratory-based science, engineering and technology subjects; C1 and C2: intermediate-cost subjects such as archaeology, design and creative arts, information technology, geography, and mathematics; D: classroom-based subjects such as humanities, business or social sciences, which are the least costly to provide).

A regional cost adjustment in the form of London weightings is also applied within both the teaching and research formulae to take account of the additional costs of operating in London.

Currently, a weighting of 12 per cent and 8 per cent is applied for Inner London and Outer London respectively in both the student premium elements of the teaching grant and in the main research allocation, and those relating to research students and charities. In addition, HEFCE provides a separate targeted allocation within the teaching grant to support the additional costs faced by providers that have students attending courses in London, with rates of grant varying by subject.

2.2 Objective of the study

In HEFCE's 2016 grant letter, the Council was asked by the Government to review its approach to allocating teaching funding. HEFCE recently completed a review of funding for access and student success, including progression to taught postgraduate study[9]. Whilst the approach to account for the additional costs of operating in London has evolved since it was first established, the evidence underpinning it has not been updated.

In this context, HEFCE commissioned Deloitte to undertake a study to gather evidence on the variation in relative costs and benefits for HEPs due to operating in different geographical areas of England, and how these might vary according to different institutional activities, such as teaching and research.

This report sets out the methodology used to estimate the regional variation in costs and benefits and summarises the output of the analysis, which involves:

- **Literature review**. A review of the allocation formulae used by other public funders in England, focusing on the regional adjustment aspect of the formulae;
- **Stakeholder engagement**. A summary of insights gained from interviews and a workshop with a sample of representatives from HEIs, FECs and APs as well as sector bodies undertaken as part of this study;
- **Hypothesis development**. Development of a set of testable hypotheses considering the outcomes of the qualitative analysis; and
- **Quantitative analysis**. Testing of the hypotheses using multiple models and various data sources, both higher education-specific and other economic (non-sector specific) data.

The analysis presented in this report, especially the quantitative analysis, are technical in nature. Notwithstanding this, the report has been drafted primarily for a non-technical audience. Technical details of the analysis are provided in the Technical Appendix for readers with at least some background in statistics and econometrics.

[9] Higher Education Funding Council for England, 2016, 'Funding to support teaching in higher education', available at http://www.hefce.ac.uk/pubs/year/2016/201639.

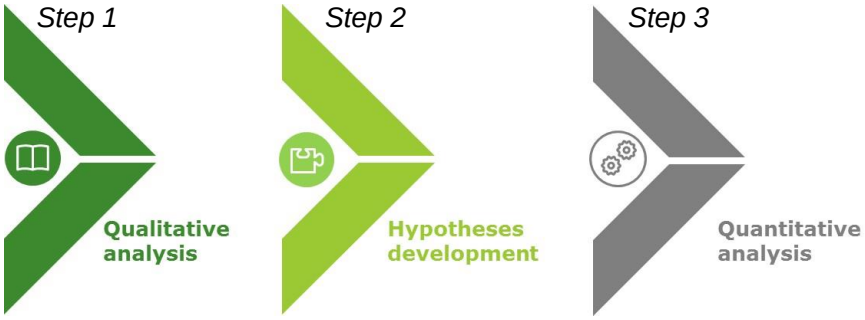
3 Methodology

At a high level, the methodology consisted of a three-step process:

- The first step involved undertaking a review of the related literature and engaging with the sector;
- The second step used the outcome of the literature review and stakeholder engagement to generate a number of hypotheses about how costs and benefits for HEPs may be influenced by regional factors; and
- The third and final step then utilised higher education-specific data, as well as the other economic data sources to test the hypotheses that have been developed and estimate the scale of the regional impacts on costs and benefits.

Figure 1 below illustrates this over-arching methodology.

Figure 1: Over-arching methodology



3.1 Step 1: Qualitative analysis

The qualitative analysis was composed of a literature review and stakeholder engagement.

3.1.1 Literature review

The aim of the literature review was to understand the scope of the regional variation considered by other public funders in their funding allocation formulae together with their methodologies for quantifying geographical variation.

The literature review focused on the following public funders:

- National Health Service England (NHSE);
- Department for Communities and Local Government (DCLG);
- Education Funding Agency (EFA); and
- Skills Funding Agency (SFA)[10].

[10] The EFA and SFA were separate entities at the time of undertaking this study but have since been merged to form the Education and Skills Funding Agency (ESFA) in April 2017. The newly formed agency sits within the Department for Education.

These public funders were chosen based on the following considerations[11]:

- **Budget size**. All these public funders have a large budget, ranging from c. £3 billion (SFA) to £100+ billion (NHSE). Given the quantum of the budget, these public funders apply relatively sophisticated methodologies to estimate the regional variation in costs. These methodologies were useful in the development of the quantitative methodology used in this study.

- **Service relevance.** Reviewing the methodology of the EFA and SFA helped to clarify the factors that are relevant in the education sector.

- **Geographical and service coverage.** The services funded by the public funders reviewed are provided across the whole country and cover a broad range of areas (health care, education, police, highway maintenance, and environment), which provided broad context and insights[12].

3.1.2 Stakeholder engagement

The objective of the stakeholder engagement was to collect the sector's views around the types of costs and benefits that are likely to vary by location. The engagement also provided some insights around the methodology used to quantify the regional variation in costs and benefits together with possible limitations of the approach.

The stakeholder engagement was carried out by way of one-on-one interviews with provider representatives, typically from finance, human resources, strategy and planning departments, and sector representative bodies. Thirty-five individuals from 28 institutions participated in the interviews at the beginning of the project[13]. The interviews were open, but guided by a set of themes around possible differences in costs and benefits of providing higher education services across the country[14].

In addition to the interviews, a workshop with 20 individuals from HEPs and representative bodies was also carried out at a later stage of the project to test the quantitative methodology and draft results with the sector.

The stakeholders invited in the interviews and workshop were selected so that there was a good representation of different provider types (HEIs, FECs, APs, specialists/generalists), geographies (e.g. providers located in London, South, North, urban, rural and remote areas) and institution size.

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[11] It is recognised that these sectors are different from the higher education sector in that the majority of their beneficiaries' income is coming from public sources.

[12] Particular similarity between the higher education sector and the health sector has been noted by the Association of University Directors of Estates (Association of University Directors of Estates, 2014, 'Higher Education estates statistics report 2014', available at http://www.sustainabilityexchange.ac.uk/files/2aude-he-estates-statistics-report-2014-vfinal.pdf) whereby in many towns and cities a hospital or university are the major employers. In addition the size of the HEI estate is very similar to the NHS estate, and relatively evenly distributed across the country (while other government institutions are found to be more London-centric).

[13] Seventeen with HEIs, four with FECs, four with APs, and three with representative bodies. Some interviews involved more than one interviewee from the same institution.

[14] A few examples of the questions asked in the interviews are: Do you think that the costs of providing higher education services varies across the country?; What are the main types of costs that vary across the country?; What do you think attracts staff to your institution?; Could you comment on how the region in which you are located affects the recruitment and retention of your staff?; What do you think are the main factors that attract students to your university?; Do you think that the region is an important factor in determining students' choice?

3.2 Step 2: Hypotheses development

This step consisted of synthesising the qualitative outputs from the literature review and stakeholder engagement to develop a set of hypotheses that were subsequently tested using quantitative analysis. Seven key hypotheses were developed, which focused on these three areas:

- Staff costs;
- Estates costs; and
- Benefits.

3.2.1 Staff costs

All public funders reviewed make an adjustment in their allocation formulae for differences in average staff costs across England (see Section 4.1 for further details). The underlying hypothesis is that wages are determined by a range of factors including age, gender, occupation and location. These public funders as well as this study aimed to isolate location as a determining factor and measure its relative impact. Employers located in relatively unattractive areas or where the cost of living is high may need to offer higher-than-average wages to attract staff.

It was recognised that wages in higher education are subject to pay scales, which could imply that location has little to no impact on wages. However, the scales are quite wide and employers could up-scale employees if they need to attract or retain staff. The impact of pay scales on staff costs was an area discussed with stakeholders who suggested that location could have an impact on wages despite the pay scales (see Section 4.2 for further details on the insights gained from the stakeholder engagement).

The geographical variation in staff costs may differ between academic and non-academic staff, as well as research and teaching academic staff, as these types of staff have different skills and might be subject to different factors that affect wages. For instance, as suggested in the stakeholder engagement, there may be a greater number of international academic staff for London institutions, which could hold wages down. This could imply that the impact of location on staff costs is different for academic and non-academic staff, especially for providers located in London. Furthermore, academic staff might live further afield as generally they have greater freedom and often attend their main location of work fewer than five days a week, potentially making academic staff wages less sensitive to providers' locations.

3.2.2 Estates costs

Two of the four public funders reviewed make an adjustment in their allocation formulae for differences in estates costs across the country. Estates costs are likely to vary across the country due to differences in property prices, rents and maintenance costs. With regards to the latter, differences in staff costs and level of regional competition between vendors could lead to different maintenance costs across the country. Discussions with stakeholders suggest that the main differences in estates costs are expected to be between London and the rest of the country.

3.2.3 Benefits

The public funders reviewed do not take into consideration potential benefits such as income that may arise from operating in certain locations. However, the stakeholders engaged as part of this study suggested that there are significant benefits associated with location and attracting students, especially between London and the rest of the country. In particular, it was suggested that providers in London and other big cities might find it easier to attract students due to better transport links and job opportunities for graduates.

3.2.4 Summary

A summary of the key hypotheses investigated is provided in Table 1.

Table 1: Hypotheses

#	Area	Hypothesis
1	Staff costs	Academic staff pay rates vary across the country or by institution
2		Non-academic staff pay rates vary across the country or by institution
3		Regional wage variation is different between academic and non-academic staff
4		Regional wage variation is different between teaching-oriented and research-oriented academic staff (HEIs only)
5	Estates costs	Building and land costs vary across the country or by institution
6		Maintenance costs vary across the country or by institution
7	Benefits	Tuition income varies across the country or by institution (HEIs only)

3.3 Step 3: Quantitative analysis

This step involved testing the hypotheses developed as well as estimating the scale of the regional variation of costs and benefits. A summary of the data and methodology used, by area of analysis and provider type, is set out in Table 2. The different approaches were tailored to the hypotheses examined, and are discussed in detail in the remainder of this section.

Table 2: Summary of quantitative methodology

Area		Provider type	Data Source	Regression analysis?
Staff costs	Academic	HEI	HESA	✓
		FECs and APs	ONS ASHE	✓
	Non- academic	HEIs, FECs and APs	ONS ASHE	✓
Estates costs	Maintenance costs	HEIs, FECs and APs	BCIS	✗
	Building costs and land value	HEIs, FECs and APs	VOA	✗
Benefits	Student enrolment	HEIs	HESA	✓

Notes: HESA: Higher Education Statistics Agency; ONS ASHE: Annual Survey of Hours and Earnings from the Office for National Statistics; BCIS: Building Costs Information Service (life-cycle costs); VOA: Valuation Offices Agency (rateable value).

3.3.1 Staff costs

3.3.1.1 Data

The largest dataset used in the staff cost analysis was the Annual Survey of Hours and Earnings (ASHE) dataset. The ASHE dataset is a sample survey of employee jobs.[15] It covers all employee jobs in all industries and occupations across the UK and provides a rich source of data containing weekly earnings by employee, and employee features such as age, gender, place of residence and work, tenure at the current job, industry, occupation, and type of contract.

The advantage of ASHE is that it provides the most comprehensive dataset for wage analysis in England. It contains wage data for a large number of individuals across England together with individual- and job-specific characteristics. Furthermore, ASHE provides information that allows categorising employees by occupation and constructing occupation groups that are comparable to HEPs' academic and non-academic staff. Given that the regional variation in wages may be different between occupation groups (this point was also raised by stakeholders in the stakeholder engagement workshop) the analysis was conducted by different comparator occupation groups.

For non-academic staff, the comparator group was defined by the following occupations across all industries except finance[16]: administrative and secretarial occupation (classified as category SOC[17] Major Group 4), IT staff and lab technicians (SOC Subgroup 31), hall/facilities managers, and counsellors (SOC Units 2317 and 3235). These occupation groups do not cover senior management roles, e.g. chief executives, finance and human resources directors, and therefore they are not fully comparable to all non-academic staff. Notwithstanding this, the results do not seem sensitive to the choice of the comparator group (see Section 6.2).

Discussions with providers and sector representatives (as part of the stakeholder engagement) suggested that academic staff in FECs and APs are comparable to private sector professionals. On the basis of this, the following two occupations were used as occupation comparators for FECs' and APs' academic staff: managers, directors and senior officials (SOC Major Group 1) and professional occupations (SOC Major Group 2)[18].

For HEIs, stakeholders suggested that there is not a suitable occupation comparator for HEIs' academic staff. Therefore, provider-specific data from the Higher Education Statistics Agency (HESA) were used for the HEIs' academic staff cost analysis. HESA collects, analyses and undertakes quality-checks on data provided by HEIs and APs which have a statutory requirement to report data to higher education funding bodies. This includes data covering students, staff, graduates, provider finances and estates, and academic departments and courses[19].

The advantage of the HESA data is that it does not require any assumptions to be made around a comparator occupation. On the other hand, the sample size is smaller, meaning that it is more challenging to separate the impact of location from other factors (see Section 5). Furthermore, the HESA cost data is generated by HEIs using a cost allocation methodology based on HESA's guidelines; however, the guidelines may not be interpreted in the same way by all HEIs. Due to these limitations, the results generated using the HESA data have been compared against the results based on the ASHE data (see Section 6.3).

[15] The survey is based on a 1 per cent random sample of jobs on the HM Revenue and Customs' Pay As You Earn (HMRC PAYE) register.
[16] The finance industry was excluded due to its idiosyncratic nature.
[17] Sector Occupation Classification.
[18] As in the case of non-academic staff, data across all industries, except finance, was used.
[19] HESA has been collecting data since 1994/95.

A summary of the data used in the quantitative analysis is provided in the Technical Appendix A1.

3.3.1.2 Regression analysis

One approach to determining the regional variation in staff costs would be to compute the average wage by region (using the HESA or ASHE data). However, this would be problematic as average wages between geographies are likely to vary due to a number of factors unrelated to location, e.g. experience, skills, industry and occupation composition of the region. If these factors are not controlled for, then the regional estimates would not represent the actual impact of location.

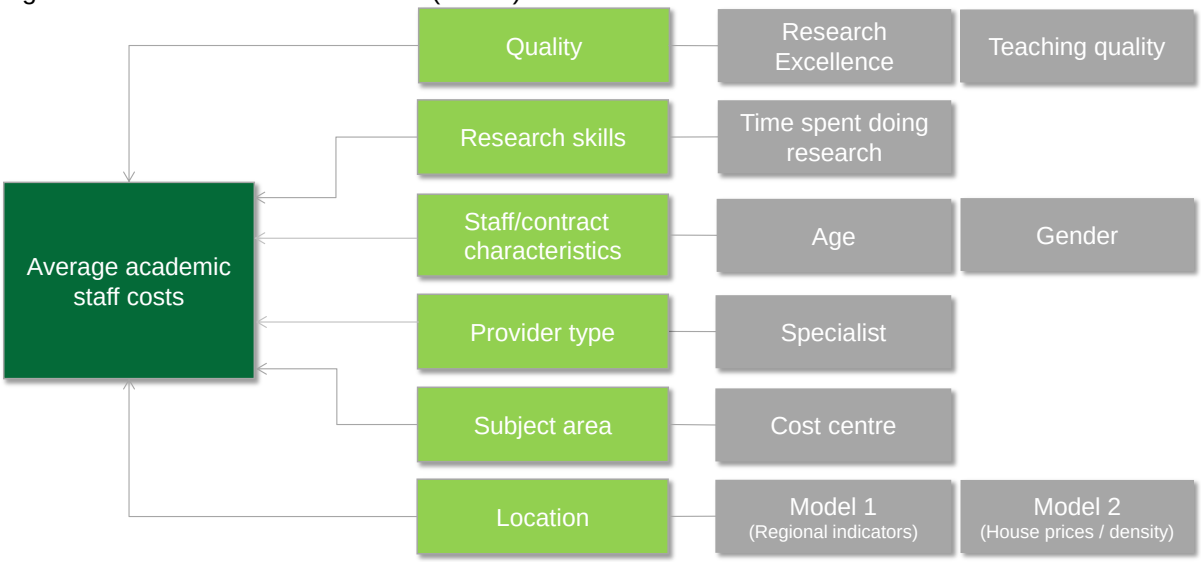
In this study, the impact of geographical location on staff costs was estimated using multivariate regression models. These models were designed to take out the impact of factors that are unrelated to geographical location (e.g. experience and skills) and measured the regional variation in staff costs on a more comparable basis.

Two separate sets of regression models were estimated; one set of models using the ASHE dataset and another set of models based on the HESA data. The regression models are summarised in the remainder of this section. A detailed exposition of the regression methodology is provided in the Technical Appendix A2.

HESA regression analysis

The regression model used to estimate the regional variation in HEIs' academic staff costs is set out in Figure 2. (Versions of this model were estimated with different combinations of variables.)

Figure 2: Academic staff cost model (HESA)



The key factors the HEIs' academic staff costs model took into account were:

- **Quality.** Average staff costs by provider may vary due to differences in the quality of the academic staff. Two types of measures were included in the model to control for staff quality: the percentage of 'world leading' research activity from the 2014 REF[20] which is an indicator of average research quality, and teaching quality measures. The

[20] The REF is the system for assessing the quality of research in UK HEIs. The data used for the model was from the latest exercise which took place in 2014. The variable chosen was the percentage of four star output, defined as: 'world-leading in terms of originality, significance and rigour'. The output percentage is unweighted (the data could be weighted by the staff FTE).

main teaching quality indicator used is the National Student Survey (NSS)[21] learning and teaching z-score, however, the sensitivity of the results was examined across other indicators including the NSS assessment and feedback (z-score), NSS academic support (z-score) and non-continuation (z-score) and employment and further study (z-score)[22,23]. It is recognised that teaching quality is complex to measure. These indicators are being used in combination as a proxy for teaching quality for the purpose of this analysis.

- **Research skills.** This variable was included to entertain the possibility that greater research skills and research capacity of the academic staff are connected to a higher average salary[24]. In order to control for this, the percentage of time spent on research, obtained from Transparent Approach to Costing (TRAC) data, was included in the model as a measure of staff research skills and capacity[25].

- **Staff/contract characteristics.** An indicator that captures the average age of academic staff was included to control for the impact of experience and skills on average staff costs, assuming that these are generally correlated with age. The percentage of professors, which was included in some of the models estimated as part of the sensitivity analysis, also aims to capture the impact of experience and seniority on wages. Given the gender pay gap reported in various studies, the percentage of female staff was also included.

- **Provider type.** An indicator reflecting whether a provider is a specialist institution was included in the model to control for possible differences in average academic staff costs between specialist and non-specialist HEIs[26].

- **Subject area.** Average salaries are likely to vary across subject areas, such as medical, economics and engineering studies. In order to control for this, cost centre indicators were included in the model. The cost centres were taken from HESA which classifies staff costs and FTEs into 45 academic cost centres, each of them corresponding to a different academic subject area.

- **Location.** Once the above factors are controlled for, two models were used to measure the location impact:

    - Model 1 utilised regional indicators based on the following regional classification: North East, North West, Yorkshire and Humber, East Midlands,

[21] The NSS gathers students' opinions on the quality of their courses. It has been capturing final-year undergraduate students' feedback on their course experience since 2005. Every university in the UK takes part, as do many colleges and APs. Further information is available from www.hefce.ac.uk/lt/nss/.

[22] The non-continuation indicator was provided by HEFCE derived from analysis of the HESA (HEIs) and Individualised Learner Record (ILR) data (FECs).

[23] Another teaching quality indicator used in the sensitivity analysis was the employment and further study indicator from the Destinations of Leavers in Higher Education (DLHE) survey. This indicator expresses the number of UK domiciled graduates who say they are working or studying (or both) approximately six months after completing their qualification as a percentage of all those who are working or studying or seeking work.

[24] Research skills and capacity are used to describe employees' ability to generate research output.

[25] In particular, this data has been taken from TRAC, Section F2b, unweighted for salaries. TRAC is an activity-based costing system that allocates the income and expenditure of a university between teaching, research and other activities. The data on time spent on different activities is collected by means of a Time Allocation Survey (TAS). This survey collects data from all staff (except ancillary staff) based on a sample of three weeks in a 12-month period.

[26] Specialist is defined according to the TRAC peer group classification as 'specialist music/arts teaching institutions' (Peer Group F).

West Midlands, South West, East of England, South East, Outer London and Inner London[27].

- Model 2 used house prices and population density, obtained from the Office for National Statistics (ONS), to identify the regional differences. The motivation is that house prices and population density are correlated with the cost of living, location attractiveness, and access to transport links, that is, the underlying factors that make one location more or less appealing than another location.

Results from both models are reported. The advantages and disadvantages of these models are discussed in Technical Appendix A2.1.

Finally, the models were estimated at the cost centre level using data from 2012/13 to 2014/15.

Research and teaching staff costs

A modified version of Model 2 was estimated to test the hypothesis that the regional variation in staff costs is different between research and teaching academic staff in HEIs. The approach used to investigate this hypothesis is described in Technical Appendix A2.2.

ASHE regression analysis

A similar regression approach was applied to the ASHE data to quantify the regional differences in average wages. In particular, a number of controls such as age, gender, occupation, industry, organisation size, and contract type were included in the model to control for differences in individual and job characteristics. The impact of location was measured at a regional as well as local authority level. Further details on the factors included in the ASHE model are provided in the Technical Appendix A2.3.

The model is very similar to the model estimated by NHSE and DCLG in relation to their allocation formulae[28], and ONS[29] and was estimated using three years' worth of data (2013 to 2015) and three alternative occupation groups: (1) all occupations; (2) academic staff comparator occupations[30]; and (3) non-academic staff comparator occupations[31,32].

3.3.2 Estates costs

Two types of estates costs were considered:

- **Land and building costs.** The regional differences in land and building costs were estimated using data on rateable values provided by the Valuations Office Agency

[27] This model involved mapping each provider onto one of 10 regions. In turn, each region was codified into an indicator variable to facilitate estimation of the location impact. For instance, the South East indicator variable takes the value of 1 if the provider is located in South East, and 0 if the provider is located in another area. Ten indicator variables were constructed, one for each region.
[28] National Health Service England, 2014, 'Guide to the Market Forces Factor', available at: https://www.gov.uk/government/publications/guide-to-the-market-forces-factor-201415
[29] Office for National Statistics, 2016,'Analysis of factors affecting earnings using the Annual Survey of Hours and Earnings: 2016, available at: https://www.ons.gov.uk/releases/analysisoffactorsaffectingearningsusingannualsurveyofhoursandearnings2016
[30] Managers, directors and senior officials (SOC Major Group 1) and professional occupations (SOC Major Group 2).
[31] Administrative and secretarial occupations (SOC Major Group 4), IT staff and lab technicians (SOC Subgroup 31), hall/facilities managers, and counsellors (SOC Units 2317 and 3235).
[32] The number of observations used were: 419,468 in 'all occupations' analysis; 104,130 in 'academic staff comparator occupations' analysis and 67,289 in 'non-academic staff comparator occupations' analysis.

(VOA). The data represent the average rateable value per square metre across 10 regions. The underlying assumption is that differences in the average rateable value across regions reflect geographical differences in rents and property prices reasonably well[33]. It is recognised that land and building costs may vary across providers due to other reasons such as whether the property is rented, purchased with retained earnings, a mortgage or has been repaid (this was a point raised by the stakeholders in the stakeholder engagement workshop). However, these factors are out of the scope of this study which focuses solely on the average regional differences in costs. Also, it is recognised that providers' actual estates cost may be different from the average estates cost within a region. However, the purpose of the analysis is to estimate relative average regional costs, not provider-specific costs[34].

- **Maintenance costs**. The regional differences in maintenance costs were estimated using data from the Building Costs Information Service (BCIS) of the Royal Institute of Chartered Surveyors (RICS)[35].

Apart from these sources, estates costs data from the HESA Estates Management Record (EMR) were also considered in the analysis although they were subject to two main limitations:

- The EMR provides data only for HEIs' estates costs; an alternative measure for FECs and APs would still be required; and

- They reflect actual costs, and therefore, providers' circumstances or management decisions (e.g. whether the estates are being rented or have been purchased, financed with a mortgage or retained profit) rather that the average regional costs, which was the focus of the analysis.

Due to these limitations, the EMR data was only used to cross-check the results from the analysis using the VOA and BCIS data.

3.3.3 Benefits

This section describes the methodology used to estimate the regional variation in student enrolment, which is one of the factors that drive differences in tuition income. The other factor is tuition fees which may also vary across regions. The focus of the analysis is on student enrolment and not explicitly on tuition income for two reasons:

- Sufficient data on tuition income or fees is not available (e.g. at cost centre level) although it is recognised that data could be constructed by linking the HESA data with data available from the SLC; and

[33] This is the same approach adopted by the DCLG for its regional cost adjustment in its funding allocation formula.

[34] An alternative variable considered to measure the regional variation in land/building costs was the residential property prices. However, this variable was eventually disregarded as the regional variation in residential property prices may be different from the regional variation in commercial property prices (HEPs' estates cost are, in theory, better measured by commercial estates costs rather than residential estates costs).

[35] This approach was also used by NHSE to compute the regional variation in building costs for its regional cost adjustment in the funding allocation formula.

- It is expected that the main driver of tuition income differentials across regions is variation in student numbers rather than variation in tuition fees[36,37].

3.3.3.1 Data

Due to data availability issues, the analysis was carried out only for the HEIs. The student enrolment data was taken from HESA which provides student enrolment by cost centre and provider. The data is also split by student type on the basis of residential status (Home, EU, and International) and degree level (undergraduate and postgraduate).

The analysis focused on international (undergraduate and postgraduate) students and postgraduate (Home, EU and International) students due to the historical student caps applied to Home and EU students: student number caps have historically constrained providers' ability to recruit Home and EU undergraduate students. As such, the observed student enrolment numbers may reflect the historical caps rather than the actual student demand (or the impact of location).

3.3.3.2 Regression analysis

Similar to the staff cost analysis, the regional variation in student enrolment was quantified using regression models. The motivation for this was that student enrolment may vary across England due to factors other than the geographical location, such as provider perceived quality and reputation, and if these factors are not controlled for then the regional estimates may be considerably inaccurate.

The main controls used in the student enrolment model are associated with perceived quality of the provider, reputation and type:

- **Perceived quality.** Two types of indicator have been included in the model to control for perceived quality: the percentage of four-star research output (REF) and teaching quality measured by the NSS learning and teaching z-score, albeit the sensitivity of the results was tested using alternative measures of teaching quality (NSS assessment and feedback (z-score), NSS academic support (z-score), non-Continuation (z-score) and the employment and further study indicator (z-score)).

- **Perceived reputation.** Perceived reputation, i.e. students' perception about the quality and reputation of HEPs, is challenging to measure. It was assumed that specific groups of providers, in particular Russell Group and Oxbridge HEIs, have higher reputations than other providers. The choice of these groups was based on research quality considerations (e.g. in the 2014 REF, 68% of world-leading

[36] Tuition fees for undergraduate Home and EU students are quite similar across providers: the vast majority of providers (96%) charge the maximum allowed fees, as found after a review of data from 'The Complete University Guide' (Source: https://www.thecompleteuniversityguide.co.uk/university-tuition-fees/reddin-survey-of-university-tuition-fees/foundation-undergraduate-tuition-fees-2016–17,-ukeu/#england). In contrast, the same data showed that on average, for a sample of 114 universities, the fees charged overseas students were approximately £13,000 for year 2016/17. Tuition fees for international students and postgraduate students are unregulated and can vary. For instance, fees for postgraduate degrees range between £4,900 and £30,000 a year (source: UCAS website).

[37] The impact of location on fees could be either positive or negative; students may be willing to pay higher fees, for instance, for providers located in London, if they consider London more attractive than other locations. Conversely, students are likely to make choices not on the basis of tuition fees alone but rather on the total costs of the degree which is a function of both tuition fees and cost of living. From that point of view, providers in London or other high-cost regions may have to charge lower fees to remain competitive compared to other providers. Notwithstanding this, students in London can access higher maintenance support (now loans, previously also grants), with full pay-back of student loans depending on future earnings over the next 30 years. As a result, tuition fees and cost of education may not play a significant factor in student choice.

research and 68% of research with an outstanding impact was carried out in Russell Group universities[38]) and their history (Oxbridge universities are two of the oldest universities in England). It is recognised that this is an imperfect approach and that there are other HEIs with similar or better perceived reputations compared to Russell Group and/or Oxbridge providers[39]. However, it should be recognised that perceived reputation is a measure that was only used in the benefits analysis.

- **Provider type.** Two provider type indicators capturing specialist and research-intensive providers were included in the model to entertain the possibility that the student enrolment varies between specialist, research-intensive and other HEIs[40,41].

A technical description of the model and estimation approach is provided in the Technical Appendix A2.4.

[38] See http://russellgroup.ac.uk/news/research-excellence-framework/.
[39] Also, within the Russell Group, there are considerable differences between providers in terms of student composition, admission criteria, research intensity and fees.
[40] Specialist is defined as per the TRAC Peer Group F: Specialist music/arts teaching institutions.
[41] The research intensity of an HEI is measured by the percentage of time allocated in research, obtained from the TRAC.

4 Qualitative analysis

This section sets out the key insights from the qualitative analysis, comprising the literature review and stakeholder engagement.

4.1 Literature review[42]

As discussed in Section 3.1.1, the literature review focused on four major public funders: NHSE[43], DCLG, EFA and SFA. The key lessons from this review are summarised in Table 3 and discussed below.

- **Types of costs.** All the public funders reviewed make an adjustment for differences in staff costs across regions whereas NHSE and DCLG also incorporate a regional adjustment for differences in building and land costs. NHSE and EFA make further adjustments for remoteness and sparsity, respectively, motivated by the premise that provision of services in remote or sparsely populated areas is more costly due to providers operating at small scale[44].

- **Data.** The approach used by these public funders to estimate the geographical variation in costs is based on a mixture of sector-specific and general economic data. NHSE and DCLG use data from the ASHE for staff costs. EFA also uses the ASHE data for non-teaching staff costs and sector-specific data for teaching staff costs. SFA uses sector-specific data for teaching staff costs. For estates, the main source of information used by NHSE and DCLG is BCIS (building costs) and VOA (rateable value).

- **Methodology.** The methodologies used by the public funders reviewed to estimate the regional differences in staff costs are primarily based on regression analysis whereby the impact of factors such as skills, experience and occupation are controlled for. For land and building costs, an average cost value is computed by region. NHSE also applies a glide path and interpolation techniques to account for funding volatility and cliff-edges (see Technical Appendix A6 for further details).

[42] This section primarily draws from the following sources: Department for Education, 2016, 'School revenue funding: current funding arrangements' available at: https://consult.education.gov.uk/funding-policy-unit/schools-national-funding-formula/supporting_documents/Current_funding_system.pdf; Skills Funding Agency, 2016, 'Funding Rates and Formula 2016 to 2017, available at: https://www.gov.uk/government/publications/sfa-funding-rates-and-formula-2016-to-2017; National Health Service England, 2014, 'Guide to the Market Forces Factor', available at: https://www.gov.uk/government/publications/guide-to-the-market-forces-factor-201415; Department for Communities and Local Government, 2014, 'Methodology Guide for the Area Cost Adjustment 2013/14', available at: http://webarchive.nationalarchives.gov.uk/20140505104649/http:/www.local.communities.gov.uk/finance/1314/methacas.pdf.

[43] The NHSE formula reviewed is related to health services rather than education of health service professionals.

[44] In addition to these major public funding bodies the practices of some smaller funding bodies were also considered. The funding practices of Health Education England, the National College of Training and Leadership, and General Student Finance were reviewed and it was found that all apply a regional adjustment, primarily for London. Health Education England allows for a 5 per cent uplift for Outer London and 8 per cent for Inner London; the National College of Training and Leadership uplifts range between 20-27 per cent for Inner London and 5-7 per cent for the Fringe area; General Student Finance provides a 30.5 per cent allowance for students in London.

Table 3: Literature review summary

Funder	Services	Types of costs				Data	Methodology	Adjustment[1]
		Staff	*Land*	*Building*	*Other*			
NHSE	Health care	✓	✓	✓	Remoteness	• **Staff costs:** ASHE • **Building and maintenance costs:** BCIS • **Land costs:** provider-specific data	Regression analysis for staff costs; 'average' index for estates costs	• **Non-medical staff index:** Ranges from 0.87 to 1.23. • **Medical and Doctors London staff weighting**: 1.02. • **Building costs index**: Ranges from 0.89 to 1.28. • **Land costs index**: Ranges from 0.016 to 19.5.
DCLG	Seven service blocks including: Children's services, Police, and Fire and Rescue	✓	✓	✓	✗	• **Staff costs:** ASHE • **Land and Building costs:** Rateable value from VOA	Regression analysis for staff costs; 'average' index for estates costs	• **Staff costs index:** Ranges from 1.0 to 1.57. • **Land and building costs index:** Ranges from 1.0 to 1.48.
SFA	Education (colleges, private training organisations, and apprenticeships)	✓	✗	✗	✗	• **Staff costs:** sector-specific data (individualised Record data (from the former Learning and Skills Council)	Regression analysis	• Staff cost index ranges from 1.0 to 1.20.
EFA	Education (primary and secondary)	✓	✗	✗	Sparsity	• **Staff costs:** ASHE for non-teaching staff and sector-specific (school workforce census) for teaching staff	Regression analysis for non-teaching staff; 'average' index for teaching	• Staff cost index ranges from 1.0 to 1.19.

Notes: [1]The regional cost adjustment used by other public funders is typically expressed as an index. An index value of 1 means that a location has average costs that are equal to the national average; an index value of 0.80 means that a location has costs that are 20 per cent lower than the national average; an index value of 1.20 means that a location has average costs that are 20 per cent higher than the national average. *Source*: Department for Education, 2016, 'School revenue funding: current funding arrangements', available at: https://consult.education.gov.uk/funding-policy-unit/schools-national-funding-formula/supporting_documents/Current_funding_system.pdf; Skills Funding Agency, 2016, 'Funding Rates and Formula 2016 to 2017', available at: https://www.gov.uk/government/publications/sfa-funding-rates-and-formula-2016-to-2017; National Health Service England, 2014, 'Guide to the Market Forces Factor', available at: https://www.gov.uk/government/publications/guide-to-the-market-forces-factor-201415; Department for Communities and Local Government, 2014, 'Methodology Guide for the Area Cost Adjustment 2013/14', available at: http://webarchive.nationalarchives.gov.uk/20140505104649/http:/www.local.communities.gov.uk/finance/1314/methacas.pdf.

- **Adjustment.** The geographical differences in costs estimated by the public funders reviewed are quite significant. For staff costs, the range (maximum-minimum) across areas/providers is up to 57 per cent for DCLG, 40 per cent for NHSE and 20 per cent for EFA and SFA. The difference in these estimates could be explained by differences in methodology and geographical unit of analysis, i.e. local authority or more aggregate regional classification.

4.2 Stakeholder engagement

The primary objective of the stakeholder engagement was to gather the sector's views around the types of costs that may vary across regions, and potential challenges or benefits associated with operating in different parts of the country. It is recognised that provider representatives may have found it difficult to assess the degree to which costs or benefits vary across regions, especially if their work experience has been with a single provider or region.

The exercise revealed a number of themes that were commonly expressed across stakeholders from different organisations and different organisation types. A summary of these common themes is provided below whereas the key insights gained from each type of HEP are summarised in Table 4.

- The majority of the providers and sector bodies interviewed suggested that there are regional differences in the costs and benefits of higher education provision across England, in particular between London and the rest of the country.

- The main types of costs that are expected to vary geographically are staff and estates costs. Stakeholders also highlighted that staff costs are the largest component of total costs and that wages are expected to vary geographically due to differences in location attractiveness and cost of living. In terms of estates costs, stakeholders appreciated that land costs vary across the country.

- Any potential benefits associated with location are expected to be with regard to student enrolment. Stakeholders agreed that while reputation is the biggest factor for attracting students, being located in London or other large cities gives an advantage in attracting international students.

Table 4: Stakeholder engagement summary

Provider type	Insights
HEIs	**Provider type**. A large number of respondents suggested that academic staff and particularly research staff are highly mobile and attracted to research quality standards.
	Location. Provider quality or reputation is more important than location in attracting academic staff and determining wages; two of the specialist institutions interviewed indicated that they generally find it easy to recruit staff.
	Academic vs non-academic staff. The regional differences in wages are expected to be higher for non-academic staff than for academic staff.
	Remoteness. Providers in relatively remote areas tend to find it challenging to attract staff, especially non-academic staff. However, most providers are of the view that once they manage to attract staff, they find it easier to retain them.

Provider type	Insights
	Student enrolment. Reputation and quality of the university is the main factor that attracts students. Good transport links to the nearest city centre and cost of living also play a role in student choice, especially when the student catchment population is largely local.
	Specialist institutions. For specialist institutions, location matters less, due to a lower number of available options.
	International students. The market for international students is quite competitive and location plays a more important role in student choice; London is more appealing to international students than other locations.
FECs	**Staff type**. FEC academic staff are comparable to staff in the private professional services sector rather than academic staff in HEIs.
	Student enrolment. The student population tends to come from the local area so the benefits associated with location attractiveness and recruitment from outside the local area tend to be low.
APs	**Location**. Most APs tend to be located in London due to more potential opportunities for staff and student recruitment.
	Student catchment. APs located outside London tend to attract students from their local catchment whereas London APs tend to attract a non-negligible share of international students.

As discussed in the methodology section, these insights together with the findings of the literature review were used to develop hypotheses around the regional variation in costs and benefits.

5 Quantitative analysis: Descriptive analysis

This section provides descriptive analysis and summary statistics for the key variables used in the analysis and sets out:

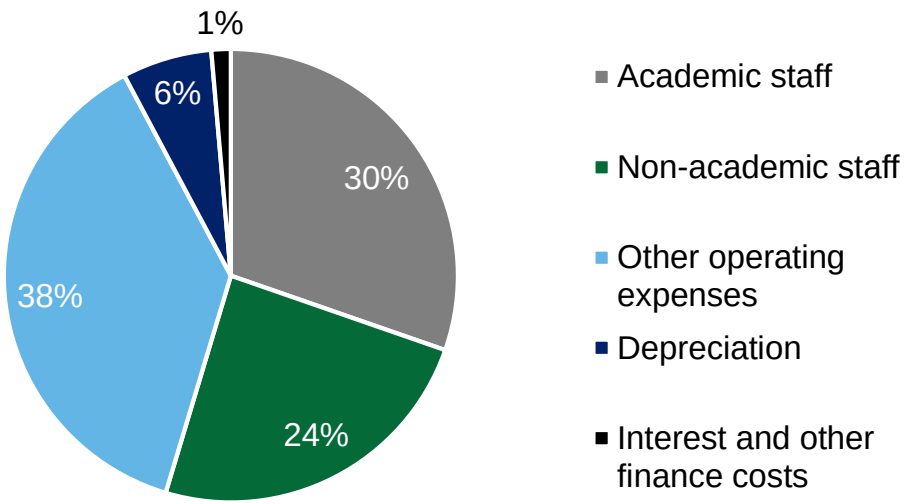
- Composition of HEIs' total costs;
- Regional differences in HEIs' average staff costs using the HESA data;
- Regional variation in wages based on the ASHE data; and
- Variation of HEIs' student enrolment across regions and over time using the HESA data.

The objective is to provide a summary of the data used in the analysis, proportionality of the staff and estates costs and the regional variation in costs and student enrolment observed in the data.

Figure 3 shows the composition of total costs for all HEIs. Staff costs is the largest component accounting for around 55 per cent of total costs (academic staff costs account for c.30 per cent and non-academic staff costs account for the other c.24 per cent). The second largest component is other operating expenses, which effectively includes all other non-staff costs incurred, except for depreciation and interest payable, which represent 6 per cent and 1 per cent of total costs, respectively.

Estates costs are spread across a number of different costs including other operating expenses, non-academic staff costs, interest and other finance costs, and depreciation and represent about 11.7 per cent of total expenses.

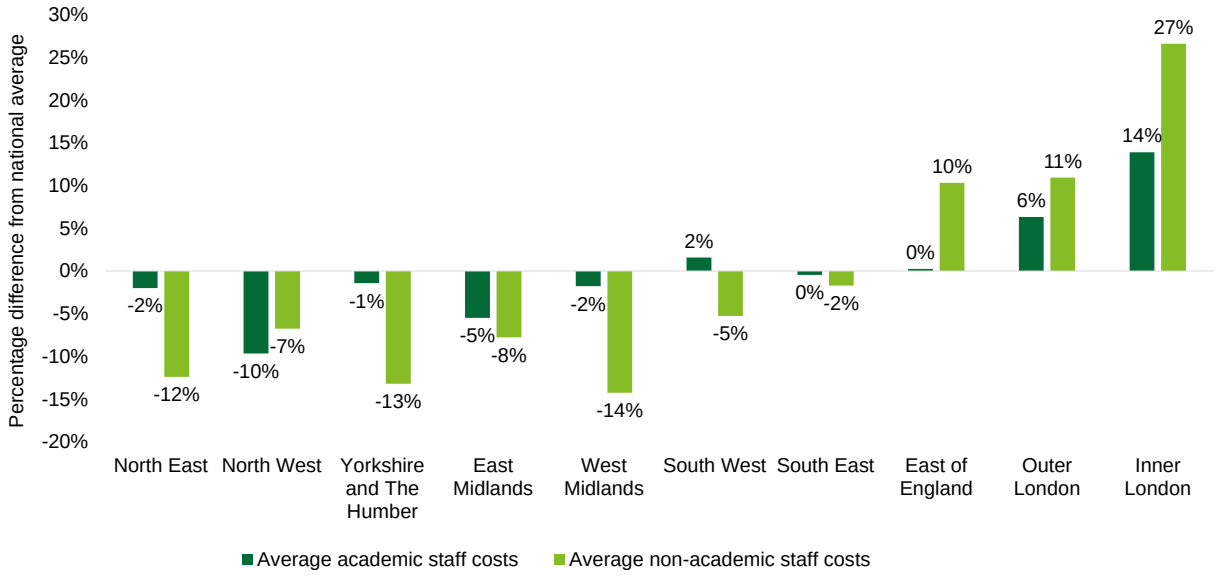
Figure 3: Cost composition, HEIs



Source: HESA finance Table 7, 2014/2015

Figure 4 sets out the regional variation in average academic and non-academic staff costs, expressed relative to the national average. The figures reflect the percentage difference between the average staff costs in a region and the average staff costs across all providers or all regions.

Figure 4: Regional variation in HEIs' average staff costs (HESA data)



Notes: Average academic costs by region are calculated as the average of the average academic costs (academic staff costs divided by academic FTEs) by cost centre and provider within a particular region over the period from 2012/13 to 2014/15; the non-academic staff costs by region are calculated as the average of the average non-academic staff costs (non-academic costs divided by non-academic FTEs) by provider within a particular region over the period from 2012/13 to 2014/15. *Source:* HESA finance and staff records 2012/13 to 2014/15.

Both academic and non-academic staff costs vary significantly across England. For example, average academic staff costs in Inner and Outer London are 14 per cent and 6 per cent higher than the national average respectively, whereas average academic staff costs in East Midlands and West Midlands are 5 per cent and 2 per cent lower than the national average respectively. Non-academic staff costs show an even greater variation. For example, Inner and Outer London average non-academic staff costs are 27 per cent and 11 per cent higher than the national average respectively, and the East Midlands and West Midlands have average non-academic staff costs that are 8 per cent and 14 per cent lower than the average.

These figures should be interpreted with care:

- There are regions that have a relatively small number of providers (see Table 5) and the results might be driven by specific providers. In particular, there are eight providers within the East of England and the average non-academic staff costs reported for this region are driven by a single provider. If this provider is excluded, average non-academic staff costs in the East of England drop from 10 per cent to 0 per cent.

- The regional differences in average staff costs may reflect not only the impact of location but also other factors (e.g. differences in the characteristics of the employees). The regression analysis discussed in Section 3.3.1 and presented in Section 6.1 was designed to control for these differences and isolate the regional effect on staff costs.

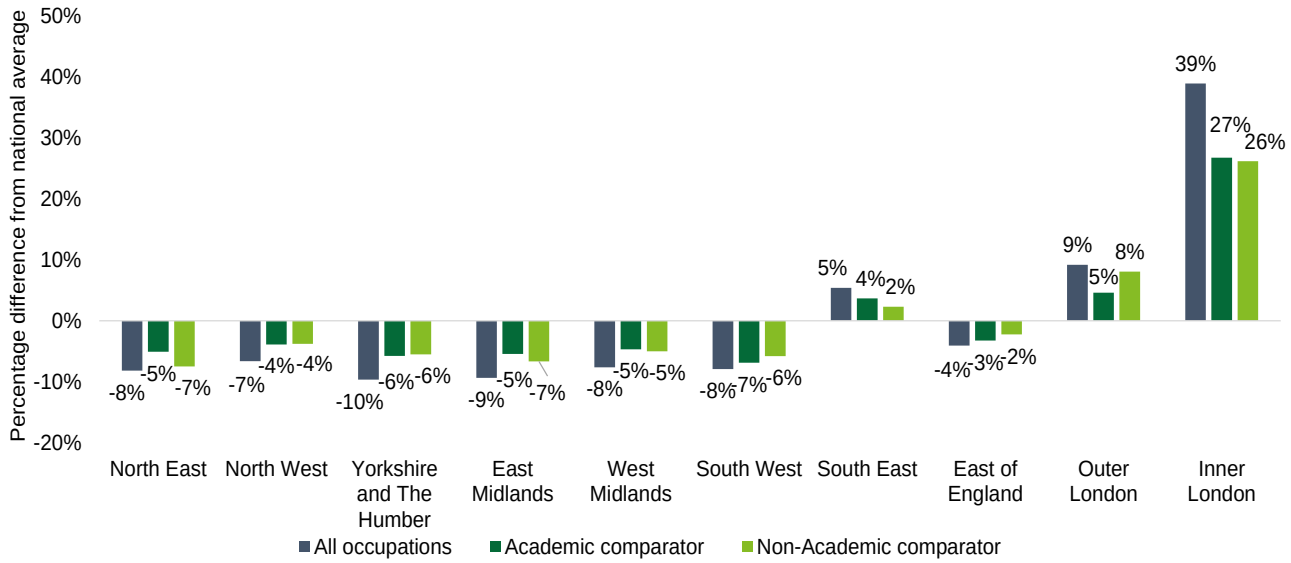
Table 5: Number of HEIs by region

Region	Number of HEIs
East Midlands	9
East of England	8
Inner London	27
North East	5
North West	15
Outer London	7
South East	17
South West	13
West Midlands	12
Yorkshire and The Humber	11
Multiple campuses	4

Notes: Universities with multiple campuses were defined as those which have campuses across two regions and at least 10 per cent of students located outside the main campus (providers that have multiple campuses within the same region are not classified as multi-campus). These are: Cranfield University, The Royal Veterinary College, The University of West London, and University of Greenwich; the results were not sensitive to the multiple campus classification (alternative models were estimated whereby Cranfield University, The Royal Veterinary College, The University of West London, and University of Greenwich were classified in the region where the main campus is located); the Open University was excluded from the analysis because the majority of the courses are provided off-campus; finally the University of London was also excluded from the sample due to the atypical nature of its provision.

Figure 5 depicts the regional variation in average salaries across three occupation groups using the ASHE data: All occupations, academic comparator occupations and non-academic comparator occupations. As in the case of the HESA data, the data is expressed as percentage differences from the national average wages.

Figure 5: Regional variation in average wages (ASHE)

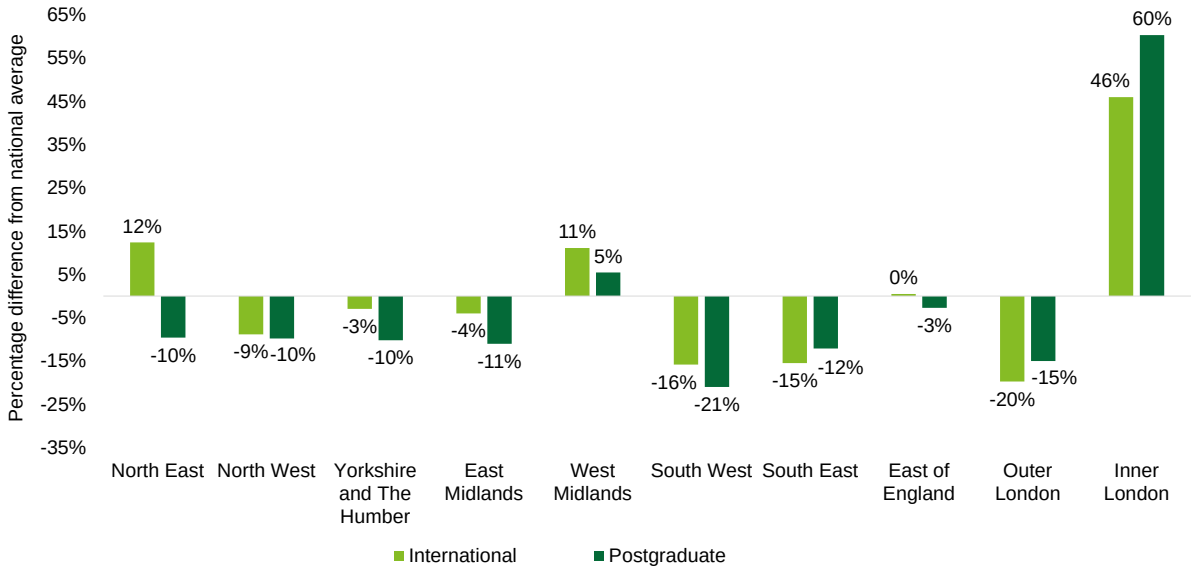


Source: ONS ASHE (2013-2015), excluding individuals employed in the financial industry; 'Academic comparator' occupation group includes managers, directors and senior officials (SOC Major Group 1), and professional occupations (SOC Major Group 2); Non Academic comparator group includes administrative and secretarial occupations (SOC Major Group 4), IT staff and lab technicians (SOC Subgroup 31), hall/facilities managers, and counsellors (SOC units 2317 and 3235).

Average wages in Inner London are between 26 per cent and 39 per cent higher, depending on the occupation group, than the national average. Wages in Outer London and the South East are also higher than the national average whereas wages in all other regions are between 2 per cent and 10 per cent lower than the national average. The regional distribution of wages observed in the ASHE data are broadly similar to the regional distribution of average staff costs observed in the HESA data, i.e. higher in London and lower in the North and Midlands.

Figure 6 shows the HEIs' average student enrolment per cost centre by student type and region, expressed as percentage difference from the national average.

Figure 6: Regional variation in HEIs' student enrolment (HESA)



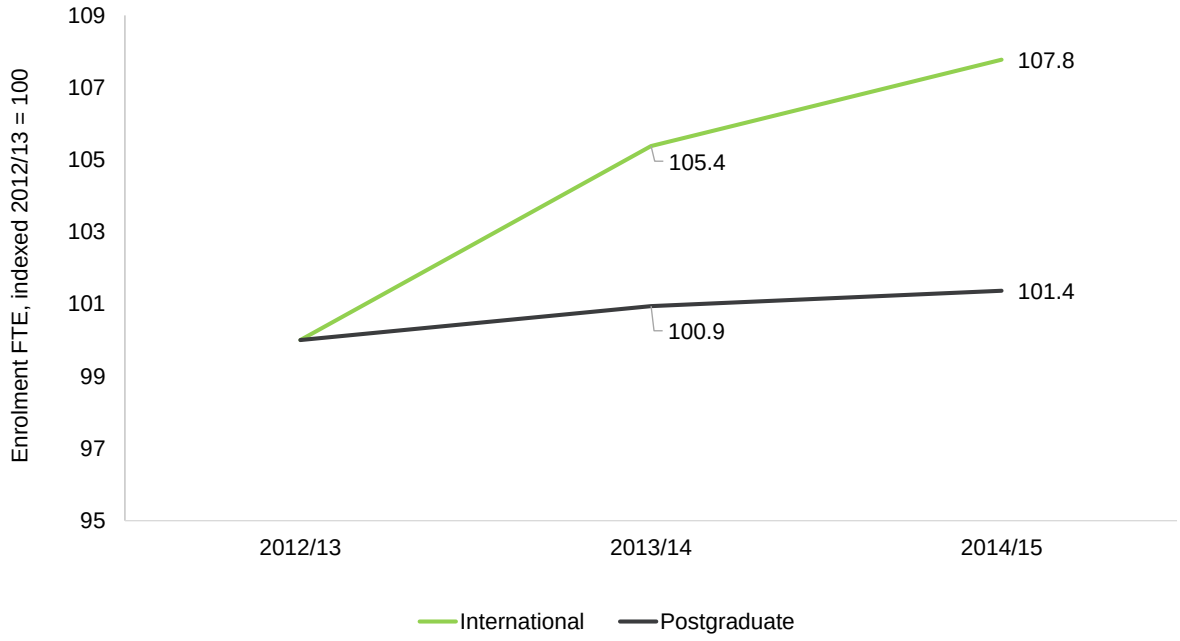
Source: HESA student record (2012/2013-2014/2015) and Deloitte analysis

International and postgraduate student enrolment per cost centre is significantly higher in Inner London HEIs (60 per cent higher for postgraduate students and 46 per cent for international students). All other regions have student enrolment numbers which are below the national average, including Outer London, with the exception of the North East (international students only), West Midlands and East of England (international students only).

Similar to the case of staff costs, these figures should be interpreted with care as the observed regional differences in average student enrolment may reflect not only the impact of location but also other factors (e.g. differences in perceived reputation). The regression analysis discussed in Section 3.2.3 and presented in Section 7 was designed to control for these differences and isolate the regional effect on student enrolment.

Figure 7 shows the evolution of international and postgraduate student enrolment in English HEIs over the period analysed. International student numbers have increased by 7.8% from 2012/13 to 2014/15 whereas the number of postgraduate students only increased marginally over the same period.

Figure 7: Student enrolment over time



Source: HESA student records (2012/13-2014/15) and Deloitte analysis

6 Quantitative analysis: costs

This section sets out the results of the quantitative analysis of costs. This section is organised into five sub-sections:

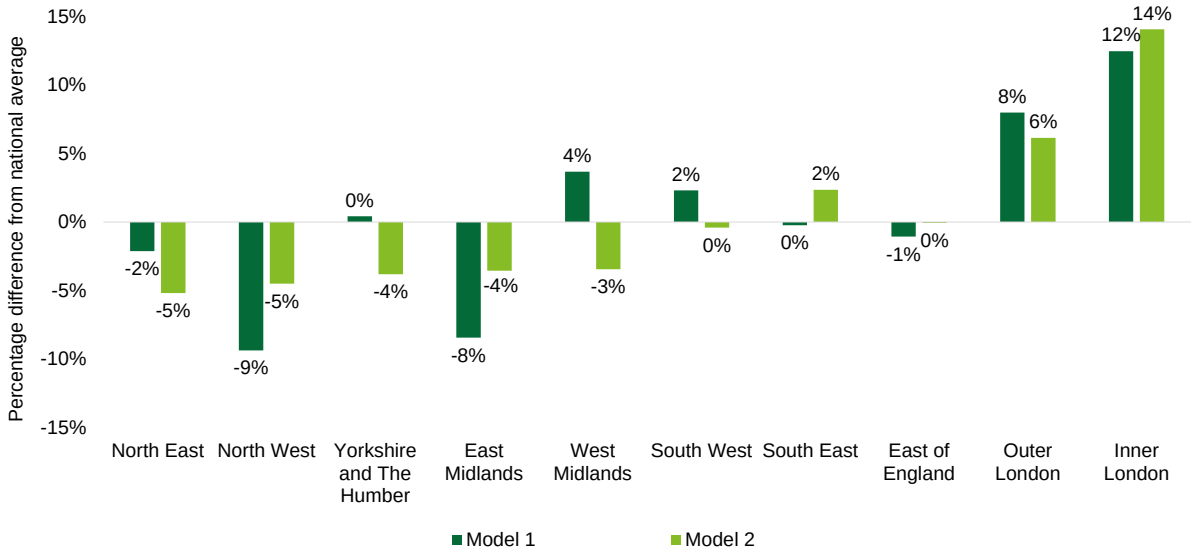
- Sub-section 6.1 presents the results of the academic staff costs analysis using the HESA data;
- Sub-section 6.2 sets out the results of the academic and non-academic staff costs analysis using the ASHE data;
- Sub-section 6.3 compares the results of the academic staff cost analysis using the HESA data and the results of the staff costs analysis using the ASHE data;
- Sub-section 6.4 discusses the results of the estates costs analysis; and
- Sub-section 6.5 provides a summary of the staff and estates costs analysis.

6.1 Academic staff cost analysis using HESA data

6.1.1 Regional differentials in average academic staff costs

Figure 8 sets out the regional average academic staff cost differentials implied by the regression models described in Section 3.3.1 and Technical Appendix A2.1. Further details on the regression output are presented in Technical Appendix A4.1.

Figure 8: Regional academic staff cost differentials



Notes: Model 1 utilised regional indicators based on the following regional classification to identify the regional differences: North East, North West, Yorkshire and Humber, East Midlands, West Midlands, South West, East of England, South East, Outer London and Inner London; Model 2 used house prices and population density to identify the regional differences. *Source:* Deloitte analysis on HESA data (2012/13-2014/15).

Two sets of results are reported in Figure 8, corresponding to Models 1 and 2 described in Section 3.3.1. Model 1 utilised regional indicators whereas Model 2 used house prices and population density to identify the regional differences.

The values reported in Figure 8 reflect the percentage difference between the average academic staff costs in a region relative to the average of all regions, i.e. national average. Details around how the model output was translated into percentage difference from the national average are provided in Technical Appendix A3.

The model results suggest that there is considerable variation in HEIs' average academic staff costs across England. In both models, Inner and Outer London show average academic staff costs which are considerably higher than the national average, between 12 per cent and 14 per cent for Inner London and between 6 per cent and 8 per cent for Outer London. The East of England, South East and South West have average staff costs that are generally close to the national average. The estimated impacts for all other regions are below the national average (the only exception is the estimate provided by Model 1 for West Midlands), albeit their magnitude depends on the model used.

6.1.2 Regional differentials in average academic staff costs: Research vs teaching academic costs

As discussed in Section 3.3.1, a different version of the main regression model was estimated to test the hypothesis that the regional variation in average academic staff costs is different between research and teaching academic staff. The results from these models are reported in Technical Appendix A5 (Table 13) and suggest that the regional variation in research and teaching academic staff in HEIs are not statistically different from each other. Notwithstanding this, this result may be due to the data and methodology limitations and, in particular, the lack of data by teaching and research staff, as discussed in Technical Appendix A2.2.

6.1.3 Sensitivity analysis

A number of additional models were estimated to test the sensitivity of the results to alternative model assumptions. For instance, alternative models were estimated that included different teaching quality indicators (NSS assessment and feedback, NSS academic support, non-continuation and employment and further study indicator) and additional controls (percentage of professors and percentage of EU academic staff), using a different estimation approach and controlling for outliers.

Overall, the results are relatively similar across these sensitivity checks. A sample of the sensitivity analysis is reported in Technical Appendix A5.

6.2 Academic and non-academic staff costs using ASHE[45]

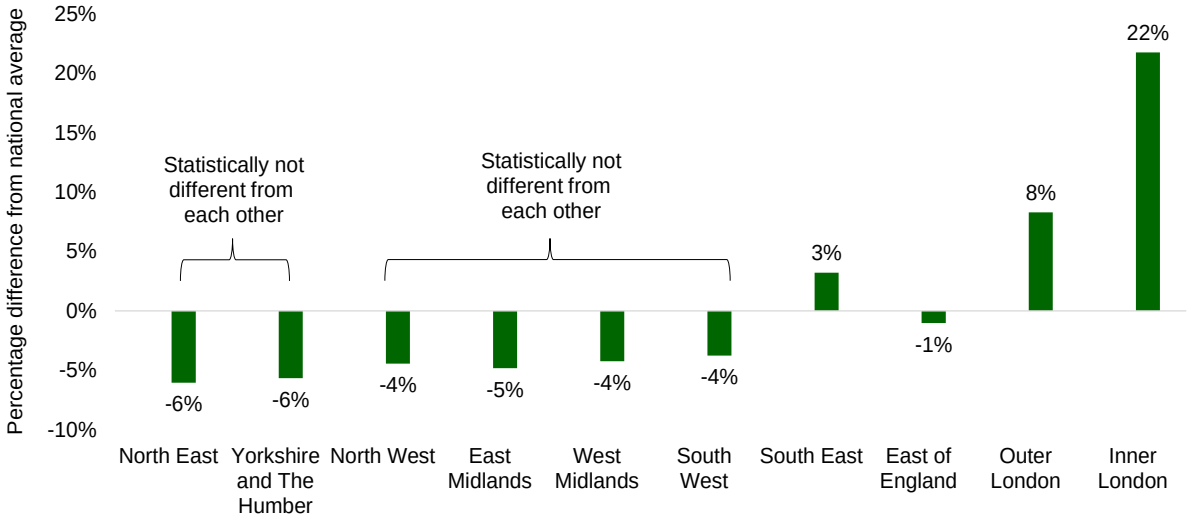
6.2.1 Regional variation in wages (ASHE)

Figure 9 shows the regional variation in the average wages across regions based on the ASHE data (all occupations) and the model described in Section 3.3.1. The ASHE data is used to quantify the regional variation in FECs' and APs' academic staff costs and all HEPs' non-academic staff costs.

Detailed model outputs and the approach used to translate the model output to the values reported in Figure 9 (percentage difference from the national average wages) are discussed in the Technical Appendix A4 and A3.

[45] This section contains statistical data from ONS which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Figure 9: Regional variation in wages (ASHE)



Source: Deloitte analysis on ONS ASHE (2013-2015)

The results of the analysis suggest that:

- **London**. Average wages are significantly higher in Inner London than the national average (around 22 per cent). Outer London also shows higher wages, with an average wage uplift of around 8 per cent.

- **East and South East**. Average wages in East and South East regions are close to the national average, at 3 per cent and -1 per cent respectively.

- **Other regions**. Average wages in the South West, Midlands and North are between 4 per cent and 6 per cent lower than the average.

- **Groups of regions**. A series of statistical tests[46] have been run which, together with the impacts discussed above, suggest that there are five distinct groups of regions:

    - **Group 1**: Average wages in the North East and Yorkshire are 6 per cent below the national average (wages in North East and Yorkshire are not statistically different from each other);

    - **Group 2**: North West, East Midlands, West Midlands and South West, with wages approximately 4 per cent below national average (these regions have average wages that are not statistically different from each other);

    - **Group 3**: East and South East with wages being close to the national average (albeit statistically different from each other);

    - **Group 4**: Outer London wages are, on average, higher than in other regions except Inner London (the difference between Outer London and other regions is statistically significant); and

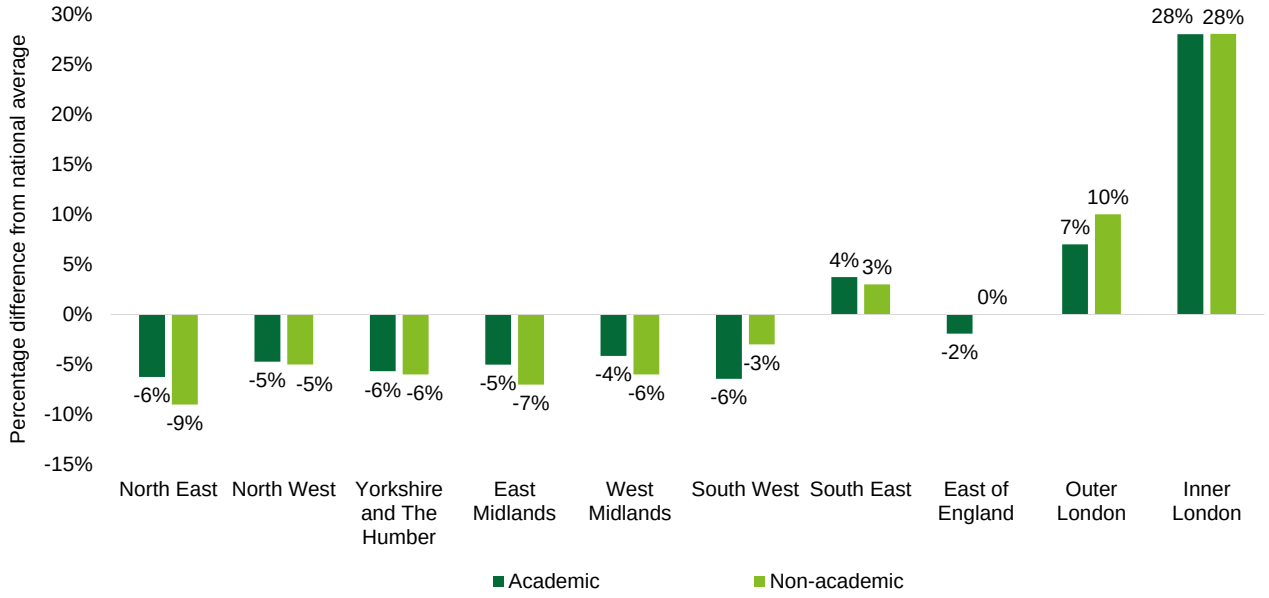
    - **Group 5**: Inner London which shows distinctively higher wages than all other regions (the difference is statistically significant).

[46] These are statistical significance tests which test whether average wages in two regions are equal to each other.

6.2.2 Comparator occupation group analysis

Figure 10 reports the results of the regression model described in Section 3.3.1 estimated using the ASHE data for two occupation groups. The academic comparator group uses data for occupations that is comparable to HEPs' academic staff and the non-academic comparator group uses data for occupations that is comparable to HEPs' non-academic staff.

Figure 10: Regional variation in wages by occupation group (ASHE)



Notes: Academic comparator occupation group includes managers, directors and senior officials (SOC Major Group 1), and professional occupations (SOC Major Group 2); the non-academic staff comparator group includes administrative and secretarial occupations (SOC Major Group 4), IT staff and lab technicians (SOC Subgroup 31), hall/facilities managers, and counsellors (SOC units 2317 and 3235). *Source:* Deloitte analysis on ONS ASHE (2013-2015).

The results of this exercise suggest that the regional distribution is quite similar between the two comparator groups; however, their variance appears to be higher compared to the model reported in the previous section using all occupations.

6.2.3 Sensitivity analysis

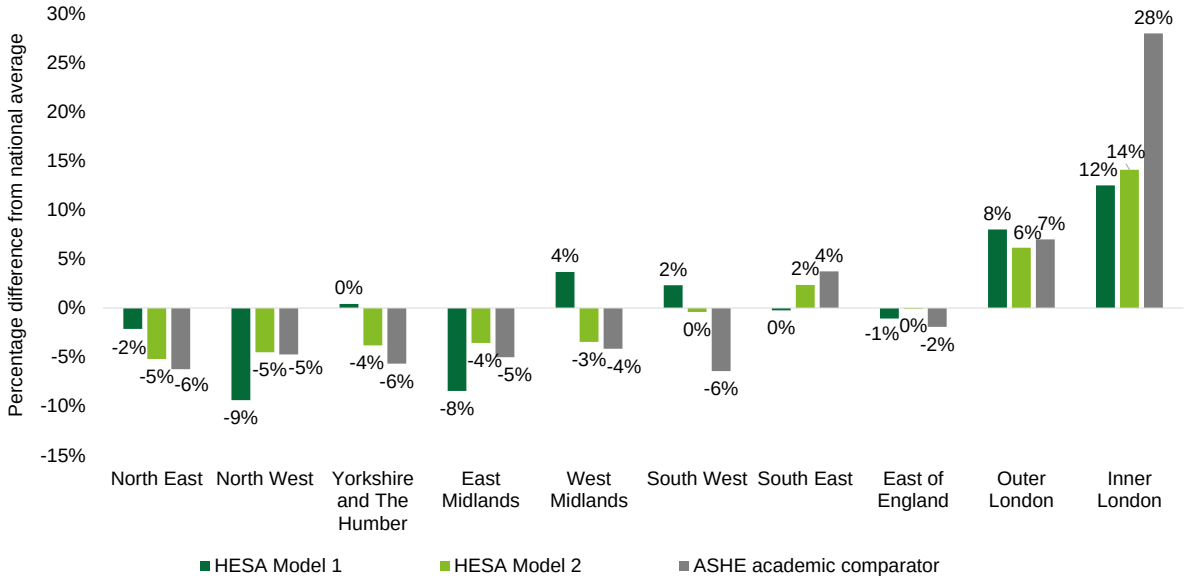
A number of sensitivity tests were performed to assess the robustness of the results to alternative model assumptions. For example, a model was estimated using employees from the private sector only (public sector and non-profit employees were excluded from the sample) and another model where specific outliers were excluded. Overall, the results of the sensitivity analysis showed that the regional variation in average wages is relatively similar to alternative model assumptions.

6.3 Comparison between HESA and ASHE results

Figure 11 compares the regional variation estimated from the HESA models for average academic staff costs against the regional variation estimates from the ASHE model (based on the academic comparator group), and suggests that the distribution of the geographical wage differentials are quite similar between the two approaches, both in terms of magnitudes and rankings (Model 2 (HESA) provides estimates that are closer to the ASHE estimates compared to Model 1 (HESA)). The exception is Inner London for which the ASHE models suggest a significantly higher differential from the national average. This is likely to reflect the limitation of the ASHE data in relation to providing a reasonable comparator occupation group for HEI academic staff. The lower Inner London premium found in the

HESA analysis could possibly be explained by two factors (as discussed in Section 3.2.1): (1) greater number of international academic staff willing to work and live in London and (2) greater freedom to choose the location of work (academic staff might live further afield as generally they have greater freedom and often attend their main location of work less than five days a week).

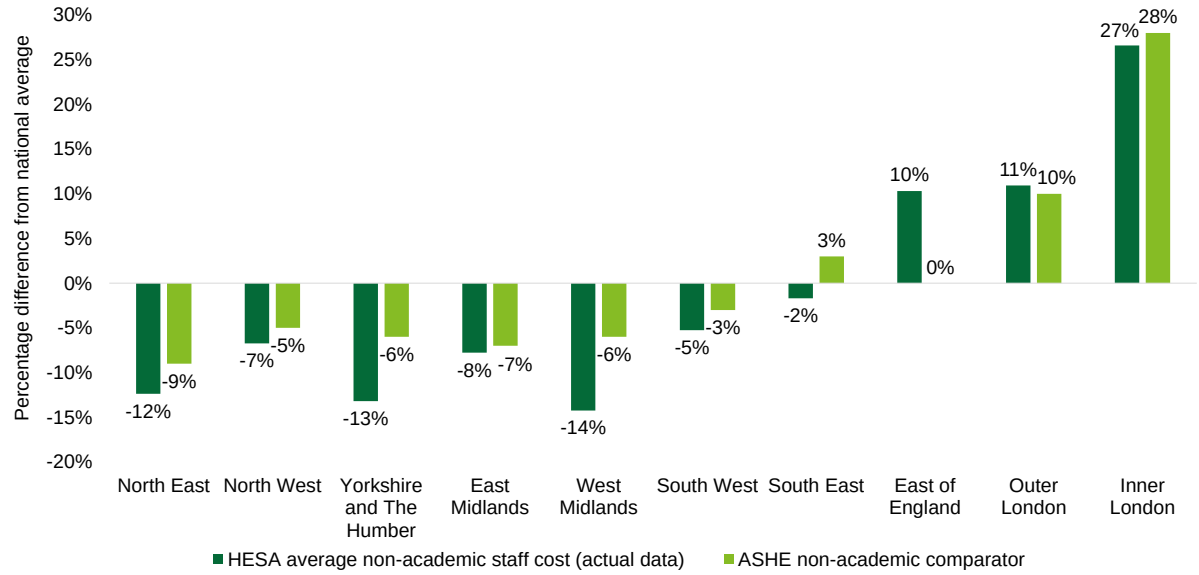
Figure 11: Comparison of HESA and ASHE estimates for academic staff



Notes: Model 1 utilised regional indicators based on the following regional classification to identify the regional differences: North East, North West, Yorkshire and Humber, East Midlands, West Midlands, South West, East of England, South East, Outer London and Inner London; Model 2 used house prices and population density to identify the regional differences. *Source:* Deloitte analysis on HESA data (2012/13-2014/15) and ASHE data (2013-2015).

Figure 12 compares the ASHE regional differential estimates (based on the non-academic comparator group) with the average non-academic staff costs from HESA. The latter represent actual data, expressed as percentage differences from the national average, and not estimates from a regression model. This comparison was carried out to check that the results obtained from the ASHE analysis are comparable to the actual staff costs. Large differences would be expected if the occupation groups used in the ASHE analysis were not comparable to HEIs' non-academic staff. Some differences are expected as the actual staff data from HESA would be affected by provider-specific factors.

Figure 12: Comparison of HESA and ASHE estimates (non-academic staff)



Source: Deloitte analysis on HESA data (2012/13-2014/15) and ASHE data (2013-2015)

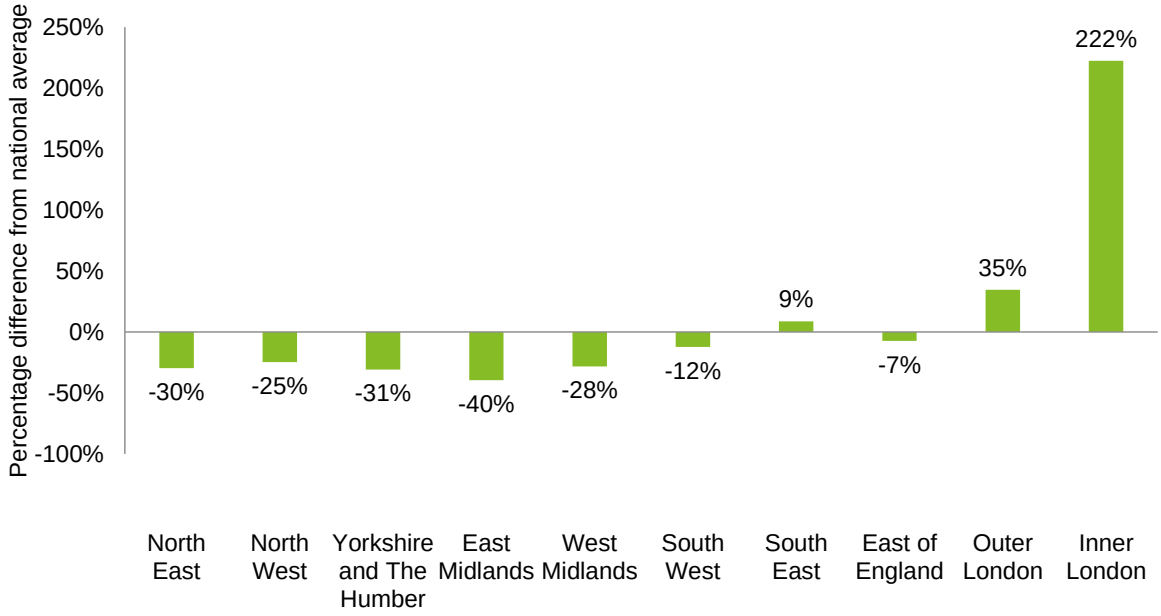
The results of this comparison suggest that the average staff cost estimates based on the ASHE analysis and the actual average staff costs from the HESA data are quite similar, both in terms of magnitude and ranking. The main exception is the East of England where a single HEI (outlier) has significantly higher staff costs than other providers. When excluding this provider, the regional variation in staff costs implied by the ASHE analysis is even closer to the regional variation in staff costs observed in the HESA data.

Overall, the results presented in this section suggest that the regional variation in staff costs is similar between academic and non-academic staff. The only exception is average academic staff costs in HEIs, for whom the variation in costs of Inner London compared to the England average is considerably less than that for non-academic staff. Also, the regional variation in HEIs' average academic staff costs is similar to the regional variation in FECs' and APs' average academic staff costs, which is based on the ASHE analysis, with the exception of Inner London where the academic staff cost premium is lower for HEIs' academic staff compared to FECs' and APs' academic staff cost premium.

6.4 Estates costs

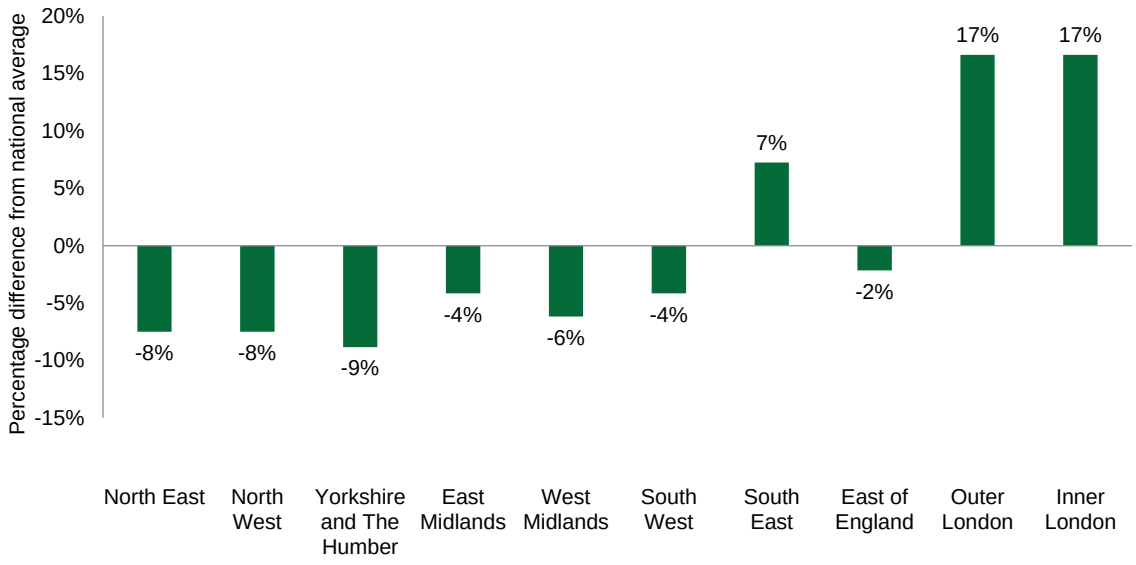
The regional variation in estates costs was computed using data from VOA and BCIS. Effectively, regional differences in rateable values per square metre from VOA were used as an approximation of geographical variation in land and building costs whereas the regional differences in BCIS life-cycle costs per 100 square metres were used as an approximation of maintenance costs.

Figure 13: Rateable value per square metre relative to national average



Notes: Rateable values are based on the 2015-16 VOA values. *Source*: VOA and Deloitte analysis.

Figure 14: Life cycle costs per 100 square metres relative to national average



Notes: Maintenance costs are based on BCIS' 2015 life cycle costs. *Source*: BCIS and Deloitte analysis.

Figure 13 and Figure 14 set out the regional distribution of estates costs.

- **Land and building costs**. Land value and building costs vary significantly across England. Costs in Inner London are around three times higher than the national average; Outer London and South East also have costs that are above the average (around 35 per cent and 9 per cent more, respectively) whereas the other regions have between 7 per cent and 40 per cent lower costs than the national average.

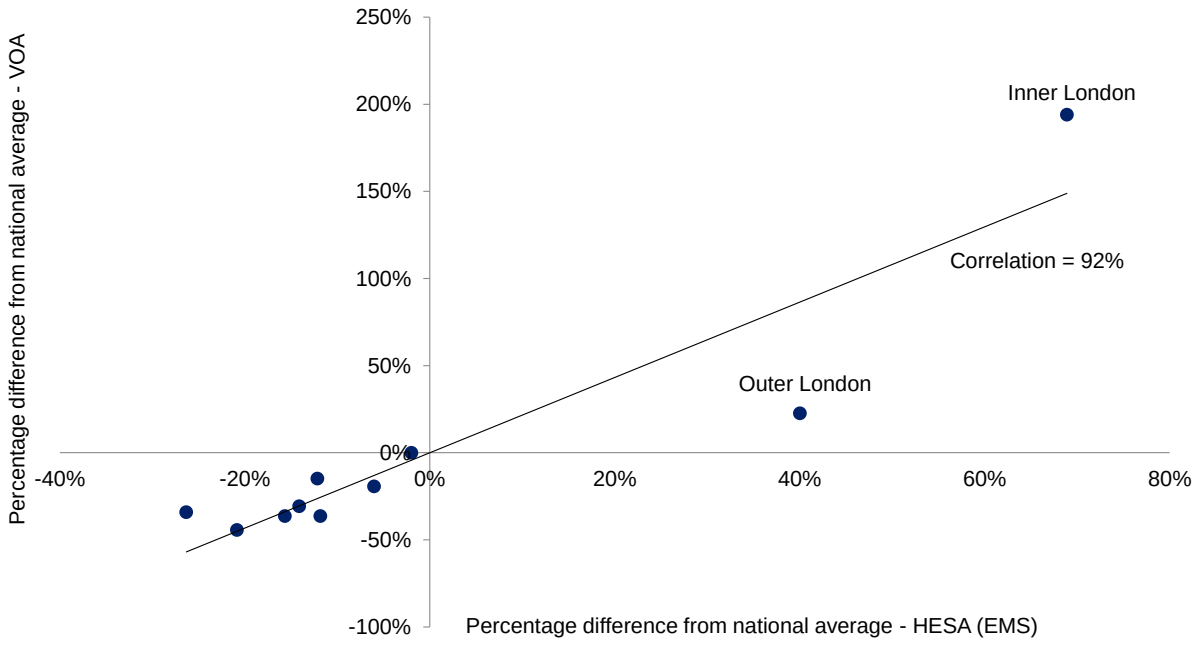
- **Maintenance costs**. Maintenance costs (life cycle costs) are also higher in London, around 17 per cent higher than the national average[47]. The South East has

[47] The information provided by BCIS is not available for Inner and Outer London.

approximately 7 per cent higher costs than the average whereas the other regions have between 2 per cent and 9 per cent lower costs than the average. The degree of variability of maintenance costs is significantly lower than that for land and building costs. Maintenance costs tend to have lower variation as they include factors such as repair work and utilities, which are generally similar across regions.

The results of this analysis have been compared against the HEIs' actual estates cost data available from HESA (EMR). In particular, Figure 15 shows the regional variation in rateable value (per square metre) using the VOA and EMR data (expressed as difference from the national average), and Figure 16 depicts the BCIS and EMR maintenance costs (per square metre; expressed as difference from the national average).[48]

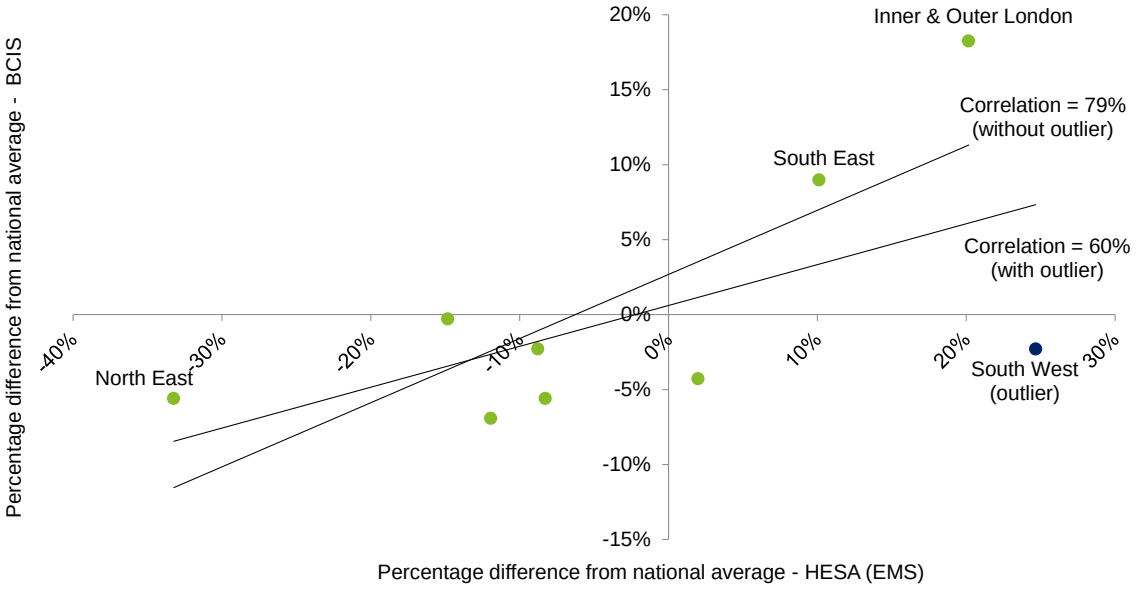
Figure 15: VOA vs EMR rateable value (percentage difference from the national average)



Source: VOA (2015) and HESA EMR (2014/15) and Deloitte calculations

[48] The rateable value from HESA is computed as rateable value (variable name: *FNRRV*) divided by total net internal area (variable name: *SMNIANRT*). The maintenance costs from HESA is computed as maintenance costs (variable name: *FNRRMCT*) divided by total net internal area (variable name: *SMNIANRT*).

Figure 16: BCIS vs EMR maintenance costs (percentage difference from the national average)



Source: BCIS (2015) and HESA EMR (2014/15) and Deloitte calculations

The results of this comparison suggest that the two sources provide different estimates; however, these estimates are highly correlated with each other, albeit based on a low number of observations. The difference could be potentially explained by two factors:

- Individual providers may experience rateable values that are different from the average rateable value of the region within which these providers are located;
- Provider-specific factors such as the age of the estates may lead to differences in maintenance costs implied by the BCIS and EMR data.

6.5 Summary of findings

The analysis described in this section suggests that there are significant differences in average costs between geographical locations, especially between Inner London and the rest of the country. In particular:

- **Academic staff costs in HEIs.** Analysis using the HESA data suggests that academic staff costs in Inner and Outer London are 12-14 per cent and 6-8 per cent higher than the national average, respectively. The East of England, South East and South West have academic staff costs that are generally close to the national average. The other regions have academic staff costs which are below the national average with the estimated magnitude dependent on the model used.
- **Research and teaching academic staff costs in HEIs.** No evidence was found of research staff wages being more or less sensitive to regional factors than teaching staff wages in HEIs.
- **Non-academic staff costs in HEIs and academic and non-academic staff costs in FECs and APs.** Analysis based on the ASHE data suggests that the regional variation in non-academic staff costs in HEIs and academic and non-academic staff costs in FECs and APs is similar to that of academic staff costs in HEIs. The

exception to this is Inner London where non-academic staff costs in HEIs and academic and non-academic staff costs in FECs and APs are 22-28 per cent higher than the national average. This is considerably higher than the 12-14 per cent premium estimated for academic staff costs in HEIs using the HESA data.

- **Land and building costs.** Land and building costs were found to vary substantially across England. Costs in Inner London are around three times higher in Inner London compared to the national average; Outer London and South East also have costs that are above the average (around 35 per cent and 9 per cent, respectively) whereas the other regions have costs between 7 per cent and 40 per cent lower than the national average.

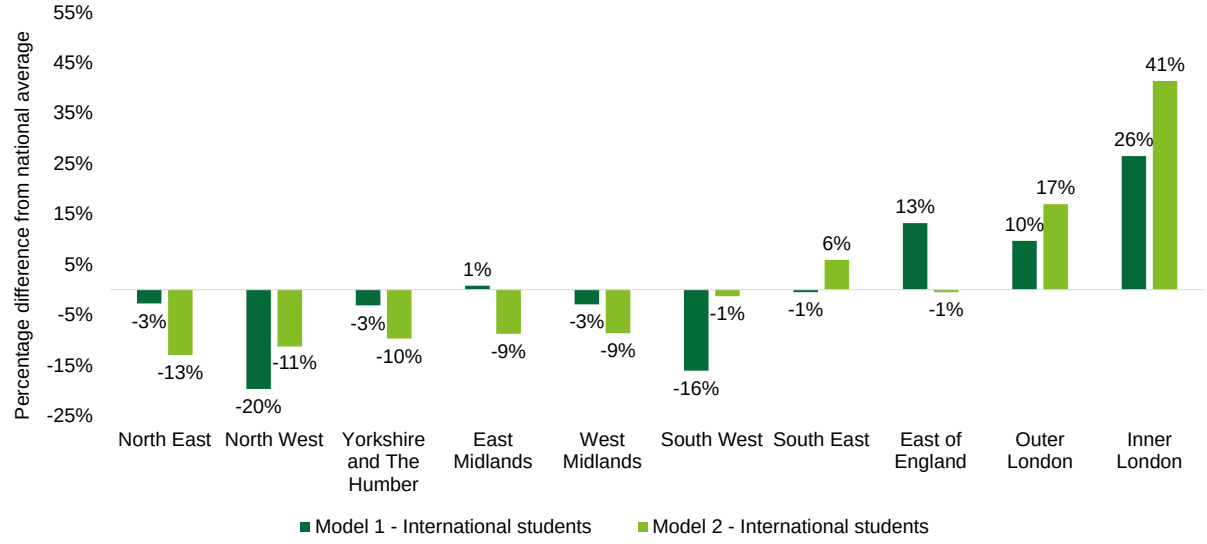
- **Maintenance costs.** Finally, maintenance costs in London are approximately 17 per cent higher than the national average; the South East has approximately 7 per cent higher costs than the average whereas the other regions have costs 2 per cent to 8 per cent below the national average.

7 Quantitative analysis: benefits

This section sets out the results of the student enrolment analysis set out in Section 3.3.3. The objective is to understand the degree to which providers located in different areas have a relative advantage over other providers at attracting students. The motivation of this analysis is that although specific providers might have higher costs due to their location, they might derive specific benefits that compensate them for these higher costs. This analysis is novel in the sense that other main public providers in England consider only regional differences in costs. Due to the experimental nature of this analysis, which at this point does not assign fee income to student enrolment, it is not possible to directly compare findings from the quantitative analysis on benefits with the quantitative analysis on costs.

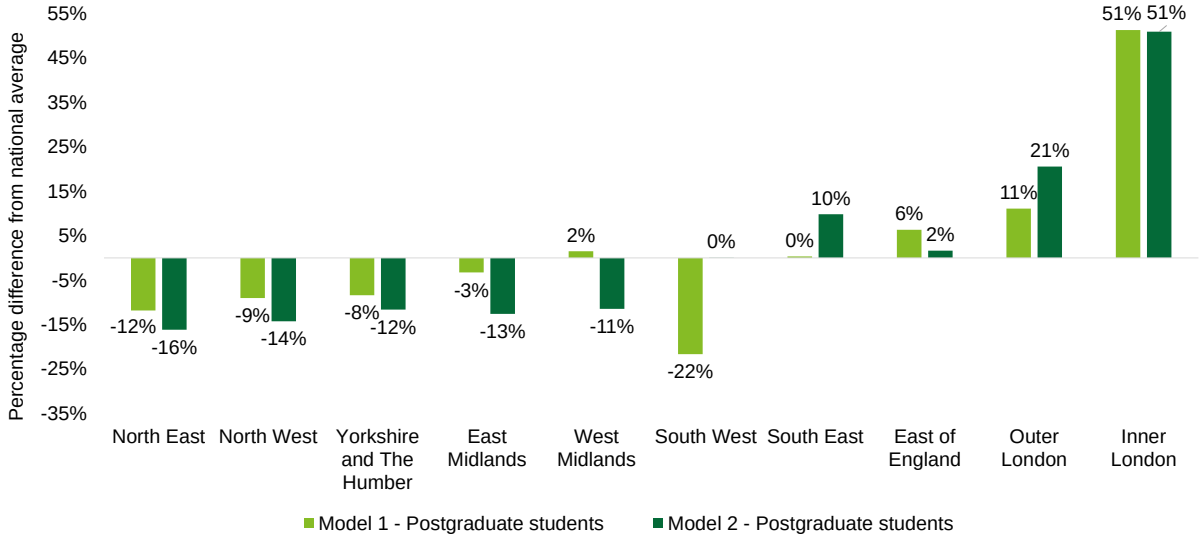
Figure 17 and Figure 18 present the regional variation in international and postgraduate HEI student enrolment implied by the models described in Section 3.3.3. Model 1 utilised regional indicators whereas Model 2 used house prices and population density to identify the regional differences. The estimates represent the percentage differences from the national average (average enrolment number across all regions). Detailed model output is reported in the Technical Appendix A2.3.

Figure 17: Regional differentials in international student enrolment



Source: Deloitte analysis on HESA data (2012/13–2014/15)

Figure 18: Regional differentials in postgraduate student enrolment



Source: Deloitte analysis on HESA data (2012/13–2014/15)

The results suggest that:

- Inner London universities appear to enrol, on average, between 26 per cent (Model 1) and 41 per cent (Model 2) more international students per cost centre than the national average (once quality and other factors are controlled for). The results for postgraduate students suggest providers in Inner London attract 51 per cent more students than the national average;

- Outer London also has an advantage over other regions; international student enrolment per cost centre is between 10 per cent and 17 per cent higher than the national average and postgraduate student enrolment per cost centre is between 11 per cent and 21 per cent higher than the national average;

- The results for the East of England and South East suggest a regional impact between -1 per cent and 13 per cent; and

- The results for the other regions suggest a negative regional impact, ranging between -3 per cent and -16 per cent relative to the national average.

The results of the international and postgraduate student enrolment are not additive as the two students groups overlap (international students include both undergraduate and postgraduate students). Furthermore, the results reflect differences in student enrolment and not the financial benefits associated with student numbers and therefore they are not comparable to the regional variation in costs[49].

A number of alternative models were estimated to test the sensitivity of the results to alternative model assumptions, e.g. different indicators of teaching quality and a different estimation approach. These results are presented in Technical Appendix A5, and suggest that the results are relatively similar across these sensitivity checks.

[49] The financial benefits could be computed by translating the enrolment uplifts into a revenue or profit value, which require a number of assumptions including on average tuition fees and profit margins.

8 Conclusion

This study provides evidence on the regional variation in costs and benefits of providing higher education services in England. The results of the analysis (summarised in Table 6 suggest that there are significant differences in costs (staff and estates costs) and benefits across the country, especially between Inner London and the rest of England. The results are broadly in line with the evidence provided by other public funders and the sector's views obtained through stakeholder engagement conducted as part of this study.

The evidence provided should be interpreted considering the data and methodological limitations.

- **Staff costs.** Although different data sources (HESA and ASHE) and approaches (regression analysis and averages of raw data) suggest that there are considerable differences in average staff costs between regions, the estimates depend on the approach used and are subject to data and methodological limitations. The two key limitations are related to the assumptions that the regional differences in HEPs' staff costs are comparable to regional differences in staff costs in other sectors (see Section 3.3.1.1) and that the regression analysis can sufficiently control for the impact of quality and other factors unrelated to location on staff costs (see Section 3.3.1.2).

- **Estates costs.** It is assumed that average regional differences in rateable value across England reasonably approximate the regional variation in land/building costs for HEPs. Also, it is recognised that the estates cost estimates provided in this study reflect the average regional estates costs, which might be different from the costs faced by providers due to provider-specific circumstances and management decisions (e.g. property financing) and factors (e.g. age of the estates). However, the objective of the study was not to estimate provider-specific costs, but rather average regional costs.

- **Student enrolment (benefits).** Due to challenges with the historical student caps, the analysis did not consider the impact of location on Home and EU undergraduate student enrolment. Also, there is limited precedent in modelling student enrolment in higher education and incorporating benefits associated with income in public funding allocation formulae. As such, the evidence provided should be viewed as preliminary and interpreted with care.

The objective of this study is to gather evidence on the variation in relative costs and benefits for HEPs associated with operating in different geographic areas of England. This study is not intended to make recommendations on how the total quantum of HEFCE funding should be determined or allocated across providers, and further analysis may be required to incorporate the evidence presented into a funding formula. Moreover, the results need to be interpreted carefully given the limitations associated with the underlying data and quantitative analysis.

Table 6: Results summary

	Costs					Benefits					
Regions	HESA Model 1	HESA Model 2	ASHE - All Occupations	ASHE - Academic comparator group	ASHE - Non-Academic comparator group	Land/building costs	Maintenance costs	International student enrolment Model 1	International student enrolment Model 2	Postgraduate student enrolment Model 1	Postgraduate student enrolment Model 2
Provider type	HEIs	HEIs	FECs and APs	FECs and APs	All HEPs	All HEPs	All HEPs	HEIs	HEIs	HEIs	HEIs
Cost type	Academic staff costs	Academic staff costs	All HEPs: Non-academic staff costs	Academic staff costs	Non-academic staff costs	Estates	Estates	-	-	-	-
North East	-2%	-5%	-6%	-6%	-9%	-30%	-8%	-3%	-13%	-12%	-16%
North West	-9%	-5%	-4%	-5%	-5%	-25%	-8%	-20%	-11%	-9%	-14%
Yorkshire and The Humber	0%	-4%	-6%	-6%	-6%	-31%	-9%	-3%	-10%	-8%	-12%
East Midlands	-8%	-4%	-5%	-5%	-7%	-40%	-4%	1%	-9%	-3%	-13%
West Midlands	4%	-3%	-4%	-4%	-6%	-28%	-6%	-3%	-9%	2%	-11%
South West	2%	0%	-4%	-6%	-3%	-12%	-4%	-16%	-1%	-22%	0%
South East	0%	2%	3%	4%	3%	9%	7%	-1%	6%	0%	10%
East of England	-1%	0%	-1%	-2%	0%	-7%	-2%	13%	-1%	6%	2%
Outer London	8%	6%	8%	7%	10%	35%	17%	10%	17%	11%	21%
Inner London	12%	14%	22%	28%	28%	222%	17%	26%	41%	51%	51%

Source: Deloitte analysis based on HESA, ASHE, VOA and BCIS data

References

Association for University Directors of Estates, 2014, ‘Higher Education estates statistics report 2014’, available at: http://www.sustainabilityexchange.ac.uk/files/2aude-he-estates-statistics-report-2014-vfinal.pdf

Department for Communities and Local Government, 2014, ‘Methodology Guide for the Area Cost Adjustment 2013/14’, available at: http://webarchive.nationalarchives.gov.uk/20140505104649/http:/www.local.communities.gov.uk/finance/1314/methacas.pdf

Department for Education, 2016, ‘School revenue funding: current funding arrangements’, available at: https://consult.education.gov.uk/funding-policy-unit/schools-national-funding-formula/supporting_documents/Current_funding_system.pdf

Higher Education Funding Council for England, 2016, ‘Guide to funding 2016-17’, available at: http://www.hefce.ac.uk/pubs/year/2016/201607/

Higher Education Funding Council for England, 2016, ‘Funding to support teaching in higher education’, available at http://www.hefce.ac.uk/pubs/year/2016/201639

National Health Service England, 2014, ‘Guide to the Market Forces Factor’, available at: https://www.gov.uk/government/publications/guide-to-the-market-forces-factor-201415

Office for National Statistics, 2016, ‘Analysis of factors affecting earnings using Annual Survey of Hours and Earnings: 2016’, available at: https://www.ons.gov.uk/releases/analysisoffactorsaffectingearningsusingannualsurveyofhoursandearnings2016

Skills Funding Agency, 2016, ‘Funding Rates and Formula 2016 to 2017’, available at: https://www.gov.uk/government/publications/sfa-funding-rates-and-formula-2016-to-2017

Student Funding Panel, 2015, ‘An analysis of the design, impact and options for reform of the student fees and loans system in England’, available at http://www.universitiesuk.ac.uk/policy-and-analysis/reports/Documents/2015/student-funding-panel.pdf

The Complete University Guide: https://www.thecompleteuniversityguide.co.uk/university-tuition-fees/reddin-survey-of-university-tuition-fees/foundation-undergraduate-tuition-fees-2016–17,-ukeu/#england

Technical Appendix

The Technical Appendix provides technical details on the quantitative analysis:

- Section A1 provides a summary of the data used;
- Section A2 describes the regression methodology;
- Section A3 describes the approach used to translate the model coefficients into the regional variation estimates presented in the main body of the report;
- Section A4 sets out the model coefficient estimates; and
- Section A5 presents the results of the sensitivity analysis.

The Technical Appendix has been drafted for readers with some basic knowledge of econometrics.

A1. Data summary

Table 7 summarises the data sources used in the analysis together with the variables, time period and granularity of the information. A combination of sector-specific data sources (HESA) and other economic sources (ONS, VOA, and BCIS) were used. These sources were selected on the basis of the methodological considerations discussed in Section 3.3.

Table 7: Data summary

Area of analysis	Source	Variables	Time period	Granularity
Staff costs	HESA (Finance record)	• Staff costs split by academic and non-academic staff • FTEs by age, gender and other individual and contract characteristics • Cost centre classification	2012/13-2014/15	Cost centre level, by provider
Staff costs	ONS ASHE	• Age • Gender • Tenure at the current organisation • Occupation (based on SOC 2010 classification) • Industry (based on SIC 2007 classification) • Organisation size • Organisation type: public sector, non-profit organisation and private company • Contract type: part-time, full-time, temporary	2013-2015	Individual level
Estates - Building and land costs	VOA	Rateable value per metre square	2015	Ten regions and local authorities

Area of analysis	Source	Variables	Time period	Granularity
Estates - Maintenance costs	BCIS	Life-cycle costs per 100 metre square	2015	Nine regions
Estates	HESA (Estates management record)	• Rateable Values • Maintenance costs • Gross Internal Area	2012/13-2014/15	Provider
Benefits	HESA (Student record)	Student enrolment by student type (Home, EU, international, postgraduate and undergraduate students)	2012/13-2014/15	Cost centre level, by provider
Various	Research Excellence	Percentage of four-star research output, unweighted for staff FTE	2014	Unit of Assessment, by provider (mapped to cost centres)
	NSS	• Learning and teaching (z-score) • Assessment and feedback (z-score) • Academic support (z-score)	2013/14-2015/16 average	Provider
	HEFCE based on HESA and ILR	• Non-continuation (z-score)	2011/12-2013/14 average	Provider
	DLHE	• Employment and further study indicator (full-time) (z-score)	2012/13-2014/15 average	Provider
	TRAC	Percentage of time spent in research, teaching and other activities	2012/13-2014/15	Provider
	ONS	House prices: median house prices	2013-2015 (calendar year)	Local Authority
	ONS	Population density: persons per hectare	2013 census	Local Authority

Notes: HESA: Higher Education Statistics Agency; ONS ASHE: Annual Survey of Hours and Earnings from the Office for National Statistics; VOA: Valuation Offices Agency; BCIS: Building Costs Information Service; NSS: National Student Survey; ILR: Individualised Learner Record; DLHE: Destinations of Leavers in Higher Education; TRAC Table F2b (time allocation).

A2. Econometric model specification

This section sets out the model specification for the three sets of models presented in this report:

- Academic staff costs model using the HESA data;
- Academic and non-academic staff costs model using the ASHE data; and
- Student enrolment model using the HESA data.

A2.1 Model specification: academic staff costs (HESA)
Equation (1) describes Model 1 (regional indicator model) model used to quantify the regional variation in HEIs' academic staff costs.

$$\log C_{i,j,t} = \alpha + X\mathrm{B} + \sum_{i=1}^{k-1} CC_i + \sum_{l=1}^{\nu-1} \gamma_l + \varepsilon_{i,j,t} \qquad (1)$$

Where $\log C$ is the natural logarithm of average academic staff costs (computed as total academic staff costs divided by academic FTEs), for cost centre i, provider j and year t; X is a vector of control variables (see Section 3.3.1 for more details), B is a vector of coefficients, CC are κ cost centre dummies (κ = 40), γ_l are ν regional dummies (ν = 10) and ε is the idiosyncratic error.

The regional classification used to generate the regional dummy variables divides England into ten regions: North East, North West, Yorkshire and The Humber, East Midlands, West Midlands, South West, East of England, South East, Outer London and Inner London.

The following control variables were included in the model:

- Research excellence: percentage of four-star output in the 2014 REF;
- Teaching quality is based on the NSS: the main variable used is student satisfaction with teaching (z score); other proxies such as non-continuation rates were also tested in the sensitivity analysis;
- Time spent in research: percentage of time allocated in research obtained from TRAC, Section F2b, unweighted for salaries;
- Age: percentage of FTE staff less than 40 years old;
- Gender: percentage of FTE female academic staff;
- Professors: percentage of FTE academic staff that are professors;
- Specialist: dummy variable that takes the value of 1 if the provider is a specialist institution, and 0 otherwise, as per group F (specialist music/arts teaching institutions) in the TRAC peer group; and
- Cost centre: 45 dummies indicating the cost centre.

The model was estimated by ordinary least squares (OLS) with clustered standard errors at provider level using data from 128 HEIs, 45 cost centres and three years' worth of data (2012/13 to 2014/15)[50].Overall the sample contains more than 3,000 observations.

Model 2 described in the main body of the report is similar to equation (1) with the regional dummy variables being replaced by the house prices and density variables as described by equation (2).

[50] The model has also been estimated by multi-level mixed effects as part of the sensitivity analysis.

$$\log C_{A,i,j,t} = \alpha + X\mathrm{B} + \sum_{i=1}^{k-1} CC_i + \delta_1 \log HP_l + \delta_2 \log D_l + \varepsilon_{i,j,t} \quad (2)$$

where $\log HP$ is the natural logarithm of house prices in local authority l and D_l is the natural logarithm of population density in local authority l.

Both Model 1 and 2 have advantages and disadvantages. The advantage of Model 2 is that it provides a more direct measure of location attractiveness and cost of living than Model 1 and measures the impact of location at local authority level, i.e. allows the impact of location to vary within regions. However, the house prices and population density are imperfect measures, i.e. they also capture factors that are unrelated to location attractiveness (e.g. under-supply of homes, property price bubbles).

The main limitation of Model 1 is that it assumes that the staff cost differentials are the same within a region. Also, given the relatively small number of providers within each region (see Section 5), it is challenging to isolate the impact of location from other factors. These limitations suggest that the regional estimates are an approximation of the impact of location on provider costs and that the regional estimates could be subject to non-negligible estimation error.

A2.2 Model specification: research vs teaching academic staff costs (HESA)
Equation (3) describes the model used to test the hypothesis that the regional variation in HEIs' academic staff costs is different between research and teaching staff. The model is effectively equation (2) augmented with the house prices/time spent in research interaction variable.

$$\log C_{A,i,j,t} = \alpha + X\mathrm{B} + \sum_{i=1}^{k-1} CC_i + \delta_1 \log HP_l + \delta_2 \log D_l + \delta_3 \log HP_l * TSR_l + \varepsilon_{i,j,t} \quad (3)$$

where TSR is the percentage of time spent in research obtained from TRAC.

If the interaction term is statistically significant, it would suggest that the regional variation in average staff costs is different between teaching-oriented and research-oriented staff.

An alternative approach would be to run separate models for teaching and research staff. However, the staff costs and FTEs data are unavailable by research and teaching staff. It is recognised that a large share of academic staff is involved in both research and teaching which makes it difficult to track staff costs and FTEs by research and teaching[51].

A2.3 Model specification: academic and non-academic staff costs (ASHE)
Equation (4) describes the econometric models used to estimate the regional variation in academic and non-academic staff costs using the ASHE data.

$$\log W_{i,t} = \alpha + X\mathrm{B} + \sum_{l=1}^{\nu-1} \gamma_l + \varepsilon_{i,t} \quad (4)$$

[51] Another approach would be to use the TRAC data on time spent in different activities to split the staff costs into research and teaching costs. However, this approach would be problematic as it would assume that the average salary is the same between teaching and research staff.

where $\log W$ is the natural logarithm of average weekly earnings for individual i and year t; X is a vector of control variables (see Section 3.3.1 for more details), γ_l are either regional or local authority dummy variables[52], and ε is the idiosyncratic error. The regional classification is the same as the one used in the HESA academic cost analysis.

The following control variables were included in the model:

- Age: employee age;
- Gender: dummy variable that takes the value of 1 if the employee is female;
- Tenure: dummy variables indicating the tenure of the employee (less than six months, six months to one year, two to five years, five to 10 years, 10 to 20 years, and more than 20 years);
- Occupation dummies based on 10 SOC groups;
- Industry dummies based on 10 or 21 SIC sections;
- Part-time/full time: dummy variable indicating whether the individual is a part-time employee;
- Temporary/permanent: dummy variable indicating whether the individual is temporary;
- Organisation size: dummy variables indicating the organisation size (between one and 10 employees, between 11 and 25 employees, between 26 and 50 employees, between 51 and 250 employees, between 251 and 500 employees, and more than 500 employees);
- Public/private: dummy variables indicating whether the individual works in the public sector or for a non-profit organisation (as opposed to the private sector).

The model was estimated by weighted least squares with robust standard errors. Some individuals in the sample appear in more than one year. Recognising that observations for the same individuals are not independent, robust cluster standard errors were used to draw inference. In addition, survey weights were applied to address issues associated with sample representativeness. Weights were driven by age group, sex, occupation, and region and have been obtained from the ONS.

The sample covers the period from 2013 to 2015 and all occupation groups although separate models were estimated for two occupation groups comparable to HEPs' academic and non-academic staff as discussed in Section 3.3.1.

[52] As opposed to the HESA analysis, the granularity in the ASHE the data (i.e. individual level) allows estimation of the location effect using local authority dummies. The local authority ASHE model is comparable to HESA Model 2 which uses house prices and population density as a means to identify the regional impact at the local authority level. House prices and population density are not used in the ASHE analysis as the local authority dummy is considered a better approach, in particular, it does not assume that the regional variation in costs is directly linked to house prices and population density.

A2.4 Model specification: Benefits

Equation (5) describes Model 1 (the regional dummy variables model) used to quantify the regional variation in HEIs' student enrolment.

$$\log S_{i,j,t} = \alpha + X\mathrm{B} + \sum_{i=1}^{k-1} CC_i + \sum_{l=1}^{\nu-1} \gamma_l + \varepsilon_{i,j,t} \qquad (5)$$

where $\log S$ is the natural logarithm of student enrolment, for cost centre i, provider j and year t; X is a vector of control variables (see Section 3.3.3 for more details), CC are cost centre dummies, γ_l are the regional dummies and ε is the idiosyncratic error. The regional classification is the same as the one used in the HESA academic cost analysis.

The control variables are:

- Research excellence: percentage of four-star output in the 2014 REF;
- Teaching quality is based on the NSS: the main variable used is student satisfaction with teaching (z score); other proxies such as non-continuation rates were also tested in the sensitivity analysis;
- Russell Group and Oxbridge dummies: The Russell Group dummy takes the value of 1 if a provider belongs to the Russell Group and 0 otherwise. The Oxbridge dummy takes the value of 1 if the provider is Cambridge or Oxford, and 0 otherwise. The Russell Group and Oxbridge dummies were used to proxy for perceived reputation. It was assumed that specific group of providers, in particular, Russell Group and Oxbridge HEIs, have a higher reputation than other providers. It is recognised that this is an imperfect approach and that there are other HEIs with similar or better perceived reputations compared to Russell Group and/or Oxbridge providers.
- Time spent in research: percentage of time allocated in research obtained from TRAC, Section F2b, unweighted for salaries;
- Specialist: dummy variable that takes the value of 1 if the provider is a specialist institution, and 0 otherwise, as per group F (specialist music/arts teaching institutions) in the TRAC peer group;
- Cost centre: 45 dummies indicating the cost centre; and
- Time effects: Two time dummies have been included for the years 2012/13 and 2013/14. The 2012/13 (2013/14) dummy takes the value of 1 if the data refer to year 2012/13 (2013/14), and 0 otherwise.

The model was estimated by OLS with clustered standard errors at provider level using data from 128 HEIs, 45 cost centres and three years' worth of data (2012/13 to 2014/15).[53] Overall the sample contains more than 3,000 observations.

Model 2 (house prices/density model) is similar to equation (1) with the regional dummy variables being replaced by the house prices and density variables as described by equation (6).

[53] The model has also been estimated by multi-level mixed effects as part of the sensitivity analysis.

$$\log S_{i,j,t} = \alpha + X\mathrm{B} + \sum_{i=1}^{k-1} CC_i + \delta_1 \log HP_l + \delta_2 \log D_l + \varepsilon_{i,j,t} \quad (6)$$

where HP is the natural logarithm of house prices in local authority l and D is the natural logarithm of population density in local authority l.

A3. Translating model coefficients estimates into regional effects

The regional dummy model estimates described by equations (1), (3) and (5) were converted into regional impacts using the approach applied by NHSE[54]:

$Regional\ Variation_i = \frac{\exp(\beta_i)}{\exp(average\ \beta)} * 100$, where β_i is the dummy coefficient of region *i*.

For the density and house prices models, the regional effects were based on the model predicted values using sample average values for all variables except house prices and population density which took the average house price/density value for each region.

A4. Model coefficient estimates

This section sets out the econometric model coefficient estimates for the models presented in Sections 6 and 7.

A4.1 HESA academic staff costs

Table 8 presents the model coefficients of the regional dummies (Model 1) and house prices/density model (Model 2) described by equations (1) and (2).

Table 8: Academic staff costs regression results (HESA)

Variable	Regional dummies model (Model 1)	House prices/density model (Model 2)
Gender (% of female FTE staff)	-0.00612** (0.00279)	-0.00794*** (0.00301)
Young Age (% of FTE staff less than 40 years old)	-0.00580*** (0.00202)	-0.00630*** (0.00189)
Part time FTE staff (%)	-0.00387 (0.00382)	-0.00351 (0.00355)
REF % of four-star output	-0.000834 (0.00213)	0.000591 (0.00220)
REF % squared	0.0000405 (0.0000447)	0.0000203 (0.0000444)
Time spent doing research (%)	0.00348** (0.00161)	0.00264 (0.00177)
Specialist	-0.0176 (0.0794)	-0.0415 (0.0750)
Regional dummies (Baseline: West Midlands)		
East Midlands	-0.124**	

[54] National Health Service England, 2014, 'Guide to the Market Forces Factor', available at: https://www.gov.uk/government/publications/guide-to-the-market-forces-factor-201415

Variable	Regional dummies model (Model 1)	House prices/density model (Model 2)
	(0.0594)	
East of England	-0.0468 (0.0552)	
Inner London	0.0816 (0.0603)	
Multiple campuses	-0.0951* (0.0497)	
North East	-0.0576 (0.0501)	
North West	-0.135** (0.0582)	
Outer London	0.0409 (0.0482)	
South East	-0.0385 (0.0522)	
South West	-0.0132 (0.0441)	
Yorkshire and The Humber	-0.0319 (0.0480)	
Density (persons per hectare)		0.0160 (0.0125)
House prices (median)		0.0960*** (0.0227)
year==2013	-0.0201 (0.0217)	-0.0193 (0.0218)
year==2014	0.0429*** (0.0130)	0.0448*** (0.0130)
Constant	4.681*** (0.150)	3.533*** (0.238)
Observations	3595	3595
R-squared	0.167	0.157
Adjusted R-squared	0.153	0.145
BIC	2104.0	2081.0
F-test (regional dummies are jointly zero)	3.18***	

Note: Sample includes data for average academic staff costs over a three-year period 2012/13 to 2014/15; the dependent variable is the average academic staff costs per FTE, in logarithmic form; the models are estimated by OLS using clustered standard errors by provider; adjusted R-squared and Bayesian information criteria (BIC) are model fit measures; the F-test tests the null hypothesis that all regional dummies are jointly zero; the coefficients of the cost centre dummies are not reported; standard errors are in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis on HESA data (2012/13 to 2014/15).

The model coefficients suggest that:

- **Staff features**. Age and gender have a statistically significant impact on average wages; the impact of part-time contracts is negative but statistically insignificant.

- **Research quality**. The REF variable is statistically insignificant in both models[55]. However, the results need to be interpreted with care, as the REF variable is highly correlated with the 'time spent doing research'. When the 'time spent doing research' is excluded from the model, the REF variable becomes statistically significant (results not reported).

- **Time spent doing research**. This variable aims to capture staff's research skills and capacity and is positive in both models but statistically significant only in the regional dummies model.

- **Specialist**. The specialist dummy is negative but statistically insignificant.

- **Geographic variables**. The results provided by the regional dummies model are mixed (baseline is West Midlands). The magnitude of the coefficient estimates suggests that there is considerable variation in average academic staff wages across the country. In addition, the F-test suggests that all dummies are jointly statistically significant, which supports the regional variation hypothesis[56]. However, various other tests suggest that most of the regional dummy estimates are not statistically different from each other[57]. In particular, it was found that there are two groups of regions: (1) Inner London, Outer London, and the East of England, and (2) the South East, South West, East Midlands, North East, Yorkshire and The Humber, and North West. Regions between the two groups are statistically different from each other; but regions within each group are not statistically different from each other. These results are likely to be driven by the small within-region sample size, which makes it difficult to test for the statistical significance of these estimates. The results of the second model suggest that average staff costs are positively associated with regional house prices (the coefficient of house prices is positive and highly significant). The population density is statistically insignificant[58]. Overall, these results are interpreted to provide evidence in favour of the regional variation in average wages.

A4.2 ASHE academic and non-academic staff costs

Table 9 presents the model coefficients of the regional and local authority models described by equation (3) using all occupations.

[55] REF squared has been included in the model to entertain the possibility that the relationship between staff costs and research quality is non-linear.

[56] The statistical significance of the individual dummies needs to be interpreted with care as it depends on the baseline region selected. The baseline region in the models reported is West Midlands. Changing the baseline category does not affect the magnitude of the impacts, but it affects the standard errors and statistical significance due to differences in the number of observations within each region.

[57] These results suggest that there are two groups of regions: (1) Inner London, Outer London, and the East of England, and (2) the South East, South West, East Midlands, North East, Yorkshire and The Humber, and North West. Regions between the two groups are statistically different from each other; but regions within each group are not statistically different from each other.

[58] The density variable is statistically insignificant in this model, but statistically significant in the model where the house prices variable is excluded.

Table 9: Academic and non-academic staff costs regression results (ASHE – all occupations)

Variable	Regional model	Local Authority model
Age	0.0340***	0.0339***
	(0.00044)	(0.00044)
Age Squared	-0.000356***	-0.000355***
	(0.00001)	(0.00001)
Part-Time (vs Full-Time)	-0.0342***	-0.0313***
	(0.00194)	(0.00193)
Unclassified (Permanent/Temporary)	0.000596	-0.00766
	(0.00745)	(0.00716)
Temporary	-0.0152***	-0.0159***
	(0.00291)	(0.0029)
Male (vs Female)	0.104***	0.103***
	(0.00199)	(0.00196)
Public Sector (vs Private)	0.0657***	0.0715***
	(0.0034)	(0.00339)
Organisation Size (Base: More than 500 Employees)		
Between one and 10 Employees	-0.178***	-0.166***
	(0.00355)	(0.00355)
Between 11 and 25 Employees	-0.107***	-0.0961***
	(0.0035)	(0.00347)
Between 26 and 50 Employees	-0.0807***	-0.0717***
	(0.00353)	(0.00351)
Between 51 and 250 Employees	-0.0417***	-0.0366***
	(0.00252)	(0.00251)
Between 251 and 500 Employees	-0.0218***	-0.0173***
	(0.00366)	(0.00363)
Occupation (Base: SOC 2: Professional Occupations		
SOC 1: Managers; Directors; Senior Officials	-0.0275***	-0.0256***
	(0.00495)	(0.00489)
SOC 3: Associate Professional and Technical Occupations	-0.252***	-0.251***
	(0.00336)	(0.00333)
SOC 4: Administrative and Secretarial Occupations	-0.518***	-0.514***
	(0.00297)	(0.00294)
SOC 5: Skilled Trades Occupations	-0.522***	-0.512***
	(0.00387)	(0.00384)
SOC 6: Caring, Leisure and Other Service Occupations	-0.654***	-0.648***
	(0.003)	(0.00299)

Variable	Regional model	Local Authority model
SOC 7: Sales and Customer Service Occupations	-0.681***	-0.670***
	(0.00371)	(0.00367)
SOC 8: Process, Plant and Machine Operatives	-0.671***	-0.656***
	(0.00389)	(0.00385)
SOC 9: Elementary Occupations	-0.743***	-0.733***
	(0.00303)	(0.00303)
Tenure (Base: One to Two Years)		
Less than six months	-0.0466***	-0.0462***
	(0.00225)	(0.00224)
Six months to one year	-0.0336***	-0.0336***
	(0.00219)	(0.00219)
Two to five years	0.0337***	0.0350***
	(0.00207)	(0.00205)
Five to 10 years	0.0656***	0.0672***
	(0.00241)	(0.00238)
10 to 20 years	0.112***	0.113***
	(0.00289)	(0.00284)
20 years+	0.160***	0.163***
	(0.00384)	(0.00381)
Year 2014	0.0119***	0.0119***
	(0.00096)	(0.00095)
Year 2015	0.0323***	0.0325***
	(0.00107)	(0.00107)
Industry Dummies	Yes	Yes
Location Dummies	Regional	Local Authority
Constant	2.252***	2.301***
Observations	419,468	419,468
Adjusted R-Squared	0.57	0.58
BIC	314,859	311,459

Notes: Comparator academic occupations are: Managers, directors and senior officials (SOC Major Group 1) and professional occupations (SOC Major Group 2). Comparator non-academic occupations are: Administrative and secretarial occupations (SOC Major Group 4), IT staff and lab technicians (SOC Subgroup 31), hall/facilities managers, and counsellors (SOC units 2317 and 3235); sample includes data for individual wages over a three-year period 2013-2015 (annual data); employees working in the financial industry are excluded from the sample; dependent variable is the log of hourly earnings excluding overtime; the models are estimated by weighted least squares using clustered standard errors by individual and survey weights to address issues associated with sample representativeness; survey weights are driven by age group, sex, occupation, and region and have been obtained from the ONS; adjusted R-squared and BIC are model fit measures; the coefficients of the industry and regional dummies are not reported; standard errors in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis on ASHE data for years from 2013 to 2015.

The results suggest that:

- **Individual features**. Wages increase with age and tenure[59]; and male employees tend to earn more than female employees.
- **Job characteristics**. All the variables associated with job characteristics are statistically significant in both models. For example, part-time and temporary employees earn, on average, less than full-time and permanent employees. The larger the organisation size, the higher the wages, and professional occupations tend to earn, on average, more than other types of occupations.
- **Model fit**. Both models fit the data quite well; R-square is around 57 per cent whereas the local authority model has a slightly better fit as indicated by the BIC (coefficient estimates are very similar between the regional and local authority models)[60].
- **Precedent**. The coefficient estimates are broadly in line with a recent study carried out by ONS using the ASHE data[61].

A4.3 HESA benefits (student enrolment)

Table 10 presents the model coefficients of the regional dummy variable (Model 1) and house prices/density model (Model 2) described by equations (5) and (6).

Table 10: International student enrolment regression results (HESA)

Variable	Regional dummies model (Model 1)	House prices/density model (Model 2)
REF % of four-star output	0.0277*** (0.00673)	0.0272*** (0.00654)
REF % squared	-0.000458*** (0.000121)	-0.000451*** (0.000118)
NSS learning and teaching z-score	-0.00826 (0.0155)	0.00275 (0.0144)
Russell Group	0.428*** (0.0968)	0.430*** (0.101)
Oxbridge	-0.0681 (0.205)	-0.124 (0.138)
Specialist	-0.322 (0.703)	-0.423 (0.697)
Time spent doing research (%)	0.0155***	0.0135***

[59] The relationship between wage and age is non-linear as implied by the quadratic age term.
[60] The BIC is a model fit criterion; the lower the BIC the better the model fit.
[61] Office for National Statistics, 2016, 'Analysis of factors affecting earnings using Annual Survey of Hours and Earnings: 2016', available at: https://www.ons.gov.uk/releases/analysisoffactorsaffectingearningsusingannualsurveyofhoursandearnings2016. Note that the results may not fully correspond to official ONS statistics because the data used for this project is research data for external use provided by the ONS at the Virtual Microdata Laboratory. In addition, the ONS publication uses data that is adjusted for bonus payments which is not available to external researchers.

Variable	Regional dummies model (Model 1)	House prices/density model (Model 2)
	(0.00395)	(0.00425)
Regional dummies (Baseline: West Midlands)		
East Midlands	0.0371 (0.153)	
East of England	0.153 (0.165)	
Inner London	0.264* (0.150)	
Multiple campuses	-0.0272 (0.233)	
North East	0.00162 (0.127)	
North West	-0.190 (0.150)	
Outer London	0.122 (0.323)	
South East	0.0243 (0.146)	
South West	-0.145 (0.120)	
Yorkshire and The Humber	-0.00236 (0.118)	
year==2013	0.0441*** (0.0123)	0.0447*** (0.0120)
year==2014	0.0648*** (0.0172)	0.0653*** (0.0171)
House prices (median local authority prices; log)		0.247*** (0.0766)
Density (persons per hectare; log)		0.0458 (0.0429)
Constant	3.777*** (0.198)	0.720 (0.845)

Variable	Regional dummies model (Model 1)	House prices/density model (Model 2)
Observations	3345	3345
R-squared	0.602	0.604
Adjusted R-squared	0.595	0.598
BIC	8669.1	8589.1
F-test (regional dummies are jointly zero)	3.52***	

Note: Sample includes data for all HEI providers over the period 2012/13 to 2014/15 (annual data); dependent variable is the log of international student enrolment by cost centre; the models are estimated by OLS using clustered standard errors by provider; adjusted R-squared and BIC are model fit measures; the F-test tests the null hypothesis that all regional dummies are jointly zero; the coefficients of the cost centre dummies are not reported; standard errors in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis using HESA data (2012/13-2014/15).

The results suggest that:

- **Quality variables**. The REF variable is positive and statistically significant at 1 per cent level in both models, suggesting that university quality is positively associated with international student enrolment[62]. On the other hand, the coefficient of NSS learning and teaching z-score, a proxy for teaching quality, is statistically insignificant.

- **Perceived reputation.** The Russell Group and Oxbridge dummies have been included in the model to control for perceived reputation, albeit it is recognised that this approach is imperfect. The Russell Group dummy is positive and statistically significant in both models. After controlling for other factors, Russell Group HEIs have around 43 per cent more international students than other HEIs. The Oxbridge dummy is statistically insignificant.

- **Provider type**. The specialist variable is negative but statistically insignificant, suggesting that there are no significant differences in student enrolment between specialist and non-specialist HEIs. However, the percentage of time spent in research is positive and statistically significant suggesting that research intensive HEIs enrol more students than other HEIs.

- **Time effects**. The time dummies are positive and statistically significant. These estimates reflect the increase in international student numbers over the period 2012/13 to 2014/15.

- **Regional variables**. The magnitude of the regional dummies (baseline is West Midlands)[63] indicate that there is large variation in student enrolment by geography, and the F-test suggests that their effect is jointly significant. The model that proxies the impact of location by house prices and population density also suggests statistically significant differences in student enrolment by location.

- **Model fit**. Both models presented have a reasonable fit: R-square is around 60 per cent. The BIC shows that the house price/density model is somewhat superior to the regional model.

[62] The coefficient of the REF squared term suggests that the relationship between enrolment and quality is non-linear.
[63] The dummy for 'multiple campuses' is also included to account for institutions that have campuses located across different regions.

Table 11 sets out the model coefficient estimates for the postgraduate student enrolment. The results are qualitatively similar to those of the international student enrolment.

Table 11: Postgraduate student enrolment regression results (HESA)

Variable	Regional dummies model (Model 1)	House prices/density model (Model 2)
REF % of four-star output	0.0220*** (0.00611)	0.0199*** (0.00624)
REF % squared	-0.000388*** (0.000115)	-0.000347*** (0.000117)
NSS learning and teaching z-score	-0.00242 (0.00902)	0.000290 (0.00951)
Russell Group	0.395*** (0.0770)	0.422*** (0.0758)
Oxbridge	0.337 (0.203)	0.195 (0.177)
Specialist	0.401 (0.283)	0.370 (0.266)
Time spent doing research (%)	0.00541* (0.00280)	0.00317 (0.00280)
Regional dummies (Baseline: West Midlands)		
East Midlands	-0.0480 (0.164)	
East of England	0.0468 (0.145)	
Inner London	0.399*** (0.148)	
Multiple campuses	0.00997 (0.172)	
North East	-0.141 (0.137)	
North West	-0.109 (0.148)	
Outer London	0.0905 (0.194)	
South East	-0.0113 (0.128)	

Variable	Regional dummies model (Model 1)	House prices/density model (Model 2)
South West	-0.259* (0.142)	
Yorkshire and The Humber	-0.103 (0.131)	
year==2013	0.000769 (0.0119)	-0.0000791 (0.0120)
year==2014	0.0102 (0.0144)	0.0116 (0.0146)
House prices (median local authority prices; log)		0.331*** (0.0564)
Density (persons per hectare; log)		0.0287 (0.0303)
Constant	4.946*** (0.224)	0.910 (0.654)
Observations	2871	2871
R-squared	0.565	0.566
Adjusted R-squared	0.556	0.558
BIC	6219.0	6151.7
F-test (regional dummies are jointly zero)	7.33***	

Note: Sample includes data for all HEI providers over the period 2012/13 to 2014/15 (annual data); dependent variable is the log of postgraduate student enrolment by cost centre; the models are estimated by OLS using clustered standard errors by provider; adjusted R-squared and BIC are model fit measures; the F-test tests the null hypothesis that all regional dummies are jointly zero; the coefficients of the cost centre dummies are not reported; standard errors in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis using HESA data (2012/13-2014/15).

A5. Additional analysis and sensitivity analysis

This section sets out the results of additional regression analysis:

- Table 12 presents the results of a sample of the sensitivity checks conducted for the HEIs' academic staff costs model alongside the baseline results;
- Table 13 reports the coefficients for the models used to test the hypothesis that the regional variation in research and teaching academic staff costs in HEIs are different from each other;
- Table 14 presents the coefficient estimates of the ASHE model for the academic and non-academic comparator groups alongside the results based on all occupation groups; and
- Table 15 presents some sensitivity analysis with regard to the student enrolment analysis.

Table 12: Academic staff costs model coefficients (HESA) – Sensitivity analysis

	Baseline models		Baseline model without outliers (excl. large year-on-year changes in staff costs)[1]		Baseline model without outliers (based on dfbeta)[2]		Alternative specification	
	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)
Gender (% of female FTE staff)	-0.00612** (0.00279)	-0.00794*** (0.00301)	-0.00671** (0.00286)	-0.00819*** (0.00307)	-0.00268* (0.00155)	-0.00478** (0.00197)	-0.00283 (0.00254)	-0.00509* (0.00282)
Young Age (% of FTE staff less than 40 years old)	-0.00580*** (0.00202)	-0.00630*** (0.00189)	-0.00585*** (0.00205)	-0.00625*** (0.00193)	-0.00615*** (0.00127)	-0.00712*** (0.00143)	-0.00594*** (0.00180)	-0.00681*** (0.00173)
Part time FTE staff (%)	-0.00387 (0.00382)	-0.00351 (0.00355)	-0.00356 (0.00377)	-0.00345 (0.00358)	-0.00669*** (0.00234)	-0.00390 (0.00261)	-0.00509 (0.00357)	-0.00458 (0.00330)
REF % of four-star output	-0.000834 (0.00213)	0.000591 (0.00220)	0.000574 (0.00227)	0.00199 (0.00249)	0.0000552 (0.00127)	0.000334 (0.00160)	-0.0000579 (0.00197)	0.00121 (0.00208)
REF % squared	0.0000405 (0.0000447)	0.0000203 (0.0000444)	0.00000726 (0.0000450)	-0.0000112 (0.0000475)	0.0000155 (0.0000263)	0.0000209 (0.0000311)	0.0000260 (0.0000391)	0.00000878 (0.0000392)
Time spent doing research (%)	0.00348** (0.00161)	0.00264 (0.00177)	0.00342** (0.00166)	0.00247 (0.00184)	0.00432*** (0.000922)	0.00401*** (0.00112)	0.00428*** (0.00153)	0.00344** (0.00167)
Specialist	-0.0176 (0.0794)	-0.0415 (0.0750)	-0.0128 (0.0797)	-0.0349 (0.0760)	-0.00640 (0.0318)	-0.0189 (0.0377)	-0.0240 (0.0525)	-0.0461 (0.0504)
Regional dummies (Baseline: West Midlands)								
East Midlands	-0.124** (0.0594)		-0.133** (0.0605)		-0.0518*** (0.0164)		-0.120* (0.0618)	
East of England	-0.0468 (0.0552)		-0.0442 (0.0564)		-0.0203 (0.0171)		-0.0538 (0.0530)	
Inner London	0.0816 (0.0603)		0.0796 (0.0626)		0.123*** (0.0244)		0.0545 (0.0610)	

	Baseline models		Baseline model without outliers (excl. large year-on-year changes in staff costs)[1]		Baseline model without outliers (based on dfbeta)[2]		Alternative specification	
	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)
Multiple campuses	-0.0951* (0.0497)		-0.113** (0.0504)		-0.0985*** (0.0210)		-0.114** (0.0499)	
North East	-0.0576 (0.0501)		-0.0592 (0.0509)		-0.0366 (0.0227)		-0.0598 (0.0507)	
North West	-0.135** (0.0582)		-0.136** (0.0587)		-0.0706*** (0.0266)		-0.155*** (0.0581)	
Outer London	0.0409 (0.0482)		0.0243 (0.0519)		0.0495** (0.0214)		0.0193 (0.0473)	
South East	-0.0385 (0.0522)		-0.0549 (0.0564)		-0.00982 (0.0264)		-0.0427 (0.0517)	
South West	-0.0132 (0.0441)		-0.0163 (0.0445)		0.00474 (0.0165)		-0.0196 (0.0424)	
Yorkshire and The Humber	-0.0319 (0.0480)		-0.0378 (0.0489)		-0.0331 (0.0204)		-0.0368 (0.0458)	
Density (persons per hectare)		0.0160 (0.0125)		0.0150 (0.0128)		0.0188** (0.00863)		0.0148 (0.0139)
House prices (median)		0.0960*** (0.0227)		0.0950*** (0.0236)		0.0843*** (0.0146)		0.0908*** (0.0223)
Year == 2013	-0.0201 (0.0217)	-0.0193 (0.0218)	-0.0157 (0.0223)	-0.0148 (0.0224)	-0.000838 (0.00602)	-0.0120 (0.00813)	-0.0236 (0.0217)	-0.0225 (0.0218)
Year == 2014	0.0429*** (0.0130)	0.0448*** (0.0130)	0.0484*** (0.0139)	0.0500*** (0.0139)	0.0283*** (0.00617)	0.0272*** (0.00899)	0.0380*** (0.0127)	0.0406*** (0.0127)
NSS learning and teaching z-score							-0.00366 (0.00340)	-0.0000126 (0.00346)

	Baseline models		Baseline model without outliers (excl. large year-on-year changes in staff costs)[1]		Baseline model without outliers (based on dfbeta)[2]		Alternative specification	
	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)	Regional dummies (Model 1)	House prices/density model (Model 2)
	4.681*** (0.150)	3.533*** (0.238)	4.695*** (0.153)	3.546*** (0.252)	4.531*** (0.0945)	3.564*** (0.158)	4.562*** (0.144)	3.503*** (0.240)
Observations	3595	3595	3562	3562	2908	3332	3570	3570
R-squared	0.167	0.157	0.177	0.165	0.439	0.248	0.171	0.159
Adjusted R-squared	0.153	0.145	0.163	0.152	0.427	0.237	0.157	0.146
BIC	2104.0	2081.0	1915.8	1903.6	-2648.0	-630.5	1923.2	1910.8

Notes: [1]Observations that exhibit significant year-on-year variation, corresponding to the top and bottom 5 per cent of the year-on-year growth in staff costs distribution, were excluded [2]; observations that have large difference in betas (*dfbetas)* were excluded (*dfbetas* is a statistic that measures the difference between the regression coefficient when the *i*th observation is included and excluded, the difference being scaled by the estimated standard error of the coefficient); sample includes data for average academic staff costs over a three-year period 2012/13 to 2014/15; the dependent variable is the average academic staff costs per FTE, in logarithmic form; the models are estimated by OLS using clustered standard errors by provider; adjusted R-squared and BIC are model fit measures; the coefficients of the cost centre dummies are not reported; standard errors are in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis on HESA data (2012/13 to 2014/15).

Table 13: Academic staff costs model coefficients (HESA) – Research vs teaching academic staff costs

	Baseline model		Alternative model specification	
	House prices/density model	House prices/density model: house prices/time spent in research interaction	House prices/density model	House prices/density model: house prices/time spent in research interaction
Gender (% of female FTE staff)	-0.00794*** (0.00301)	-0.00793** (0.00304)	-0.00509* (0.00282)	-0.00510* (0.00283)
Young Age (% of FTE staff less than 40 years old)	-0.00630*** (0.00189)	-0.00629*** (0.00193)	-0.00681*** (0.00173)	-0.00684*** (0.00177)
Part time FTE staff (%)	-0.00351 (0.00355)	-0.00352 (0.00360)	-0.00458 (0.00330)	-0.00455 (0.00334)
REF % of four-star output	0.000591 (0.00220)	0.000568 (0.00218)	0.00121 (0.00208)	0.00126 (0.00204)
REF % squared	0.0000203 (0.0000444)	0.0000207 (0.0000440)	0.00000878 (0.0000392)	0.00000769 (0.0000389)
Time spent doing research (%)	0.00264 (0.00177)	0.00323 (0.0188)	0.00344** (0.00167)	0.00181 (0.0202)
Specialist	-0.0415 (0.0750)	-0.0416 (0.0751)	-0.0461 (0.0504)	-0.0447 (0.0512)
Density (persons per hectare)	0.0160 (0.0125)	0.0161 (0.0129)	0.0148 (0.0139)	0.0147 (0.0145)
House prices (median)	0.0960*** (0.0227)	0.0974** (0.0467)	0.0908*** (0.0223)	0.0866* (0.0506)
year==2013	-0.0193 (0.0218)	-0.0193 (0.0217)	-0.0225 (0.0218)	-0.0224 (0.0217)
year==2014	0.0448*** (0.0130)	0.0447*** (0.0131)	0.0406*** (0.0127)	0.0407*** (0.0128)

	Baseline model		Alternative model specification	
	House prices/density model	House prices/density model: house prices/time spent in research interaction	House prices/density model	House prices/density model: house prices/time spent in research interaction
Interaction: (House prices)x(Time spent doing research, %)		**-0.0000478**		**0.000135**
		(0.00153)		**(0.00166)**
NSS learning and teaching z-score			-0.0000126	-0.0000333
			(0.00346)	(0.00353)
	3.533***	3.514***	3.503***	3.554***
	(0.238)	(0.583)	(0.240)	(0.629)
Observations	3595	3595	3570	3570
R-squared	0.157	0.157	0.159	0.159
Adjusted R-squared	0.145	0.145	0.146	0.146
BIC	2081.0	2089.2	1910.8	1919.0

Notes: Sample includes data for average academic staff costs over a three-year period 2012/13 to 2014/15; the dependent variable is the average academic staff costs per FTE, in logarithmic form; the models are estimated by OLS using clustered standard errors by provider; adjusted R-squared and BIC are model fit measures; the coefficients of the cost centre dummies are not reported; standard errors are in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis on HESA data (2012/13 to 2014/15).

Table 14: ASHE regression estimates by occupation group

	All occupations		Academic comparator occupations		Non-academic comparator occupations	
	Regional model	Local Authority model	Regional model	Local Authority model	Regional model	Local Authority model
Age	0.0340***	0.0339***	0.0608***	0.0608***	0.0341***	0.0341***
	(0.00044)	(0.00044)	(0.00153)	(0.00151)	(0.00093)	(0.00091)
Age Squared	-0.000356***	-0.000355***	-0.000601***	-0.000599***	-0.000357***	-0.000357***
	(0.00001)	(0.00001)	(0.00002)	(0.00002)	(0.00001)	(0.00001)
Part-Time (vs Full-Time)	-0.0342***	-0.0313***	0.0353***	0.0376***	-0.0722***	-0.0656***
	(0.00194)	(0.00193)	(0.00545)	(0.00543)	(0.00402)	(0.00399)
Unclassified (Permanent/Temporary)	0.000596	-0.00766	-0.0162***	-0.025***	0.00434***	-0.00257***
	(0.00745)	(0.00716)	(0.0162)	(0.01603)	(0.01607)	(0.01606)
Temporary	-0.0152***	-0.0159***	-0.00388***	-0.00525***	-0.0482***	-0.0511***
	(0.00291)	(0.0029)	(0.00681)	(0.00682)	(0.00648)	(0.00642)
Male (vs Female)	0.104***	0.103***	0.142***	0.14***	0.0899***	0.0909***
	(0.00199)	(0.00196)	(0.00443)	(0.00439)	(0.00454)	(0.00445)
Public Sector (vs Private)	0.0657***	0.0715***	0.0629***	0.0746***	0.0424***	0.0462***
	(0.0034)	(0.00339)	(0.00746)	(0.00757)	(0.00711)	(0.00699)
Non Profit (vs Private)	0.0349***	0.0326***	-0.0549***	-0.0549***	0.0906***	0.0778***
	(0.00376)	(0.00376)	(0.00849)	(0.00855)	(0.00813)	(0.00808)
Organisation Size (Base: More than 500 Employees)						
Between one and 10 Employees	-0.178***	-0.166***	-0.382***	-0.362***	-0.0864***	-0.0737***
	(0.00355)	(0.00355)	(0.00956)	(0.00957)	(0.00697)	(0.0069)
Between 11 and 25 Employees	-0.107***	-0.0961***	-0.173***	-0.155***	-0.0818***	-0.0676***
	(0.0035)	(0.00347)	(0.0096)	(0.00954)	(0.00733)	(0.00721)
Between 26 and 50 Employees	-0.0807***	-0.0717***	-0.102***	-0.0883***	-0.0711***	-0.0607***
	(0.00353)	(0.00351)	(0.00938)	(0.00929)	(0.00736)	(0.00731)
Between 51 and 250 Employees	-0.0417***	-0.0366***	-0.0261***	-0.0186***	-0.0607***	-0.0544***
	(0.00252)	(0.00251)	(0.00567)	(0.00571)	(0.00557)	(0.00553)
Between 251 and 500 Employees	-0.0218***	-0.0173***	-0.00313***	0.00539***	-0.0394***	-0.0328***
	(0.00366)	(0.00363)	(0.00803)	(0.00804)	(0.00774)	(0.00777)
Occupation (Base: SOC 2: Professional Occupations)					-0.667***	-0.659***
SOC 1: Managers; Directors; Senior Officials	-0.0275***	-0.0256***	0.0476***	0.0505***	(0.04869)	(0.04796)
	(0.00495)	(0.00489)	(0.00543)	(0.00537)	-0.0864***	-0.0737***
SOC 3: Associate Professional And Technical Occupations	-0.252***	-0.251***			-0.777***	-0.783***
	(0.00336)	(0.00333)			(0.0203)	(0.02003)
SOC 4: Administrative And Secretarial Occupations	-0.518***	-0.514***			-0.894***	-0.898***
	(0.00297)	(0.00294)			(0.01986)	(0.01963)
SOC 5: Skilled Trades Occupations	-0.522***	-0.512***				
	(0.00387)	(0.00384)				

	All occupations		Academic comparator occupations		Non-academic comparator occupations	
	Regional model	Local Authority model	Regional model	Local Authority model	Regional model	Local Authority model
SOC 6: Caring, Leisure and Other Service Occupations	-0.654***	-0.648***				
	(0.003)	(0.00299)				
SOC 7: Sales and Customer Service Occupations	-0.681***	-0.670***				
	(0.00371)	(0.00367)				
SOC 8: Process, Plant and Machine Operatives	-0.671***	-0.656***				
	(0.00389)	(0.00385)				
SOC 9: Elementary Occupations	-0.743***	-0.733***				
	(0.00303)	(0.00303)				
Tenure (Base: One to Two Years)						
<six Months	-0.0466***	-0.0462***	-0.0465***	-0.0424***	-0.0654***	-0.0654***
	(0.00225)	(0.00224)	(0.00632)	(0.00629)	(0.00555)	(0.00551)
Six Months to One Year	-0.0336***	-0.0336***	-0.0226***	-0.0201***	-0.0458***	-0.045***
	(0.00219)	(0.00219)	(0.00521)	(0.00517)	(0.00522)	(0.00517)
Two to Five Years	0.0337***	0.0350***	0.0272***	0.0303***	0.043***	0.0451***
	(0.00207)	(0.00205)	(0.00486)	(0.00481)	(0.00449)	(0.00442)
Five to 10 Years	0.0656***	0.0672***	0.0374***	0.0411***	0.0685***	0.072***
	(0.00241)	(0.00238)	(0.0055)	(0.00544)	(0.0051)	(0.005)
10 to 20 Years	0.112***	0.113***	0.0723***	0.0772***	0.112***	0.117***
	(0.00289)	(0.00284)	(0.00625)	(0.00619)	(0.00589)	(0.00583)
20 Years+	0.160***	0.163***	0.0849***	0.0902***	0.175***	0.18***
	(0.00384)	(0.00381)	(0.00798)	(0.00792)	(0.00753)	(0.00739)
Regional dummies (Base: Inner London)						
North East	-0.259***		-0.311***		-0.335***	
	(0.00468)		(0.01077)		(0.00937)	
North West	-0.242***		-0.295***		-0.29***	
	(0.00373)		(0.00779)		(0.0075)	
Yorkshire and The Humber	-0.255***		-0.305***		-0.309***	
	(0.00392)		(0.00856)		(0.00821)	
East Midlands	-0.246***		-0.298***		-0.311***	
	(0.00404)		(0.00901)		(0.00836)	
West Midlands	-0.240***		-0.289***		-0.305***	
	(0.00386)		(0.00833)		(0.00801)	
South West	-0.235***		-0.313***		-0.278***	
	(0.0039)		(0.00816)		(0.00786)	
East	-0.207***		-0.266***		-0.247***	
	(0.00387)		(0.00801)		(0.00794)	
South East	-0.165***		-0.21***		-0.214***	
	(0.00366)		(0.00718)		(0.00747)	
Outer London	-0.117***		-0.179***		-0.146***	

	All occupations		Academic comparator occupations		Non-academic comparator occupations	
	Regional model	Local Authority model	Regional model	Local Authority model	Regional model	Local Authority model
	(0.00444)		(0.00917)		(0.00896)	
Year 2014	0.0119***	0.0119***	0.00901***	0.00925***	0.0135***	0.0135***
			(0.00211)	(0.0021)	(0.00212)	(0.0021)
Year 2015	0.0323***	0.0325***	0.0222***	0.0226***	0.0377***	0.0378***
			(0.0024)	(0.0024)	(0.00238)	(0.00236)
Industry Dummies	yes	yes	yes	yes	yes	yes
Geographic Dummies	Regional	Local Authority	Regional	Local Authority	Regional	Local Authority
Constant	2.252***	2.301***	1.448***	1.550***	2.806***	2.871***
Observations	419468	419468	104130	104130	67289	67289
Adjusted R-Squared	0.570	0.577	0.243	0.260	0.397	0.416
BIC	314859	311459	117220.4	118192.4	36027.5	37024.4

Notes: Comparator academic occupations are: Managers, directors and senior officials (SOC Major Group 1) and professional occupations (SOC Major Group 2). Comparator non-academic occupations are: Administrative and secretarial occupations (SOC Major Group 4), IT staff and lab technicians (SOC Subgroup 31), hall/facilities managers, and counsellors (SOC units 2317 and 3235); sample includes data for individual wages over a three-year period 2013-2015 (annual data); employees working in the financial industry are excluded from the sample; dependent variable is the log of hourly earnings excluding overtime; the models are estimated by weighted least squares using clustered standard errors by individual and survey weights to address issues associated with sample representativeness; survey weights are driven by age group, sex, occupation, and region and have been obtained from the ONS; Adjusted R-squared and BIC are model fit measures; the coefficients of the industry and regional dummies are not reported; standard errors in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis on ASHE data for years from 2013 to 2015.

Table 15: Student enrolment – sensitivity analysis

	International students		Postgraduate students	
	Regional Dummies (Model 1)	House prices/density (Model 2)	Regional Dummies (Model 1)	House prices/density (Model 2)
REF % of four-star output	-0.0223** (0.0105)	-0.0222** (0.0104)	-0.00655 (0.00859)	-0.00939 (0.00849)
REF % squared	0.000218 (0.000198)	0.000217 (0.000197)	-0.0000479 (0.000160)	-0.00000339 (0.000158)
NSS learning and teaching z-score	-0.00202 (0.0138)	0.0128 (0.0130)	-0.00865 (0.0106)	-0.00481 (0.0102)
Russell Group	0.708*** (0.137)	0.629*** (0.125)	0.362*** (0.0955)	0.414*** (0.0901)
Oxbridge	-0.0702 (0.322)	-0.173 (0.276)	0.560** (0.219)	0.324 (0.201)
Specialist	-0.0400 (0.391)	-0.284 (0.377)	0.408 (0.290)	0.366 (0.288)
Time spent doing research (%)	0.00612*** (0.00221)	0.00601*** (0.00219)	0.00227 (0.00182)	0.00143 (0.00181)
Regional dummies (Baseline: West Midlands)				
East Midlands	0.00877 (0.243)		-0.175 (0.167)	

	International students		Postgraduate students	
	Regional Dummies (Model 1)	House prices/density (Model 2)	Regional Dummies (Model 1)	House prices/density (Model 2)
East of England	0.197 (0.270)		0.0203 (0.189)	
Inner London	0.365* (0.222)		0.418*** (0.155)	
Multiple campuses	0.0824 (0.447)		-0.115 (0.324)	
North East	-0.0813 (0.264)		-0.106 (0.185)	
North West	-0.429* (0.231)		-0.266* (0.161)	
Outer London	0.306 (0.334)		0.0514 (0.234)	
South East	0.0223 (0.216)		-0.103 (0.152)	
South West	-0.142 (0.246)		-0.190 (0.169)	
Yorkshire and The Humber	-0.0723 (0.230)		-0.0752 (0.157)	
year==2013	0.0514*** (0.00936)	0.0514*** (0.00936)	0.000262 (0.00779)	0.000265 (0.00779)
year==2014	0.0836***	0.0836***	0.0102	0.0103

	International students		Postgraduate students	
	Regional Dummies (Model 1)	House prices/density (Model 2)	Regional Dummies (Model 1)	House prices/density (Model 2)
	(0.00937)	(0.00937)	(0.00784)	(0.00784)
House prices (median local authority prices; log)		0.377*** (0.0979)		0.390*** (0.0711)
Density (persons per hectare; log)		0.0851 (0.0525)		0.0190 (0.0393)
Constant	3.934*** (0.196)	-0.900 (1.139)	4.687*** (0.144)	-0.114 (0.823)
Observations	3345	3345	2871	2871
BIC	4762.4	4694.4	2666.3	2600.2

Notes: Sample includes data for student enrolment in FTE over a three-year period 2012/13 to 2014/15; the dependent variable is the cost centre enrolment in FTE, in logarithmic form; the models are estimated by a mixed level linear model; Adjusted R-squared and BIC are model fit measures; the coefficients of the cost centre dummies are not reported; standard errors are in parentheses; ***, **, * reflect statistical significance at 1 per cent, 5 per cent and 10 per cent level, respectively. *Source*: Deloitte analysis on HESA data (2012/13 to 2014/15).

A6. Pace of change and cliff-edges

NHSE takes into account two key practical considerations when they implement their funding allocation formula:

- Pace of change; and
- Cliff-edges.

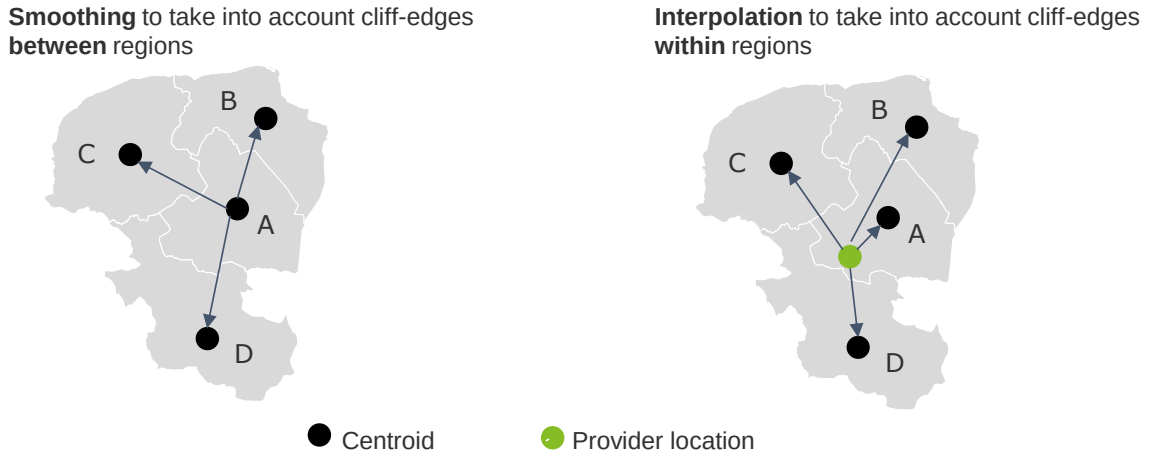
Pace of change

When the funding allocation formula is updated, often there are providers that experience significant changes in the funding they receive from NHSE. In order to deal with this volatility, which could create significant challenges to providers that experience large reductions in their income, NHSE implement changes in the allocation formula gradually through a 'pace of change' approach. Effectively, the actual funds allocated to providers change gradually, over a four to five- year period, towards the target allocations implied by the formula.

Cliff-edges

NHSE computes the regional variation in costs across regions by applying a weighted average approach with the weights being determined by distances between and within regions. Effectively, this approach recognises that costs are likely to vary geographically in a relatively continuous manner. Regional estimates based on a geographical unit (region or local authority) offer an approximation to the true geographical variation in costs and would create breaks at the boundary between neighbouring areas, known as cliff-edges. The approach applied by NHSE, illustrated below, aims to deal with this challenge.

Figure 19: NHSE's smoothing and interpolation approach



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