

2019

Sport & Exercise Science Education

IMPACT ON THE UK ECONOMY

Full Report



Contents

3	Foreword
4	Participating universities and colleges
5	Partners
6	Introduction
8	Key findings
10	Chapter 1: Profile of Sport and Exercise Science
10	Sport and Exercise Science student demographics
11	Sport and Exercise Science student achievement
11	Sport and Exercise Science student earnings
12	Top Sport and Exercise Science occupations
12	Top Sport and Exercise Science industry sectors
13	National data
14	Conclusion
15	Chapter 2: Economic Impact Analysis
16	Graduate impact
22	Chapter 3: Investment Analysis
23	Student perspective
31	Social and public purse perspective
38	Conclusion
40	Chapter 4: Sensitivity Analysis
40	Sensitivity analysis of impact assumptions
40	Sensitivity analysis of investment assumptions
42	Conclusion
43	Appendices
43	Appendix 1: Resources and References
47	Appendix 2: Full Glossary of Terms
49	Appendix 3: Emsi Input-Output Model
51	Appendix 4: Industry to Industry Sector Map



Foreword

We are delighted that The Physiological Society and GuildHE have partnered with Emsi to commission an independent analysis of the contribution Sport and Exercise Science (SES) makes to the UK. Using standard methodologies and analyses, the study assesses the benefits of SES courses to local and national economies, focusing on the contributions of students, universities, and colleges working in the field. It analyses institutions of all sizes throughout the UK that offer SES courses, and points to some of the contributions that this important field makes to the wider UK economy.

The results show that SES courses added £3.9 billion in income to the UK economy, with average salaries for SES graduates at £21,100 per annum after six months of employment. The report also examines the social value of SES courses. Graduates and postgraduate researchers demonstrate critical thinking, attention to detail, interdisciplinary working and, in all four nations of the UK, are using these skills during and after their courses to benefit their local communities and the UK as a whole.

One vital component of SES courses is physiology, the science of the functions of living organisms. Physiological understanding is the foundation of advancements in sport training, performance and health; just as athletes and coaches seek to maximise performance and reduce injury, SES graduates are involved in disciplines as diverse as health education, research into the impact of exercise on physical and mental health, disease prevention, and post-operative outcomes.

SES is also a useful lens through which to recognise the value of diversity and inclusivity in science. The data kindly provided by institutions, supplementing national statistics from the Higher Education Statistics Agency, identifies SES as an area where diversity and inclusivity are both strong and are leading to positive outcomes. For example, case studies within the report highlight the contribution of SES courses in promoting women in sport and working with people from disadvantaged backgrounds.

The case studies also illustrate the impact and importance of SES knowledge exchange activities. Staff and students undertake work that benefits local communities and make crucial contributions to wider society in areas as diverse as flexibility therapy to adventure tourism.

This report is just the beginning. For both our organisations, it will form the bedrock of ongoing work within SES. Importantly, we hope that it will also serve as a useful tool for sport and exercise scientists and professionals in highlighting both the economic and social value of this field of research and study in the UK.

Bridget Lumb
President, The Physiological Society

David Llewellyn
Chair, GuildHE
Vice-Chancellor, Harper Adams University

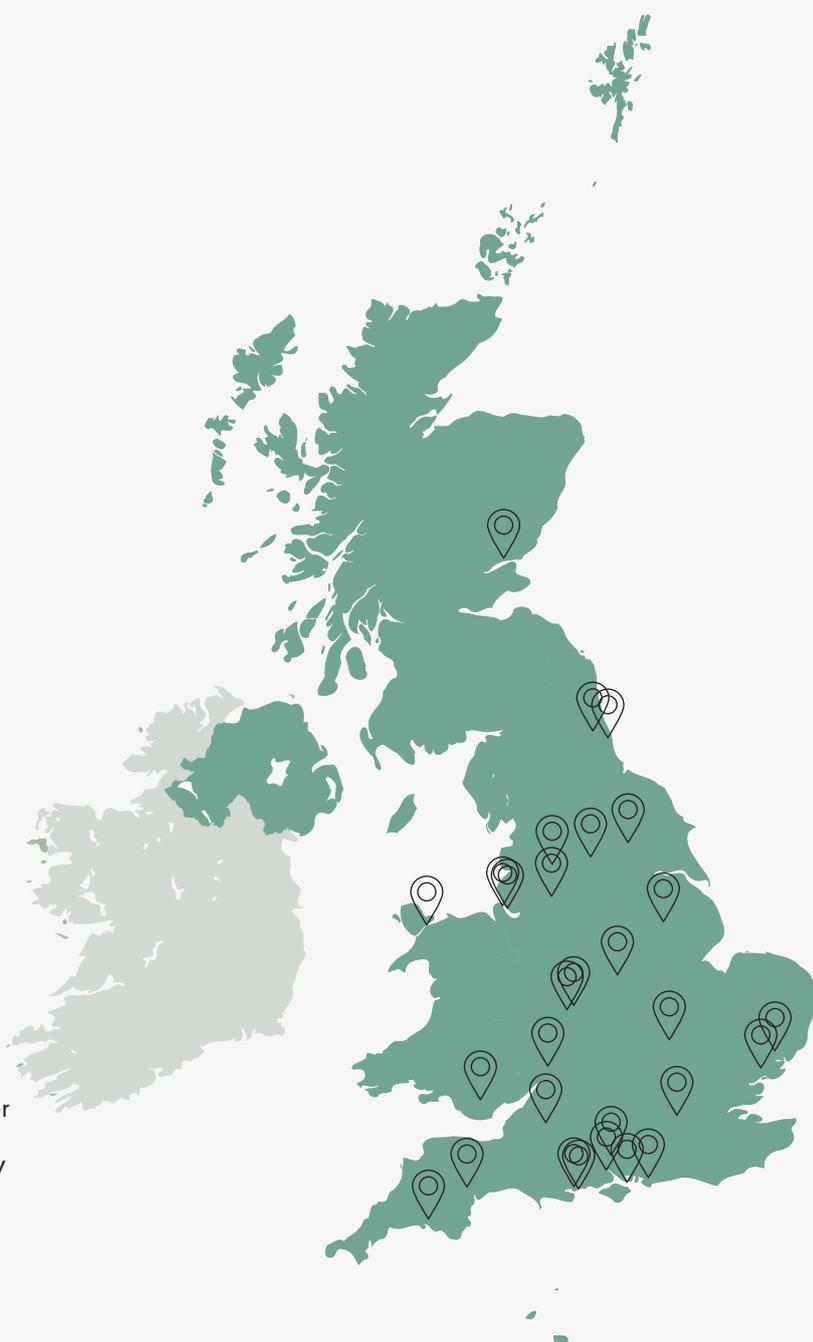
Acknowledgements

Emsi gratefully acknowledges the support of all the Sport and Exercise Science focused universities and colleges in making this study possible. Special thanks also go to The Physiological Society and GuildHE for their input on this report, and Professor Mike Tipton, University of Portsmouth, and Professor Jamie McPhee, Manchester Metropolitan University, for their review and expertise. Any errors in the report are the responsibility of Emsi and not any of the mentioned institutions or individuals.

Participating universities and colleges

Thanks to the universities and colleges listed below for their contribution and support to this analysis. Please note the views in this report should not be attributed to these individuals or institutions.

Abertay University	St Mary's University, Twickenham
AECC University College	Solent University
Bangor University	University Campus of Football Business
Bishop Grosseteste University	University College Birmingham
Bournemouth University	University of Bath
Essex University	University of Bedfordshire
Hartpury University	University of Chichester
Leeds Trinity University	University of Exeter
Liverpool Hope University	University of Portsmouth
Liverpool John Moores University	University of South Wales
Loughborough University	University of Suffolk
Manchester Metropolitan University	University of Sunderland
Newman University	University of Winchester
Northumbria University	University of Worcester
Plymouth Marjon University	York St John University



Partners



As the largest network of physiologists in Europe, with academic journals of global reach, The Physiological Society continues a 140 year tradition of being at the forefront of the life sciences. We support the advancement of physiology by promoting collaboration between physiologists around the world, and research that will contribute to a better understanding of the complex functions of living organisms. Research in physiology helps us to understand how the body works; it also helps us to determine what goes wrong in disease, facilitating the discovery of new treatments. The Society is therefore committed to ensuring that the full potential of SES courses in the UK is realised and that departments have the opportunity to showcase their work.

For more information, see:
www.physoc.org or @ThePhySoc



GuildHE is the officially recognised voice of smaller and specialist universities and colleges in the UK. We champion a diverse higher education sector. We represent 50 members, including multi-faculty universities, university colleges, further education colleges and specialist universities from both the traditional and private ("not for profit" and "for profit") sectors.

Our members prepare students for success in specialist careers, such as SES. They offer living and learning in small academic communities and focus on delivering practical research for real-world impact.

For more information, see:
www.guildhe.ac.uk or @GuildHE



Emsi is a leading provider of economic impact studies and labour market data to universities, workforce planners, and regional developers in the UK, US, and internationally. Since 2000, Emsi has completed over 2,000 economic impact studies for educational institutions in four countries.

For more information about Emsi's products and services, see
www.economicmodelling.co.uk



Introduction

Sport and exercise science (SES), a varied set of disciplines involving the health and science of physical activity, is a hugely important part of the UK economy, with Sport England estimating that sport-related activity generates £20.3 billion per year for the English economy alone, supporting over 400,000 jobs.¹ SES plays a crucial role in this and the wider UK economy. SES includes, but is not limited to, physiology, biomechanics, psychology, strength and conditioning, sport development, and management. SES has as part of its core the study of how the human body works during exercise. Physiology – the science that aims to understand the mechanisms of living – is a fundamental component of SES.

The “sport” aspect of SES includes the examination of sport performance, coaching and officiating, and the impact of sport on the nation. The “exercise” component of SES includes investigation of the positive and preventative impact of exercise on a wide range of major physical and mental health conditions, including inactivity, obesity, diabetes, cancer, cardiac rehabilitation, and depression. This is one of the ways the exercise component of SES is intimately related to important health outcomes. Research in this area helps prevent and treat conditions and diseases, such as diabetes, that accrue significant direct costs to the National Health Service (NHS), as well as resulting in indirect costs to the UK economy, such as due to loss of productivity. For example, Type 2 diabetes treatment costs the NHS around £8.8 billion every year, which is just under 9% of the annual NHS budget.²

Other widely transferable health-related work undertaken beneath the umbrella of SES include the study of healthy ageing; the production of occupational fitness and health standards; the investigation of the health-related benefits of different supplements; and the examination of the causes of

sport-related deaths and injuries including soft tissue injuries, sudden cardiac death, and drowning. Thus, by its very nature, SES brings together researchers from across different specialties, universities, and colleges throughout the UK to undertake research into human activity and health.

The aim of the work presented in this report is to independently and objectively assess the economic value of SES to the UK.

ABOUT THIS REPORT

This analysis of the economic value of SES higher education provision on the UK economy was undertaken by Emsi, an independent economic modelling company that provides economic impact studies and labour market data to universities and institutions. The work was carried out on behalf of The Physiological Society, the largest network of physiologists in Europe, and GuildHE, one of the UK’s recognised representative bodies for higher education.

The study focuses on the economic impact of SES courses, in terms of added income to the UK economy

1 See www.sportengland.org/research/benefits-of-sport/economic-value-of-sport/

2 See www.gov.uk/government/publications/health-matters-preventing-type-2-diabetes/health-matters-preventing-type-2-diabetes

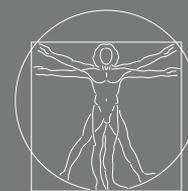
and jobs supported. It builds on information generously provided by institutions representing over a quarter of a million students from across the UK. The report features case studies from a diverse range of universities and colleges, large and small, demonstrating the wider benefits for students and graduates, the national economy, and wider society.

This report is aimed at students considering SES courses, universities and colleges that are creating or expanding SES departments, and policymakers responsible for funding and supporting these endeavours. We are enormously grateful to those institutions that have taken the time to share case studies recognising the human, as well as financial, impact that their SES students, practitioners, and researchers have had on local and national economies.

ORGANISATION OF THE REPORT

This report has four chapters and four appendices. Chapter 1 provides an overview of AY 2016-17 SES students, their outcomes, and labour market conditions. Chapter 2 considers the impact of SES students on economic growth in the UK. Chapter 3 provides the benefits analysis results from the perspectives of students, society, and the public purse. Finally, Chapter 4 provides sensitivity analyses of several key variables.

The appendices include a list of resources and references in Appendix 1, a glossary of terms in Appendix 2, a discussion of the Emsi input-output model in Appendix 3, and an industry to industry sector map in Appendix 4.



What is physiology?

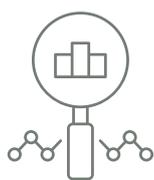
As the science of life, physiology underpins much of Sport and Exercise Science. Physiology is the branch of biology that aims to understand the mechanisms of living, from the atomic basis of cell function to the integrated behaviour of the whole body and the influence of the external environment.

Research in physiology helps us to understand how the body works; it also helps us to determine what goes wrong in disease, facilitating the discovery of new treatments.

Methodology

The approach here is to set this study apart from those undertaken strictly for advocacy purposes and provide a true economic audit of the economic value of SES. Data and assumptions used in the study are based on several sources, including survey data from participating universities and colleges; the most recent student completions, earnings, and demographic data from the Higher Education Statistics Agency; industry and employment data from Nomis official labour market statistics, and Emsi's input-output model. The study applies a conservative methodology and follows standard practice using only the most recognised indicators of economic impact.

The following two analyses are presented: 1) national economic impact analysis, measured in terms of graduate impact, and 2) benefits analysis to students, society, and the public purse. High-level methodology and results for both analyses are described more fully in each section later in this report. Student data reflect AY 2016-17, the most recent year for which full data were available.



Key findings

The study focuses on the economic value of current and former SES students using a two-pronged approach that involves an economic impact analysis and a benefits analysis. Results of the analysis reflect Academic Year (AY) 2016-17, the most recent full-set of data available.



GRADUATE IMPACT



Approximately 96%

of SES students stay in the UK after graduating. Their enhanced skills and abilities bolster the output of employers, leading to higher income and a more robust economy.



The accumulation of SES students currently employed in the workforce amounts to

£3.9 billion

in added income in the UK's economy each year. This is an annual impact and is equivalent to supporting over

147,300 jobs

Glossary of key terms

Graduate impact Graduate impact refers to the SES graduates' higher wages, increased productivity, and associated multiplier effects in Academic Year (AY) 2016-17. This is an annual impact.

Multiplier effects Multiplier effects refer to the additional income and jobs that are created due to the impacts of SES graduates. For example, as an SES graduate earns more money, they create additional demand for goods and services across the wider economy due to their increased spending.

Social benefits Social benefits, also referred to as benefits to society, are benefits accruing to the public purse and private UK citizens over time as a result of graduates receiving an SES education. They are measured in

terms of higher earnings, added tax revenues, social savings, and public purse savings.

Present value Present value refers to expressing projected future revenues and costs in today's terms. In other words, £1 today is not worth the same as £1 five years from now.

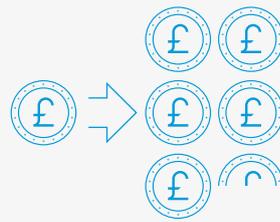
Benefit-cost ratio Dividing the benefits by costs yields the benefit-cost ratio. It demonstrates how many pounds are returned in increased earnings for each £1 invested.

Rate of return The rate of return is the annual percentage return to SES graduates in terms of increased earnings over their career.



BENEFITS TO STUDENTS

Costs incurred by Academic Year (AY) 2016-17 SES student include **£304.4 million** for tuition fees and books and supplies, and **£395.4 million** in forgone earnings had they been working instead of learning. In return, they will receive **£3.8 billion** in increased earnings (present value) over their working lives. For example, a Level 6 graduate (equivalent to a bachelor's degree) will earn **£667,000** (not adjusted for inflation) more in earnings across their working life compared to if they had a Level 3 education (equivalent to A levels in England, Wales, and Northern Ireland and Highers/Advanced Highers in Scotland).



Overall, every £1 that students invest in their education in SES yields

£5.50

in higher future wages.



SES graduates will enjoy an annual rate of return of

20.9%

compared to their previous level of education.



BENEFITS TO SOCIETY & PUBLIC PURSE

The social and public purse benefits to the UK from AY 2016-17 SES students equal a present value of

£7.8 billion

These benefits include

£6.15 billion

in income from higher student lifetime earnings and increased business output and

£1.35 billion

in added tax revenues.



Additionally, the public purse and the rest of UK society will experience savings as better educated students lead improved lifestyles. This leads to a present value of

£267.1 million

in social and public purse savings related to health, crime, and unemployment savings.



TOP SPORT & EXERCISE SCIENCE OCCUPATIONS



Around 71%

of AY 2016-17 graduates are employed in SES or related occupations six months after graduation.

SES graduates work in a range of exciting and fulfilling careers that put their education into practice. Some graduates focus their career on the science of sport and exercise by working as sport scientists and physiotherapists, while other graduates work in occupations such as sport instructors, secondary education professionals, and coaches.

Chapter 1: Profile of Sport and Exercise Science

Sport and Exercise Science (SES) higher education provision is defined as the following Joint Academic Coding System (JACS) codes from the Higher Education Statistics Agency (HESA):

- C600: Sport & exercise science
- C610: Sport coaching
- C620: Sport development
- C630: Sport conditioning, rehabilitation & therapy
- C640: Sport studies
- C650: Sport technology
- C690: Sport & exercise science not elsewhere classified
- C813: Sport psychology
- N880: Sport management

We tailor the analysis to focus on the students and their outcomes from the above definition of SES. Data and assumptions used in the study are based on several sources, including survey data from participating universities and colleges; the most recent student completions, earnings, and demographic data from the Higher Education Statistics Agency; industry and employment data from Nomis official labour market statistics, and Emsi's input-output model.

This section provides an overview of the SES students, their earnings, the occupations they are employed in, and the labour market conditions around SES occupations and industries.

Sport and Exercise Science student demographics

Higher education institutions served 46,340 full-time and 5,465 part-time SES students, totaling 51,800 SES students in AY 2016-17. These are counted in terms of full person equivalents (FPEs). This count includes students who may have withdrawn or gained a separate award.³

The average age of SES students was 21 years old. The breakdown of these students by gender was 70% male and 30% female, and the breakdown by ethnicity was 79% White, 7% other ethnic backgrounds, 6% Black, 4%

The “sport” aspect of SES includes the examination of sport performance, coaching and officiating. The “exercise” component of SES includes investigation of the positive and preventative impact of exercise on a wide range of major physical and mental health conditions, including inactivity, obesity, diabetes, cancer, cardiac rehabilitation, and depression.

³ SES student FPE provided by HESA.

Asian, and 4% mixed background.⁴ Data on ethnicity and gender becomes important in the calculation of marginal earnings change since earnings by gender and ethnicities differ, sometimes widely, depending on the region under analysis.

Sport and Exercise Science student achievement

Student achievement data around SES are used to determine the value of the learning provided by the universities. To do this we first determine the notional level of student FPEs and their associated credits. It is worth noting that the notional level of the student will not always match the notional level of the credits they are taking, but all credits will contribute to the terminating qualification.

Table 1.1 shows the student FPE data around SES, with rows representing the notional level of the FPE categorised by whether a qualification was awarded or is in-progress. The latter category reflects, for example, a student who completed year one of a planned three-year programme. The categorisation between

TABLE 1.1: SES STUDENTS AND CREDITS BY AWARD LEVEL, AY 2016-17

Awarded Qualification	FPEs	Awarded Credits
Foundation degree	550	62,400
HND	185	17,400
First degree	11,505	1,791,200
Masters	1,955	204,800
Doctorate	165	19,935
Subtotal	14,360	2,095,735
Qualification In-Progress	FPEs	Awarded Credits
Foundation degree	935	109,200
HND	255	26,400
First degree	27,005	4,189,600
Masters	1,520	160,800
Doctorate	1,060	128,065
Subtotal	30,775	4,614,065
Total	45,135	6,709,800

Source: HESA.

awarded qualifications and those in-progress follows the Unistats methodology.⁵ The FPEs reflect students who did not withdraw or gain a separate award, hence why it is lower than the 51,800-FPE reported earlier. Table 1.1 also shows the SES credits completed by the associated FPEs.

Sport and Exercise Science student earnings

Table 1.2 presents the salary bands of AY 2016-17 SES students six months after leaving a university with a qualification. The data was provided by HESA and is based on the Destinations of Leavers from Higher Education (DLHE) Providers AY 2016-17 survey. Furthermore, the table represents students who are in full-time employment. In other words, it excludes students in part-time work, those who are working while studying, and those who are still studying. It also only includes students who responded to the survey.

TABLE 1.2: SES STUDENT EARNINGS BY SALARY BAND, AY 2016-17

Salary Band	Headcount	% of Students
Under £10k	35	1.2%
£10,000 to £14,999.99	440	15.2%
£15,000 to £19,999.99	1,150	39.8%
£20,000 to £24,999.99	715	24.7%
£25,000 to £29,999.99	265	9.2%
£30,000 to £34,999.99	115	4.0%
£35,000 to £39,999.99	65	2.2%
£40,000 to £44,999.99	35	1.2%
£45,000 to £49,999.99	20	0.7%
£50,000 to £54,999.99	15	0.5%
£55,000 to £59,999.99	5	0.2%
£60,000 to £64,999.99	15	0.5%
£65,000 to £69,999.99	0	0.0%
£70,000 to £74,999.99	5	0.2%
£75,000 to £79,999.99	0	0.0%
£80,000 to £84,999.99	5	0.2%
£90,000 to £94,999.99	0	0.0%
£100,000 and above	5	0.2%
Totals	2,890	100.0%

Source: HESA DLHE data.

4 SES gender and ethnicity data provided by HESA and corroborated by completion of data survey by participating universities.

5 See the Unistats website here: unistats.ac.uk/find-out-more/about-unistats/

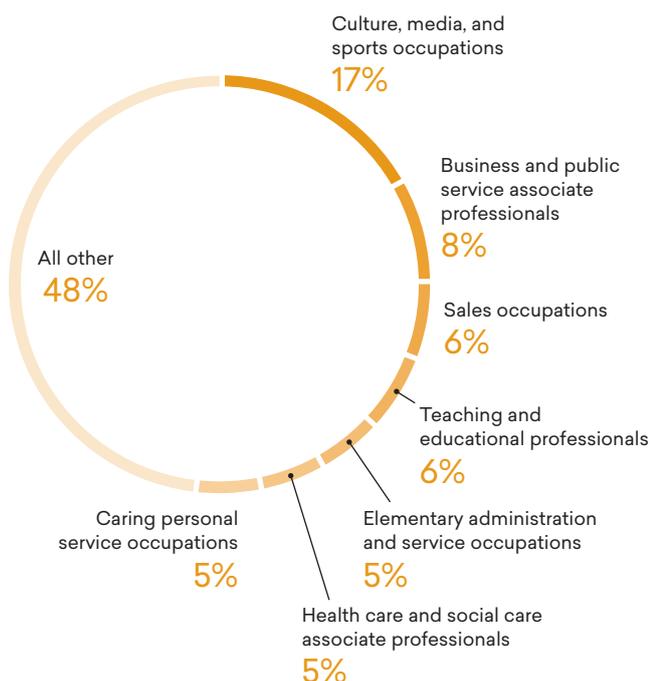
As seen in Table 1.2, the most students (1,150) are in the £15,000 to £19,999.99 salary band. The £20,000 to £24,999.99 salary band follows with 715 students. Altogether, the weighted average salary of SES Students six months post earning a qualification is £21,158.

Top Sport and Exercise Science occupations

Figure 1.1 shows the top occupation groups SES students are employed in six months after receiving a qualification. In other words, it focuses on the job roles of SES students. It is again based on the DLHE AY 2016-17 survey. It includes a couple occupation groups that are not specifically SES, such as teaching and educating professionals. Although these may not seem to be direct SES occupations, they could be teaching children about physical activities or facilitating research within SES.

Altogether, SES students work in a variety of occupations six months after leaving higher education institutions. The largest SES occupation groups are culture, media, and sport occupations (17%) and

FIGURE 1.1: TOP OCCUPATION GROUPS OF SES STUDENTS, PERCENTAGE OF AY 2016-17 STUDENTS



Source: HESA DLHE data.

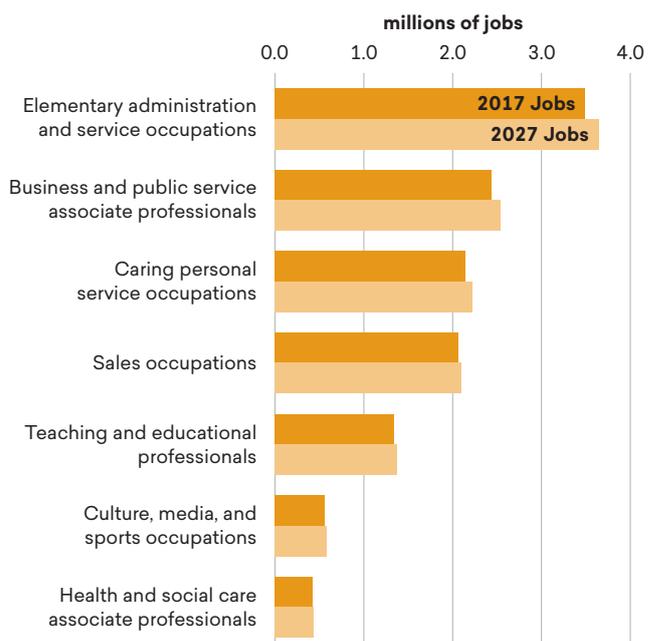
business and public service associate professionals (8%). Around 48% of SES students are employed in an unknown or all other occupation group.

Figure 1.2 shows labour market data for Great Britain around the top occupation groups in which SES students are employed. The most jobs are found within elementary administration and service occupations. However, this occupation only employs 5% of SES students. Culture, media, and sport occupations, the occupation group in which the most SES students are employed in, holds the sixth largest number of current jobs. All of the top occupation groups are projected to grow over the next ten years.

Top Sport and Exercise Science industry sectors

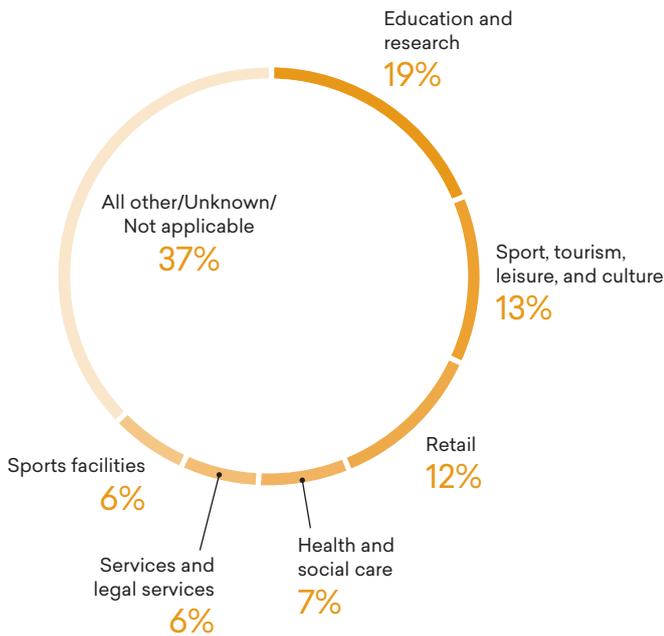
The DLHE survey data also provides insight into the industries in which SES students are employed. Industries differ from occupations in that industry sectors refer to the final product produced by a firm, whereas occupations refer to a specific task or set of tasks a worker performs. For example, the occupation “teaching and educational professionals” will primarily

FIGURE 1.2: CURRENT AND PROJECTED JOBS IN GREAT BRITAIN FOR TOP SES OCCUPATION GROUPS, 2017 AND 2027



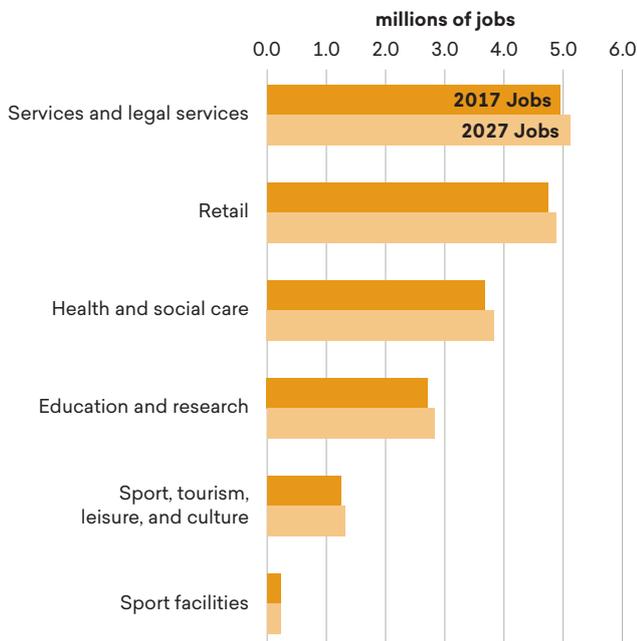
Source: Emsi Q1 2019 Labour Market data.

FIGURE 1.3: TOP INDUSTRY SECTORS EMPLOYING SES STUDENTS, PERCENTAGE OF AY 2016-17 STUDENTS



Source: HESA DLHE data.

FIGURE 1.4: CURRENT AND PROJECTED JOBS IN GREAT BRITAIN FOR TOP INDUSTRY SECTORS EMPLOYING SES STUDENTS, 2017 AND 2027



Source: Emsi Q1 2019 Labour Market data.

be found within the “education and research” industry sector. This example shows a fairly clear relationship between occupation and industry. However, some occupations, such as managers, can be found across a variety of industries since each industry is in need of managers.

Knowing the industries primarily employing SES graduates will especially factor in to Chapter 2 when we calculate the graduate impact. The specific industries have been aggregated in Figure 1.3 into industry sectors. See Appendix 4 for the industry to industry sector map.

As seen in Figure 1.3, students served in AY 2016-17 are employed in a variety of industry sectors six months upon achieving a qualification. The industry sectors range from health and social care to sport facilities. The education and research industry sector employs 19% of SES graduates six months after graduation, and the sport, tourism, leisure, and culture industry subsector 13% of graduates.

Figure 1.4 shows the current and projected jobs in Great Britain across the industry sectors displayed in Figure 1.3. The most jobs are found within the services and legal services industry subsector and the retail industry subsector. The latter employs 12% of AY 2016-17 SES students. Education and research, the industry subsector in which the most SES students are employed in, holds the fourth largest number of current jobs and is projected to grow by 3% over the next ten years. All of the top industry sectors are projected to grow over the next ten years.

National data

The data and methodology collected from research largely come from government studies and are usually treated as constants or parameter values in the analysis. For example, The Green Book issued by HM Treasury reports the following table in Appendix 6.

In accordance with this, we apply a 3.5% discount rate to the cash flows for the first 30 years and a 3%

TABLE 1.3: THE DECLINING LONG-TERM DISCOUNT RATE

Period of years	0-30	31-75	76-125	126-200	201-300	301+
Discount rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%

Source: The Green Book Table 6.1.

Table 1.4: National data and sources

Research Data	Source
Regional employment and earnings	Annual Survey of Hours and Earnings - ONS (NOMIS)
Earnings by education level and ethnicity	Labour Force Survey – ONS Destination of Leavers from Higher Education - HESA
Population	Population Estimates - ONS
Attrition	
Retirement	Gov.UK, Life Tables - NHS
Unemployment	Labour Force Survey - ONS
Social variables	
Smoking	NHS, ASH
Mental Health	Sainsbury Centre for Mental Health (SCMH), NHS
Crime	National Literacy Trust, Home Office Online Report
Unemployment	Labour Force Survey - ONS, Department for Work and Pensions
Obesity	NHS, Department of Health
Student spending	Student Income and Expenditure – BIS/BEIS



Benefits to students CASE STUDY HIGHLIGHT

Disability sport

University of Worcester



Image courtesy of the University of Worcester

“The benefits of sport are for everyone at the University of Worcester, where ‘The Worcester Way’ is to take the lead in disability sport. This includes establishing the International Centre for Inclusive Sport, which received national acclaim in 2019’s Guardian University Awards. The Centre pursues a global and inclusive perspective in

developing university education in disability sport. We are proud to have started the world’s first degree programme in disability sport education, and we ensure the University’s arena is properly inclusive. In 2018 more than 330 students took courses related to disability sport, and the University’s graduates are teachers, coaches, and volunteers in disability sport programmes across the UK and abroad. The University offers global inclusive teacher programmes as far afield as China and Japan and has published a handbook on best practices called ‘The Worcester Way.’”



Mick Donovan, Deputy Pro Vice Chancellor & Head of School of Sport & Exercise Science

discount rate for the cash flows greater than 30 years.⁶ Many of the research sources, along with the constants or parameter values drawn from them, will be referenced throughout this report, but a short list of the most prominent sources are provided here.

Conclusion

This chapter summarises key data and facts on SES. The figures presented in the tables above represent the broader elements of the database used to determine the results. Additional detail on data sources, assumptions, and general methods underlying the analyses are conveyed in the remaining chapters and appendices. The core of the findings is presented in the next two chapters. The appendices detail a collection of theory and data issues.

⁶ The time horizon does not extend beyond 75 years since it is limited to the student’s working life.

Chapter 2: Economic Impact Analysis

One of the greatest economic impacts of SES stems from the education and skills training that it provides. Students have studied SES over the years and subsequently entered and re-entered the UK workforce. As the skills of these students accumulate, they expand the workforce's knowledge base, boost the competitiveness of UK industries, and enlarge the nation's overall output. The sum of these varied effects, measured in terms of added income, constitutes the total impact of SES students on the national economy. As the number of students employed in the nation increases, the impact that they collectively generate in the economy will continue to grow.

When exploring this economic impact, we consider the following hypothetical question:

How would economic activity change in the UK if SES students did not participate in higher education in AY 2016-17?

The economic impact should be interpreted according to this hypothetical question. Another way to think about the question is to realise that we measure a net impact, not gross impact. Gross impacts represent an upper-bound estimate in terms of capturing all activity stemming from SES; however, net impacts reflect a truer measure since they demonstrate what would not have existed in the national economy if not for SES.

Economic impact analyses use different types of impacts to estimate the results. The impact focused on in this study assesses the change in income. This measure is similar to the commonly used gross domestic product (GDP). Income may be further broken out into the **labour income** impact, also known as earnings, which assesses the change in employee compensation; and the **non-labour income** impact, which assesses the change in business profits. Together, labour income and non-labour income sum to total income.

Another way to state the impact is in terms of **jobs**, a measure of the number of average-wage jobs that would be required to support the change in income. Finally, a frequently used measure is the **sales** impact, which comprises the change in business sales revenue in the economy as a result of increased economic activity. It is important to bear in mind, however, that much of this sales revenue leaves the economy through intermediary transactions and costs. All of these measures – added labour and non-labour income, total income, jobs, and sales – are used to estimate the economic impact results presented in this section. The analysis breaks out the impact measures into different components, each based on the economic effect that caused the impact. The following is a list of each type of effect presented in this analysis:

- The **initial effect** is the exogenous shock to the economy caused by the initial spending of money, such as to purchase goods or services.
- The initial round of spending creates more spending in the economy, resulting in what is commonly known as the **multiplier effect**. The multiplier effect comprises the additional activity that occurs across all industries in the economy

and may be further decomposed into the following types of effects:⁷

- The **direct effect** refers to the additional economic activity that occurs as the industries affected by the initial effect spend money to purchase goods and services from their supply chain industries.
- The **indirect effect** occurs as the supply chain of the initial industries creates even more activity in the economy through their own inter-industry spending.

The impacts reflect the economic relationships among industries in the UK and are calculated using Emsi's proprietary input-output (I-O) model. The model uses NUTS3 area data from the Office for National Statistics' (ONS) Supply and Use Tables (SUTs), as well as regional and national industry jobs totals and national sales-to-jobs ratios, to calculate how much each industry purchases from every other industry. The factor of change that occurs from this economic activity is known as the knock-on (multiplier) effect. For more information on the Emsi I-O model, please refer to Appendix 3.



Graduate impact

SES's strong focus on workforce development manifests itself at all levels of provision. In addition to delivering specific training and consultancy solutions to businesses, universities maintain close links with local employers in order to target the type of employee training that best meets their growth strategies. Further, SES programmes allow employers and universities to work together to develop industry-specific training schemes that benefit both the students and employers. All of these services provide valuable resources to businesses and help sharpen the skills of the existing UK's labour force.

Around 96% of SES students stay in the UK⁸ and are more productive because of the quality education they attained. Over time, the skills of former SES students

accumulate, steadily increasing the training level and experience of the UK's workforce. As the skills embodied by former students build up, higher earnings generate additional rounds of consumer spending, while new and enhanced skills and training translate into increased business output and higher property income, causing still more consumer purchases and additional spending. The sum of all these direct and indirect effects comprises the total impact of the students' added skills in the UK's economy.

CALCULATING THE INITIAL EFFECT

Assigning a monetary value to the added skills acquired by SES students still active in the UK workforce requires data on the historical FPEs and corresponding achievement levels of SES students over the past 15-year period. Credits are used to determine the achievement levels of SES students and serve as a proxy for the level of skills students contribute to the UK workforce.

Of course, not all SES students remain in the workforce until retirement age, nor do all students enter the workforce immediately upon achieving a qualification. In the model, we adjust for these factors by applying yearly attrition rates derived from the probability that individuals will die, retire, or become unemployed over the course of their working careers. To these we combine migration data supplied by HESA to estimate the number of students who leave the UK upon leaving the universities. This allows us to estimate the net number of former and current SES students still active in the UK's workforce in the AY 2016-17 analysis year.

The next step is to multiply the net number of former students still working in the UK by the average number of credits achieved per student per year. According to data received from HESA, the average number of credits per FPE was around 149 credits in AY 2016-17. We use this average as a starting point for estimating the average credits per student over the previous 15-years. Using this methodology, the estimated number of SES credits in the UK workforce comes to 68 million, as shown in Table 2.1. These are the credits that accumulated in the workforce over the past 15-year period and were active in the AY 2016-17 analysis year.

Next, we reduce the gross number of active credits to account for the students' alternative education opportunities. For this analysis, we assume an

⁷ Many regional studies also include "induced effects" created by consumer spending. In national models, however, induced effects generally overstate impacts and are thus excluded from the analysis.

⁸ Estimates of the percentage of SES students remaining in the UK is based off data provided by HESA and corroborated by the participating universities.

TABLE 2.1: NUMBER OF CREDITS STILL ACTIVE IN THE NATIONAL WORKFORCE, AY 2016-17

	Credits
Number of credits in workforce, gross	68,021,734
Alternative education adjustment (15%)	(10,203,260)
Number of credits in workforce, net	57,818,474

Source: Emsi model.

alternative education variable of 15%, meaning that 15% of the SES student population would have generated benefits even without studying SES at university. We assume students would have to leave the country to receive an SES education or be limited to direct industry training through workforce experience to generate the impacts. A sensitivity analysis of this variable is provided in Chapter 4. The application of the alternative education adjustment reduces by 10.2 million the gross total of credits in the national workforce, for a net number of credits of 57.8 million.

Table 2.2 demonstrates the total initial added income to the UK economy due to the added skills from SES former students. First, we find the initial labour income. This calculation begins by taking the age-adjusted

average value per credit of £23.54 and multiplying it by the roughly 57.8 million credits in the national workforce. This yields a value of £1.4 billion in added labour income.

Added to the initial effect on labour income is another £1 billion in non-labour income, representing the higher property values and increased investment income stemming from the initial income of SES students and enhanced productivity of the businesses that employ them. Non-labour income attributable to past student skills is obtained by disaggregating higher student income to the industrial sectors of the

TABLE 2.2: INITIAL ADDED INCOME (£ THOUSANDS), AY 2016-17

	Added Income
Initial labour income	£1,361,121
Initial non-labour income	£1,026,393
Total initial added income	£2,387,514

* Numbers may not add due to rounding.

Source: Emsi model.



Graduate impact CASE STUDY HIGHLIGHT

Students educate local communities on health and exercise

Abertay University



Image courtesy of Abertay University

Abertay University offers its sport students a variety of opportunities to put their learning to use by taking sustained placements as part of their second, third, and fourth years of their degree programmes. Dundee's high levels of economic deprivation lead to lower life expectancies and high rates of premature death. To assist this situation, the more than 20 hours per year of coaching work engaged in by Abertay students, through agencies like Active Schools, help Dundee residents make beneficial choices about health and exercise that have been linked to economic impact for the community. The programme also provides students with valuable and credible experience, with around 75% of former students surveyed indicating they are in graduate sport occupations, with a number starting up their own businesses.



Graduate impact CASE STUDY HIGHLIGHT

Community connected learning

York St John University



Image courtesy of York St John University

In Sport and Exercise Science, gaining practical experience is as important as studying theory in the classroom, but this can be challenging to arrange. To ensure students gain the opportunity to learn their skills practically, York St John University's School of Sport places students in a variety of positions with community organisations. By volunteering their time with sports clubs, sport and exercise therapy clinics, and similar businesses, students build their skills and enhance their future employability. They also provide organisations access to resources they might not otherwise be able to afford. In the first semester of 2018, students provided 1,356 hours of experience time, and a further 980 were committed for the second semester, which represents a value of at least £13,782.

I-O model based on the industries the students are employed in⁹ and then multiplying these amounts by the associated value-added-to-earnings ratios. Summing labour and non-labour income together gives an initial effect of past student skills equal to approximately £2.4 billion in AY 2016-17.

CALCULATING THE MULTIPLIER EFFECTS

Economic growth stemming from a skilled workforce does not stop with the initial effect. Multiplier effects occur as SES students generate an increased demand for consumer goods and services through the expenditure of their higher wages. Further, as the industries where the students are employed (Figure 1.3) increase their output, there is a corresponding increase in the demand for input from the industries in the employers' supply chain. Together, the incomes generated by the expansions in business input purchases and household spending constitute the multiplier effect of the increased productivity of former SES students.

⁹ Industries in which SES students are employed in provided by the HESA DLHE survey. Figure 1.3 in Chapter 1 shows the top 15 industries.

TABLE 2.3: GRADUATE IMPACT (£ THOUSANDS), AY 2016-17

	Labour income (thousands)	Non-labour income (thousands)	Total income (thousands)	Sales (thousands)	Average-Wage Jobs
Initial effect	£1,361,121	£1,026,393	£2,387,514	£5,031,848	90,453
Multiplier effect					
Direct effect	£482,867	£416,471	£899,337	£2,055,924	34,072
Indirect effect	£318,032	£284,364	£602,397	£1,404,352	22,822
Total impact	£2,162,021	£700,835	£3,889,248	£8,492,124	147,347

Source: Emsi model.

The next few rows of Table 2.3 show the multiplier effects of the students' added skills. To estimate multiplier effects, we convert the industry-specific income figures generated through the initial effect to sales using sales-to-income ratios from the UK I-O model. We then run the values through the UK I-O model's multiplier matrix to determine the corresponding increases in industry output that occur in the UK. Finally, we convert all increases in sales back to income using the income-to-sales ratios supplied by the UK I-O model.

The final results are £800.9 million in labour income and £700.8 million in non-labour income, for an overall total of £1.5 billion in multiplier effects. The grand total impact of SES students thus comes to £3.9 billion, the sum of all initial and multiplier effects. This is equivalent to supporting 147,347 average-wage jobs. The total figures appear in the last row of Table 2.3.

Note that the £3.9 billion omits the effect of educated workers on innovation and technical progress. To the extent there are such technological gains, and theory suggests that there are, the stated results can be considered conservative.

These impacts, stemming from former SES students, spread throughout the UK economy and affect individual industry sectors. Figure 2.1 displays the top industry sectors impacted by SES students. By showing the impact on individual industry sectors, it is possible to see in finer detail where SES higher education provision has the greatest impact. For example, SES generated the



Graduate impact CASE STUDY HIGHLIGHT

Alumni support adventure tourism in Wales

Bangor University

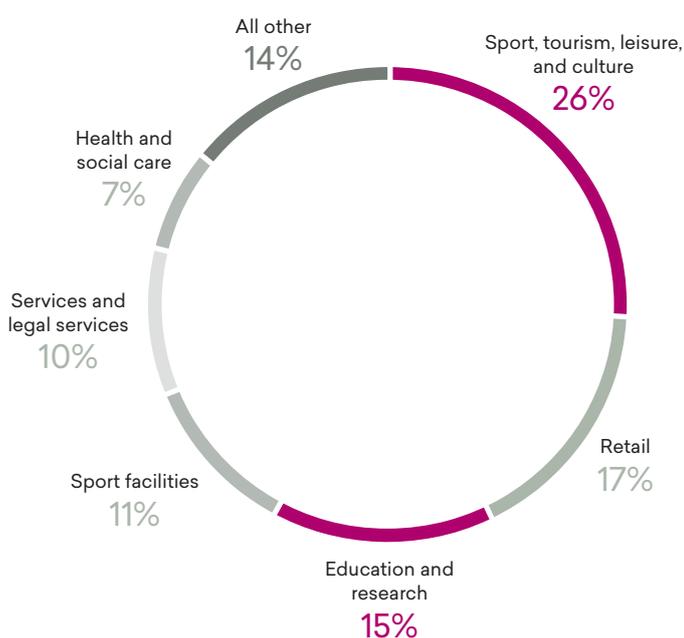


Image courtesy of Bangor University

For 40 years, Bangor University's School of Sport, Health, and Exercise Science has produced research and students whose skills are a key part of Wales' growing adventure tourism economy. The School's postgraduate researchers provide insights to help businesses like Surf Snowdonia, Outlook Expeditions, and Snowdonia Watersports innovate in their offerings. The School's alumni use their insights in sport performance to provide training and advice to adventure tourism trainers and instructors. Alumni have also directly founded a variety of businesses and services. Approximately 30% of the School's 4,000+ alumni work locally, many directly in adventure tourism, helping create an industry that attracts tourism and investment to Wales and has helped Wales be named one of Lonely Planet's top 10 regions of the world to visit in 2017.

most impact in the sport, tourism, leisure, and culture industry sector – creating just under £1 billion in added income, or 26% of the total impact of SES graduates, in AY 2016-17. These impacts can also be broken down by specific industry, as defined by the Standard Industrial Classification. Appendix 4 offers a map between these industry sectors and the specific industries, along with the impact by specific industry.

FIGURE 2.1: TOP SES STUDENT EMPLOYERS BY TOTAL ADDED INCOME, AY 2016-17



Source: Emsi model.



**Graduate impact
CASE STUDY HIGHLIGHT**

Partnership a key to success

Solent University

Solent University, in Southampton, recently launched a first-of-its-kind MSci Football Science course aimed at preparing students for the specific rewards and challenges of a career working in professional football. To support the programme and give it added utility Solent has signed a Memorandum of Understanding with the professional football team Swindon Town FC, aimed at creating mutual opportunities for research and knowledge exchange. As part of the understanding, students in the MSci course have the opportunity to take on voluntary and paid work with the club, particularly during the club’s pre-season testing at the University. Swindon Town spoke highly at every level of their experience working with the University’s students as trainers and advisors, saying it enabled them to significantly improve their training methods and it would be a key factor in their success: “The quality time we spent at Solent University for our pre-season testing will, in my opinion, prove to be a significant key factor to any success that we achieve this season.... The facility, and as important, the sport scientists provided by the University gave us another dimension to our research enabling us to improve our standards of professional training methods, ultimately improving our results on the field of play.”



Graduate impact CASE STUDY HIGHLIGHT

Students practice professional development while studying

Newman University

At Newman University in Birmingham, students in several programmes regularly spend time volunteering and working part-time at job placements related to their chosen field - placements which often last well past the end of their time at the university. For one student, a placement with a nearby professional football club's Foundation related to his coursework in mental health and football. This grew from two years of volunteer time to a part-time research assistant to, after graduation, a full-time position the student described as a "dream job." The position grew out of the inter-disciplinary nature of the university's coursework; the student credited its interplay between theory and practice, and the skills it provided in areas like sport psychology, coaching pedagogy, research, and sport development policy. Beyond expanding the student's professional horizon, this type of programme creates a role for students to make a difference across sport projects in the community relating to several health outcomes.



Graduate impact CASE STUDY HIGHLIGHT

Raising awareness and education around physical inactivity

University College Birmingham

University College Birmingham recently revalidated its longstanding Sports Therapy degree programme with the goal of expanding its usefulness in the modern market. Taking input from students, industry staff, and professionals, the University revisited the programme, which was first offered in 2004. The University chose to increase the programme's relevance by adding a Level 6 Exercise as Medicine module as a response to the increased nationwide awareness of the risks and social and personal costs of low physical fitness. The module educates students about the benefits of physical activity for diseases such as asthma and diabetes, as well as gives them motivational tools to help them encourage clients and patients to better fitness. These skills better prepare students for the workplace and enhance the programme's overall benefit to society.

Chapter 3: Investment Analysis

The benefits generated by SES higher education provision affect the lives of many people. The most obvious beneficiaries are the students; they give up time and money to go to university in return for a lifetime of higher wages and improved quality of life. But the benefits do not stop there. As students earn more, communities and citizens throughout the UK benefit from an enlarged economy and a reduced demand for social services. In the form of increased tax revenues and public sector savings, the benefits of education extend as far as the public purse.



Benefits to students CASE STUDY HIGHLIGHT

Research identifies physical demands in occupations

University of Chichester



Image courtesy of the University of Chichester

The University of Chichester's Occupational Performance Research Group (OPRG) develops evidence-based solutions to enhance the health and performance of personnel working in physically demanding occupations. This research is founded in physiology and typically involves quantifying the physical demands of a task which are then used to inform applied evidenced-based solutions which can be implemented by organisations.

Research that has been published by the OPRG includes the impact of nutrition on the recovery of muscle function, the application of mathematical models to estimate load carriage ability, and the development of gender-free, role-related physical employment standards for the UK's military and

emergency services. The OPRG's research ranges from quantifying the physical demands of the military and emergency service personnel operating in extreme environments to identifying genes that may be linked with the responses to physical training. The OPRG team is led by Professor Steve Myers and Dr Sam Blacker and comprises 12 researchers and six PhD students from Sport and Exercise Sciences backgrounds with specialities that include physiology, dance science, nutrition, biochemistry, biomechanics, and statistics.

In this chapter, we consider the benefits generated by SES higher education provision from the perspectives of its main beneficiary groups – students, society, and the public purse. For students, the approach is a standard investment analysis where benefits are weighed against costs to determine if it makes economic sense for students to invest in a SES education. Given data limitations, social and public purse costs are not available. Therefore, these analyses only assess benefits without taking costs into account.



Student perspective

Analysing the benefits and costs of education from the perspective of students is the most obvious—they give up time and money to obtain a qualification in SES in return for a lifetime of higher income and improved employment opportunities. The benefit component of the analysis thus focuses on the extent to which student incomes and employment probabilities increase as a result of education, while costs comprise all students' direct outlays, e.g. tuition fees, as well as their opportunity costs (wages and income forgone while attending university). Note that we synthesise all students, whether they are foreign or domestic, into the average SES student. It is quite true that each student has a distinct return on their investment, reflecting their specific costs and subsequent earnings. For the purposes of this analysis, we analyse only the average student.



Benefits to students CASE STUDY HIGHLIGHT

Rugby player brings her studies from the classroom to the pitch

Hartpury University



Image courtesy of Hartpury University

Hannah Jones, who plays for Gloucester and Wales, came to Hartpury University to pursue an education in Sports Therapy. Hannah chose Hartpury because of the connection between theoretical and practical education:

“I’ve always had an interest in issues like injury and how athletes are then treated and rehabilitated so it’s great to be able to study at a place like Hartpury University where there are lots of opportunities to gain practical experience on campus.”

She also says she’s seen a significant improvement in her on-pitch performance, mentally and physically, because of the personalised coaching and conditioning but also because of the increased understanding of her own biomechanics and physical needs that her classwork has provided.

“I’m a practical person and being able to get hands on with the course is really useful. From therapy practicals to sport massages, I’ve been able to put what I learn in lectures to the test in a range of situations.”

EDUCATION, EARNINGS AND EMPLOYMENT

The correlation between education, earnings, and employment is well documented and forms the basis for determining the students' benefits stream and future cash flows. Table 1.2 (Chapter 1) shows the salary bands of SES AY 2016-17 students six months after leaving with a qualification.

However, we cannot apply the full salary when calculating students' return on investment. Instead, we need to look at the difference in income between when they entered university to obtain a SES education and when they left. The differences between income levels begin to define the marginal value of moving from one education level to the next. For example, moving from Level 3 (equivalent to A levels in England, Wales, and Northern Ireland and Highers/Advanced Highers in Scotland) to Level 6

(equivalent to a bachelor's degree) yields an additional £15,182 per year. This amounts to £667,000 (not adjusted for inflation) across their working life.

Of course, several other factors such as ability, socioeconomic status, and family background also correlate with higher earnings. Failure to account for these factors results in what is known as an 'ability bias'.¹⁰ To account for the implicit bias in the data, Emsi commissioned a meta-analysis to ascertain the degree of bias and the amount by which the marginal gains should be reduced. Molitor and Leigh (2005) concluded that a 10% reduction in the earnings gain was necessary to account for such innate characteristics of the students.

¹⁰ Ability bias in data was recognised as early as Adam Smith but was formally acknowledged as a biasing factor in human capital data by J.R. Walsh in 1935.



Benefits to students CASE STUDY HIGHLIGHT

Alumnus and former professional footballer finds success after football

Loughborough University



Image courtesy of Robbie Simpson

“Loughborough is well renowned for being a world-leading sporting university in the country and as I was playing semi-professional football at the time, I really wanted to go to an outstanding sporting institution. I obviously had a passion for sport, hence wanting to study Sport Science. The whole process I went through inspired me in the foundation of Life After Professional Sport (LAPS). The aim of LAPS is to help sport professionals and elite athletes plan for and transition into new fulfilling careers post their competing days. We offer guidance and advice on CV writing, interview technique, how to network and promote entrepreneurship.

Being a professional footballer there were points in my career I thought I may have to retire and look for a new career. However, there was no platform for a former footballer to turn to for help and support with this transition. I quickly realised through speaking with other Loughborough friends in different sports, that this is an issue in most professional sports.

We have information on over 200 job roles, including video interviews with over 75 former elite athletes who have transitioned into new careers explaining their transition and how sport has helped them. We also have thousands of job opportunities advertised on our platform ready for our members to apply for.”



*Robbie Simpson, Founder of Life After Professional Sport (LAPS) –
Loughborough University Alumnus*

MARGINAL EARNINGS VALUE PER CREDIT

Not all SES students in the AY 2016-17 reporting year obtained a qualification. Some may have returned the following year to complete their education goals, while others may have taken a few units and entered the workforce without achieving a qualification. Since the education of such students still carries value, though not the weight of a full qualification, we must look deeper than qualification completion to measure the value of intermediary education provision. The most consistent way of capturing the intermediary activity of the students is through credit completions.

It is important to remember that from an economics perspective, students will eventually be paid according to their marginal value of product. Therefore, we link such output metrics to marginal gains in educational attainment. Attributing value to full qualifications alone assumes no increase in marginal value of product from intermediary education. According to prevailing human capital theory, such an assumption is flawed. It is more appropriate to utilise a quasi-continuous step function where students increase their marginal value of product, and thus income, for every credit received.

The sheepskin effect, or more generically the signaling effect, resulting from the full qualification is the cause for the step function nature of the earnings curve. A qualification signals to employers the marginal value of product a student can generate. Thus, a full qualification has additional value over a unit in terms of increased earnings and the employment premia. These two things combined represent the sheepskin effect.

We calculate the value of the SES students' credit production through a process that divides the education ladder into a series of individual steps, each equal to one credit. We then spread the income differentials over the steps required to complete each education level, assigning a monetary value to every step in the ladder.¹¹ Next we map the students' credit production to the ladder, depending on their level of achievement and the average number of credits they achieve. Finally, we multiply the volume of credits at each step in the ladder by the marginal earnings gain attributable to the corresponding step to arrive at the

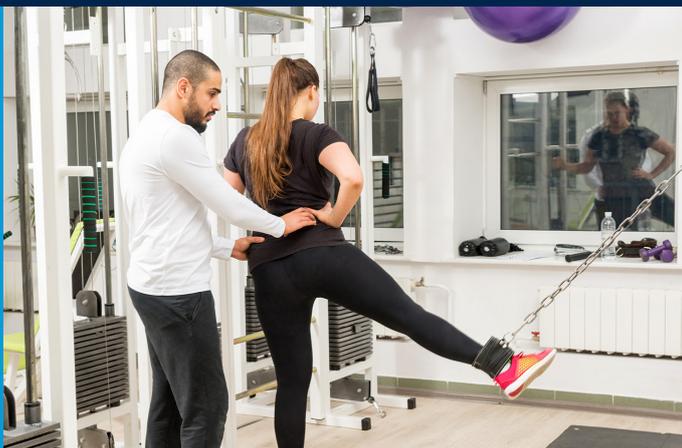
¹¹ Students who obtain their full qualification during the reporting year are granted the income boost derived from the signaling effect of the credential.



Benefits to students CASE STUDY HIGHLIGHT

Gaining real-world experience from providing rehabilitation services

AECC University College



One of many ways AECC University College, a specialist health sciences institution, pursues its goal of “transforming lives through health science” is the support its Clinical Exercise and Rehabilitation students provide to the onsite physical activity centre. By helping with the centre’s work, like physical activity programmes such as active walking and dance, students obtain practical experience working with patients who benefit from such activity. Under the supervision of scheme counsellors and activity leads, students gain the experience in delivering real programmes with real patients, while helping community members regain movement and independence.

students' average annual increase in income. Under this framework the annual change in earnings, ΔE , is computed simply as:

$$\Delta E = \sum_{i=1}^n e_i h_i \text{ where } i \in 1, 2, \dots, n$$

where $i \in 1, 2, \dots, n$ and n is the number of steps in the education ladder. Variables e_i and h_i represent the marginal earnings gain and number of credits completed by the student body for each step i . Total earnings change divided by the total credits completed by the students gives the average value per credit for the AY 2016-17 student body.

Table 3.1 displays the aggregate annual higher income for the SES student population. Also shown are the

TABLE 3.1: HIGHER ANNUAL EARNINGS, CREDIT PRODUCTION, AND VALUE PER CREDIT, AY 2016-17

Total Increase in Earnings	£239,859,748
Total Completed Credits	6,709,800
Average Value Per Credit	£35.75

Source: Emsi.

total credits generated by students and the average value per credit. Note that although each step in the education ladder has a unique value, for the sake of simplicity only the total and average values are displayed.

Here a qualification must be made. Data show that earnings levels do not remain constant; rather, they start relatively low and gradually increase as the worker gains more experience. Research also indicates that the earnings increment between educated and non-educated workers grows through time. This means that the aggregate annual higher income presented in Table 3.1 will be lower at the start of the students' careers and higher near the end of them, gradually increasing at differing rates as the students grow older and advance further in their careers.

GENERATING THE STREAM OF CASH FLOWS

The two names most often associated with human capital theory and its applications are Gary Becker and Jacob Mincer. The standard human capital earnings



Benefits to students CASE STUDY HIGHLIGHT

Disability sport

University of Worcester



Image courtesy of the University of Worcester

“The benefits of sport are for everyone at the University of Worcester, where ‘The Worcester Way’ is to take the lead in disability sport. This includes establishing the International Centre for Inclusive Sport, which received national acclaim in 2019’s Guardian University Awards. The Centre pursues a global and inclusive perspective in developing University education in disability sport. We are proud to have started the world’s first degree programme in disability sport education, and we ensure the University’s arena is properly inclusive. In 2018 more than 330 students took courses related to disability sport, and the University’s graduates are teachers, coaches, and volunteers in disability sport programmes across the UK and abroad. The University offers global inclusive teacher programmes as far afield as China and Japan and has published a handbook on best practices called ‘The Worcester Way.’”



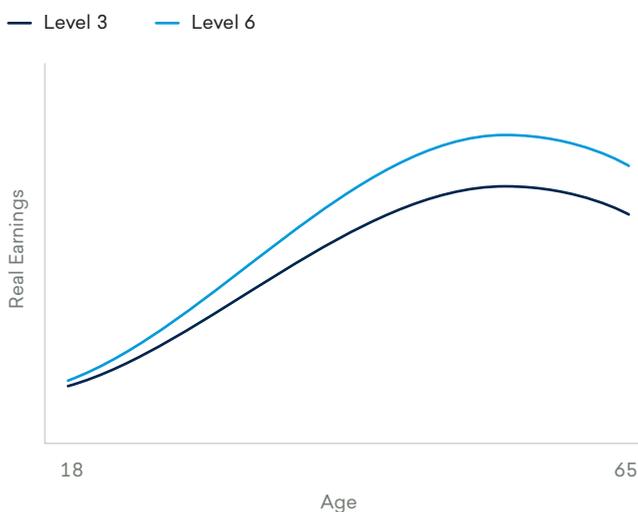
Mick Donovan, Deputy Pro Vice Chancellor & Head of School of Sport & Exercise Science

function developed by Mincer appears as a three-dimensional surface with the key elements being earnings, years of education, and experience. Figure 3.1 shows the relationship between earnings and age, with age serving as a proxy for experience. Note that, since we are using the graph strictly for illustrative purposes, the numbers on the axes are not specific to the SES.

Figure 3.1 illustrates several important features of the Mincer function. First, earnings initially increase at an increasing rate, later increase at a decreasing rate, reach a maximum somewhere after the midpoint of the working career, and then decline in later years as individuals ease into retirement. Second, at higher levels of education, the maximum level of earnings is reached at an older age. And third, the benefits of education, as measured by the difference in earnings between levels, increase with age.

In the model, we employ the Mincer function as a smooth predictor of earnings over time for as long as students remain active in the workforce. Using earnings at the career midpoint as our base, scaled from the salary bands provided by the DLHE survey six months post completion, we derive a set of scalars from the slope of the Mincer curve to model the students' increase in earnings at each age within their working careers. The result is a stream of projected future benefits that follows the same basic shape as the Mincer curve, where earnings gradually increase from the time students enter the workforce, come to a peak shortly after the career midpoint, and then dampen slightly as students approach retirement at age 65.

FIGURE 3.1: LIFETIME EARNINGS PROFILE FOR LEVEL 3 AND LEVEL 6 QUALIFICATION RECIPIENTS



Benefits to students CASE STUDY HIGHLIGHT

Research collaboration builds student expertise in science communication to improve health and wellbeing

University of Sunderland

Fuse, the Centre for Translational Research in Public Health, brings together the five North East Universities of Durham, Newcastle, Northumbria, Sunderland, and Teesside in a unique collaboration to deliver robust research to improve health and wellbeing and tackle inequalities. Fuse works hand-in-hand with the NHS, local and national government, and voluntary and community sectors to help transform public health.

The Fuse Physical Activity Group workshops aim to build research capacity in physical activity related to public health research for those working in policy, practice, and academia by sharing knowledge, providing networking opportunities, and stimulating debate across sector boundaries. Each workshop typically attracts around 80 delegates, and feature nationally and internationally renowned speakers from academia, policy, and practice. These speakers have presented innovative research findings and ideas at the workshops, as well as provided an opportunity for undergraduate and PhD students, such as Camila Rodriguez, to develop their presentation skills and networks with innovators in their field of expertise.

The benefits stream generated by the Mincer curve is a key component in deriving the students' rate of return. However, not all students enter the workforce at the end of the reporting year, nor do all of them remain in the workforce until age 65. To account for this, we discount the students' benefit stream in the first few years of the time horizon to allow time for those who are still studying to complete their educational goals and find employment. This is referred to as delaying the onset of the benefits. Next, we discount the entire stream of benefits by the estimated number of students who will die, retire or become unemployed over the course of their working careers.¹² The likelihood that students will leave the workforce increases as they age—so the older the student population is, the greater the attrition rate will be. The resulting benefits stream can be found in Table 3.3.

STUDENT INVESTMENT COSTS

Having calculated the SES students' benefits stream and adjusting it for attrition, we next turn to student costs. The students' costs of investment are composed of direct outlays and opportunity costs. Direct outlays represent any out-of-pocket expenses to the student, such as those for tuition fees (except for home students in Scotland), books, and supplies. Some students incur more out-of-pocket expenses than others. For the purposes of this analysis, we just look at the total direct outlays incurred by the student body as a whole, not separated out by levels.

It is important to note that student loans toward tuition and fee expenses are available to virtually all European

TABLE 3.2: TOTAL STUDENT INVESTMENT COSTS, AY 2016-17 (£ THOUSANDS)

	Costs
Student Direct Costs	
Tuition and Fee Expense	£395,383
Less: RAB charge	-£114,661
Books and Equipment Expense	£23,530
Student Indirect Costs	
Opportunity Costs – working students	£205,249
Opportunity Costs – non-working students	£190,170
Total Student Costs	£699,671

Source: Emsi model.

12 These data are based on the ONS life tables and net migration data following a log linear trend line.

Union students studying in the UK, recognising that home and EU students in Scotland do not pay tuition fees. While we assume student loans are repaid and thus constitute a cost to students, we also recognise that many of the government loans receive a lower interest rate and the default rate on these loans can be somewhat high. Any defaults or low repayment on these loans constitute a cost to government rather than a direct cost to students. The government includes these as part of the Resource Accounting and Budgeting (RAB) charge. As such, we extract the national default rate on RAB funds from the students' direct costs.¹³

Opportunity costs apply to all students and represent forgone income. We assume that every hour a student is in the classroom or engaged in an educational activity is an hour they could have been receiving a wage. Since tuition fees simply capture the payments made by students and their families directly toward a SES education, measuring costs and benefits through time spent in the classroom creates a more accurate representation.

A large portion of costs, however, are not captured in the direct outlays of the students but through their opportunity costs. These costs are a function of student employment rates, the number of credits taken by the students, prior education level, and the associated earnings by education level. To arrive at the full earning potential of students while enrolled, we must condition the earnings levels to the students' age, which we accomplish simply by applying a scalar derived from the Mincer curve described above. Another important factor to consider is the time that students spend at university since they would only be giving up earnings for the period in which school is in session, and then only for the hours they are in class. We use the volume of credits taken by the students as a proxy for working hours forgone. Beginning with the conditioned average annual incomes by education level and the students' education levels at the start of the reporting year,¹⁴ we determine the potential lost income to two distinct categories of students: SES students employed while attending university and

13 If we were conducting a full investment analysis for the public purse, we would apply RAB charges instead to the public purse's investment. According to a 2017 report from the Department of Education, the estimated long-run cost to the government for student loans is 29p for every £1 loaned.

14 SES student education levels at the start of the year provided by HESA and corroborated by surveys completed by participating universities.

non-working students. Based on data provided by participating institutions, 72% are working during study and 28% are non-working students.

Since students otherwise engaged in the labour force receive some portion of what their income would be otherwise, their opportunity costs are mitigated. They also forgo leisure, to which Becker (1974) attributes value. Opportunity and direct costs total £699.7 million. Students employed while attending university do a great deal to mitigate their opportunity costs and thus will have higher than average benefit-cost ratios and correspondingly higher rates of return.

STUDENT INVESTMENT OUTCOMES

Since the benefits to students do not all occur in the current year like the costs, we must discount the future benefits to their present value. As stated in *The Green Book*,

Discounting is a technique used to compare costs and benefits that occur in different time periods. It is a separate concept from inflation, and is based on the principle that, generally, people prefer to receive goods and services now rather than later. This is known as 'time preference'.

In accordance with *The Green Book*, we apply a 3.5% discount rate for the first 30 years and a 3% discount

rate for subsequent years. Standard investments tend to have a much shorter time horizon and use only one discount rate. However, education is a long-term investment and the different discount rates are used to account for any uncertainty resulting from the extended time horizon. Though the discount rate used is provided by *The Green Book*, it is not an observed value. Thus, in Chapter 4, a sensitivity analysis is provided to show how the results vary in accordance with the discount rate.

Column 1 of Table 3.3 shows the number of years beyond the analysis year (i.e., year zero is the analysis year where costs are incurred and net benefits are negative). Columns 2 through 4 show the gross cash flows received each year, the percent of students active in the workforce (including the employment premia), and the net higher earnings that are projected to be realised. Column 5 shows one year's worth of costs to the students.¹⁵ Lastly, Column 6 shows the net cash flows.

The average student age of students studying SES in AY 2016-17 is 21 years old. Adding one year to this (the analysis year) and subtracting from the retirement age of 65 years old¹⁶ yields a time horizon of 44 years. The last four rows in the table show the SES student investment results: net present value (NPV), benefit/cost ratio (B/C), internal rate of return (IRR),¹⁷ and payback period. Equations and definitions of these terms may be found in the glossary provided in Appendix 2.

The AY 2016-17 SES student body is expected to see the present value of their lifetime incomes rise by £3.8 billion, while the costs of obtaining these gains is only £699.7 million. This means students receive a net gain of £3.1 billion and, on average, their benefits are 5.5 times larger than their investment. Put another way, for every £1 students invest in direct outlays and opportunity costs, they receive £5.50 in return. This translates into a 20.9% average annual rate of return, with all of the students' costs recovered in 6 years.

¹⁵ The £699.7 million in costs is already in present value since it occurs in the current year and does not need to be discounted.

¹⁶ We recognise that not all students will retire at age 65 - some may exit the workforce early or remain in until they are older. The retirement age of 65 is an average based on the State Pension age and is useful in calculating an average time horizon for the average student.

¹⁷ The IRR is used for investments where the principle invested is not recaptured at the sale or maturity date of the investment, such as is the case with stocks or bonds.

Discount rate

The discount rate is a rate of interest that converts future costs and benefits to present values. For example, £1,000 in higher earnings realised 30 years in the future is worth much less than £1,000 in the present. All future values must therefore be expressed in present value terms in order to compare them with investments (i.e., costs) made today. The selection of an appropriate discount rate, however, can become an arbitrary and controversial undertaking. As suggested in economic theory, the discount rate should reflect the investor's opportunity cost of capital, i.e., the rate of return one could reasonably expect to obtain from alternative investment schemes.

TABLE 3.3: STUDENT PERSPECTIVE (£ MILLIONS), AY 2016-17

Year	Gross Higher Earnings	% Active in Workforce*	Net Higher Earnings	Cost	Net Cash Flow
0	99.6	66%	66.0	699.7	-633.6
1	111.3	77%	85.3	0.0	85.3
2	122.4	88%	108.0	0.0	108.0
3	133.1	88%	117.0	0.0	117.0
4	143.2	88%	126.3	0.0	126.3
5	152.9	88%	134.7	0.0	134.7
6	162.0	88%	142.7	0.0	142.7
7	170.7	88%	150.3	0.0	150.3
8	178.9	88%	157.4	0.0	157.4
9	186.6	88%	164.1	0.0	164.1
10	193.8	88%	170.3	0.0	170.3
11	200.5	88%	176.1	0.0	176.1
12	206.8	88%	181.5	0.0	181.5
13	212.6	88%	186.4	0.0	186.4
14	217.9	88%	190.9	0.0	190.9
15	222.7	88%	195.0	0.0	195.0
16	227.0	87%	198.6	0.0	198.6
17	230.9	87%	201.8	0.0	201.8
18	234.4	87%	204.6	0.0	204.6
19	237.3	87%	206.9	0.0	206.9
20	239.9	87%	208.8	0.0	208.8
21	241.9	87%	210.3	0.0	210.3
22	243.5	87%	211.4	0.0	211.4
23	244.7	87%	212.1	0.0	212.1
24	245.4	87%	212.3	0.0	212.3
25	245.7	86%	212.1	0.0	212.1
26	245.5	86%	211.5	0.0	211.5
27	244.9	86%	210.5	0.0	210.5
28	243.8	86%	209.1	0.0	209.1
29	242.3	86%	207.3	0.0	207.3
30	240.4	85%	205.0	0.0	205.0
31	238.0	85%	202.4	0.0	202.4
32	235.3	85%	199.4	0.0	199.4
33	232.1	84%	195.9	0.0	195.9
34	228.5	84%	192.1	0.0	192.1
35	224.4	84%	187.8	0.0	187.8
36	220.0	83%	183.2	0.0	183.2
37	215.1	83%	178.2	0.0	178.2
38	209.8	82%	172.8	0.0	172.8
39	204.1	82%	167.0	0.0	167.0
40	198.0	81%	160.8	0.0	160.8
41	191.6	81%	154.3	0.0	154.3
42	184.7	80%	147.5	0.0	147.5
43	177.4	79%	140.3	0.0	140.3
NPV			£3,849.5	£699.7	£3,149.9

B/C Ratio

5.5

IRR

20.9%

Payback (years)

6.4

* Percentage of students active in the workforce is based on the ONS life tables and net regional migration data. The first few years of students' careers are discounted to allow time for those who are still studying to complete their educational goals and find employment.

Source: Emsi model.

Beekeeper analogy

A classic example of positive externalities (sometimes called 'neighbourhood effects') in economics is the private beekeeper. The beekeeper's intention is to make money by selling honey. Like any other business, the beekeeper's receipts must at least cover his operating costs. If they don't, his business will shut down.

But from society's standpoint, there is more. Flower blossoms provide the raw input bees need for honey production, and smart beekeepers locate near flowering sources such as orchards. Nearby orchard owners, in turn, benefit as the bees spread the pollen necessary for orchard growth and fruit production. This is an uncompensated external benefit of beekeeping, and economists have long recognised that society might actually do well to subsidise positive externalities such as beekeeping.

Educational institutions are in some ways like beekeepers. Strictly speaking, their business is in providing education and raising people's incomes. Along the way, however, external benefits are created. Students' health and lifestyles are improved, and society indirectly enjoys these benefits just as orchard owners indirectly enjoy benefits generated by beekeepers. Aiming at an optimal expenditure of public funds, the impact model tracks and accounts for many of these external benefits.



Social and public purse perspective

Looking at benefits from the social and public purse perspective is structurally no different than the student perspective, although the breadth of the benefits captured is much larger. Capturing the social and public purse perspective provides proof that universities and colleges focusing on SES provide a social and economic, as well as academic, benefit. The higher levels of education their students gain enable the community to overcome social problems, such as by lowering crime rates and improving health. In particular, SES higher education provision improves students' life chances by giving them the tools they need to succeed in their careers. The higher incomes the students receive as a result expand the economic base, thereby creating wealth and providing a way for people to be invested in their economy. These demonstrate that training in SES ultimately serves a social mission. Furthermore, the tax base is expanded since, as SES students earn more, they make higher income tax payments and National Insurance contributions, and they save the public purse money by overcoming social problems.

Any benefits that accrue within the UK as a result of training in SES—whether they accrue to students, employers, public purse, or private residents—are claimed under the social and public purse perspective. These benefits are subdivided into two components: 1) increased income and tax receipts, and 2) social and public purse savings stemming from the improved lifestyles of students.



HIGHER EARNINGS AND INCREASED TAX RECEIPTS

Income growth occurs as the output of SES students increases as a result of their education. Capital, such as machinery and buildings, is made more productive through the increased skills derived from education. This in turn raises profits and other business property income. Together, increases in labour and capital income are considered the effect of a skilled workforce. Estimating the effect of SES on income growth begins with the projected higher student income from Table 3.3 above. Not all of these benefits may be counted as benefits to the public, however. Some students may emigrate during the course of their careers, and any benefits they generate leave with them. To account for this dynamic, we



Benefits to society CASE STUDY HIGHLIGHT

Research to optimise Paralympic swimming performances

Manchester Metropolitan University



Image courtesy of Manchester Metropolitan University

In tandem with Australia's University of the Sunshine Coast, researchers at Manchester Metropolitan University have used new testing methods and data to better understand impairments affecting para-swimming competitors. By quantifying how different kinds of conditions and impairments affect technique, efficiency, drag, and power in competitive swimming, their research has created better definitions for the competitive classes in para-swimming. Their proposed revisions, including the use of 3D kinematic data and other forms of testing, offer an evidence-based classification currently being tested and evaluated by the International Paralympic Committee. The new system using quantifiable data improves upon the subjective assessments currently used. It is expected to be introduced after the 2020 Tokyo Paralympic Games.



Benefits to society
CASE STUDY HIGHLIGHT

Survival of the fittest

University of South Wales

Centres across the world are increasingly using pre-operative cardiopulmonary exercise testing to risk stratify patients before major surgery with thousands of tests now performed annually. Research from the University of South Wales led by Professor Damian Bailey and Mr George Rose in collaboration with Drs Ian Appadurai, Richard Davies, Ian Williams and Mike Adamson of the University Hospital of Wales has identified that cardiorespiratory fitness should be considered a clinical vital sign given that it is “patient-protective” and can significantly reduce morbidity and mortality following major surgery in cancer and vascular patients. Taking a bench to bedside approach, their research has helped refine clinical risk assessment, inform shared decision making, identify targeted requirement for postoperative critical care and optimisation of comorbidities including the mechanistic bases underpinning prehabilitation. Clinical integration of their research findings is providing both clinical and economic cost-saving benefits by directing investigations and treatments.



Benefits to society
CASE STUDY HIGHLIGHT

Exercise interventions in people living with and beyond cancer

Northumbria University

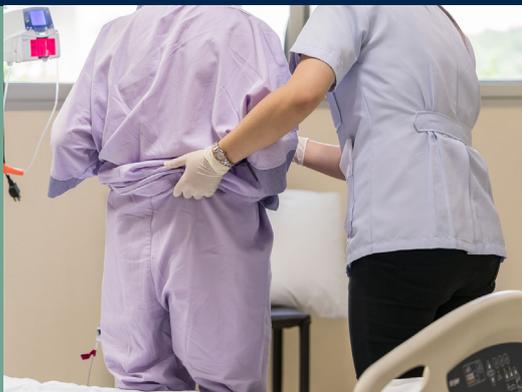


Image courtesy of Northumbria University

Research at Northumbria University led by Professor John Saxton, in collaboration with clinical colleagues based in Newcastle, Norwich, and Sheffield, is investigating the important role that structured exercise programmes can play in improving the quality and duration of cancer survivorship. Cancers of the breast, prostate, and colon are amongst the most common in western societies and although survival rates are increasing, the physiological impact of these cancers and their treatments is long-lasting.

Current research is focused on (i) the role of exercise training, in conjunction with dietary advice, in reversing adverse body composition changes in hormone-positive breast cancer patients, (ii) exercise interventions for ameliorating the side-effects of prostate cancer and its treatments, and

(iii) how exercise programmes prior to surgery can be used to improve fitness and treatment outcomes in colorectal cancer patients. Macmillan Cancer Support predicts that support for people with cancer beyond their initial treatment will cost the NHS at least £1.4 billion every year by 2020. This research is closely aligned with NHS treatment pathways and is helping to build a solid evidence-base to support the use of exercise in the clinical and self-management of people living with and beyond cancer.

use estimates on migration patterns to calculate the number of students who leave the UK upon receiving their qualification. Note that death, retirement, and unemployment have already been captured in the students' NPV calculation.

Next, we derive a stream of cash flows that accrue to the public. These comprise the direct effect of SES on income growth. Indirect effects occur when students spend more money on consumer goods, while the increased output of businesses that employ them also creates a demand for inputs and, consequently, input spending. The effect of these two spending items (consumer and business spending) leads to still more spending and more income creation, and so on. To quantify these several rounds of spending, we apply a knock-on (multiplier) effect derived from Emsi's specialised input-output (I-O) model, described more fully in Appendix 3. With an increase in labour income (both direct and indirect) comes an increase

in capital investment, thereby generating even more growth in the non-labour (or 'non-earnings') share of the economy. Non-labour income consists of monies gained through investments (dividends, interests and rent). To derive the growth in non-labour income, we multiply the direct and indirect labour income figures by a ratio of GDP (equal to labour income plus non-labour income) to total labour income.

Next, rather than adjusting for attrition, which is already captured in the students' net higher earnings, we adjust for the alternative education variable. This variable looks at the degree to which students would be able to obtain education and the increased role industry would play in providing workforce training if formal education did not exist. That is, SES students would substitute towards other educational opportunities (e.g., on-the-job training, etc.) if the SES focused universities did not exist. We assume this variable to be around 15%.



Benefits to society CASE STUDY HIGHLIGHT

Identifying the physical and health benefits of tennis

Liverpool Hope University



Image courtesy of Liverpool Hope University

Recently, an interdisciplinary team of researchers from Liverpool Hope University led by Professor Omid Khaiyat have received national attention for their study of the various benefits of playing tennis. The team evaluated a wide range of variables in cardio-metabolic, musculoskeletal, nutritional and psychosocial factors, variables as diverse as grip strength, depression, and haemoglobin levels. Compared with similarly active individuals who do not play tennis, the researchers found tennis players have higher musculoskeletal function and lower cardio-metabolic risk profiles. These findings have been gathered into two articles for future peer-reviewed publication, featured on media outlets such as BBC Breakfast, BBC Northwest, and Liverpool TV, as well as shared with various community groups and organisations to help in advocacy for tennis and exercise in general.



Benefits to society
CASE STUDY HIGHLIGHT

Sport science programme uses data to aid the Exeter Chiefs

University of Exeter



Image courtesy of the University of Exeter

“At the University of Exeter, the combination of research, technology, and real-world evidence in our sport medicine programme has created a strong relationship between us and the Exeter Chiefs rugby team. In order to support performance improvements and greater individual and team outcomes, University researchers use data from a variety of measurements to qualitatively establish baseline data for each athlete’s biomechanical measures, such as movement, loading, and strength. We use these data to inform rehabilitation programmes in the event of injury, to identify players at specific risk, and to improve overall training and conditioning. This evidence-base has proven very useful in preventing and managing injuries.”



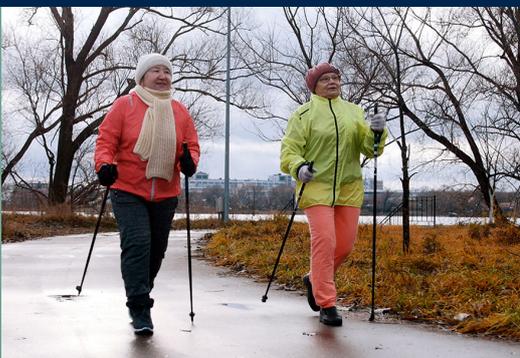
Dr Sharon Dixon,
Associate Professor in Biomechanics



Benefits to society
CASE STUDY HIGHLIGHT

Patients benefit from student-led activities

Plymouth Marjon University



Non-communicable diseases—such as cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes—are the world’s biggest killers. Many of these deaths can be prevented by tackling risk factors such as smoking, unhealthy diet, physical inactivity, and the harmful use of alcohol.*

In collaboration with the NHS, Live Well Southwest, Sentinel Health Care, and many other community partners, students at Plymouth Marjon University support ongoing work providing lifestyle physical activity programmes to patients with a variety of non-communicable conditions. Students lead activities such as swimming, flexibility therapy, and aerobic fitness, as well as providing advice to patients on lifestyle factors such as diet and hygiene. This helps to improve the quality of life for patients with

fibromyalgia, leg ulcers, back pain, cancer, and chronic pain. Over the 12 years the programmes have been offered thousands of patients have participated, seeing results such as 80% acceleration in leg ulcer healing and significant quality of life improvements for cancer and back pain patients.

* See www.who.int/nmh/events/ncd_action_plan/en/

The higher income generated by businesses and students in the UK leads to higher income tax payments and national insurance contributions. The portion of the higher earnings that students spend leads to higher value added tax (VAT) receipts. Likewise, as employers increase their output and make more purchases for supplies and services, they benefit the public purse through their higher corporation tax and VAT payments.

The higher earnings of students and businesses, along with broader increases in income across the UK arising from these higher earnings, amounts to a present value of £6.15 billion. Due to these higher earnings, the public purse will see an additional present value of £1.35 billion in added tax revenues. Together, this means society and the public purse will see a total present value of £7.5 billion in higher earnings and increased tax revenues over the course of the AY 2016-17 SES students' working lives (see "higher earnings" and "added tax revenue" boxes in Figure 3.2).



SOCIAL AND PUBLIC PURSE SAVINGS

In addition to higher income, education is statistically correlated with a variety of lifestyle changes that generate social and public purse savings, also known as external or incidental benefits of education. These social and public purse savings represent avoided costs that would have otherwise been drawn from private and public resources absent the education provided by SES.



Benefits to the public purse CASE STUDY HIGHLIGHT

Research in biomechanics helps older adults to avoid stair falls

Liverpool John Moores University



Image courtesy of Liverpool John Moores University

"Stair falls are the leading cause of accidental death in older people. Falls on domestic stairs cause over 350,000 injuries to older UK residents each year, with personal consequences such as loss of independence, hospitalisation, and even death, not to mention £2 billion in demands on the NHS.

In hopes of understanding the mechanisms underpinning stair falls and developing the first stair fall screening tool for

older people, we run Research to Improve Stair Climbing Safety (RISCS). This is a multidisciplinary group with experience on empirical research, data analytics, community health provision and policy making, who are supported by both external and institutional funding to investigate how stair safety in old age can be improved.

The RISCS group uses state-of-the-art stair gait biomechanics and gaze behaviour measurements to investigate the complex relation of functional capabilities such as strength, balance, and cognitive status; environmental design factors like step dimensions and illumination; and behaviour elements such as knowing proper stepping technique and where to look and when.

Over the last ten years our ongoing research has been disseminated to scientific meetings, and it hopes to achieve a positive societal impact in the near future by providing means and tools, applicable at the community level, to minimise stair fall risk for older people."



*Professor Costis Maganaris,
School of Sport & Exercise Sciences*

It is important to note that calculating social externalities is not a straightforward task of counting actual monies saved. The process is difficult because of the uncertainties about what data to include, what methodologies to employ, and what assumptions to make. Because of this, results should not be viewed as exact, but rather as indicative of the impacts of education on health and well-being. Social externalities stemming from education break down into three main categories: 1) health savings, 2) crime savings, and 3) national insurance savings.

In the model, we quantify the effect of social externalities first by calculating the probability at each education level that individuals will have poor health, commit crimes, or claim national insurance transfers. Deriving the probabilities involves assembling data at the national level and breaking them out by gender and ethnicity. We then spread the probabilities across the education ladder and multiply the marginal

differences by the corresponding credit production at each step. The sum of these effects counts as the upper bound measure of the number of individuals who, due to their SES education, will not have poor health, commit crimes, or claim welfare and unemployment benefits.

Of course, there are other influences that impact an individual's behaviour, and separating these out from the non-economic benefits of education is a challenging task. For the purpose of this analysis, we dampen the results by the 'ability bias' adjustment discussed earlier in this chapter to account for other influences besides education that correlate with an individual's quality of life, such as socioeconomic status and family background. We also apply the same alternative education adjustment used above for the added income. The final step is to express the results in financial terms by multiplying them by the associated costs per individual, based on data supplied by national



Benefits to the public purse CASE STUDY HIGHLIGHT

Studies on immersion physiology improve the prevention, search, rescue and treatment of immersion casualties

University of Portsmouth

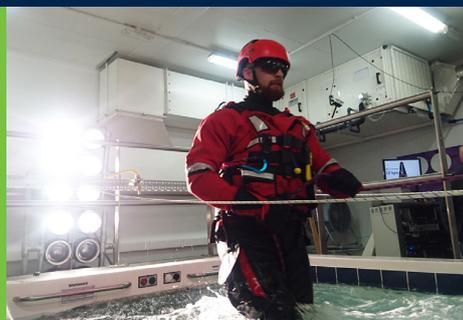


Image courtesy of the University of Portsmouth

The University of Portsmouth research in cold water immersion physiology is the foundation of the search, rescue, and treatment of a large number of organisations worldwide. For example, research led by Professor Mike Tipton, Dr Heather Massey, Dr Clare Eglin, and Dr Martin Barwood (now Leeds Trinity University) has played a key role in the development of new approaches to drowning prevention and water safety education. Drowning is a significant risk for elite athletes and a leading cause of accidental death in the UK, particularly in young people, causing approximately 400 deaths per year. Aside from the human cost, drowning and related incidents cost over £63 million per year, costs that can be prevented by safety measures and education. To that end, Portsmouth's research has underpinned the Royal National Lifeboat Institution's "Respect the Water"

National Water Safety Campaign, informing its "know about Cold Shock" and "Float First" approach to cold-water survival. This campaign has been cited by a number of drowning-incident survivors, without solicitation, as the reason they survived an immersion.

studies and surveys. These comprise the overall savings to society and the public purse.

Health service savings include avoided medical costs associated with smoking, obesity, and mental ill-health. While the public purse primarily benefits from reduced NHS expenditures, the savings to the rest of society are multi-faceted. For example, individuals will see reduced private healthcare costs, spend less time away from work, and live healthier lives. Savings strictly to the public purse amount to a present value of £21.9 million, while savings to the rest of society are equal to a present value of £66.9 million. Together, the AY 2016-17 SES students will save the public purse and the rest of society a present value of £88.8 million over their working lives from healthcare and related costs. A strongly emerging theme is the amount of health-related research being undertaken with SES departments. Much of the research undertaken within SES has health benefits and thereby reduces NHS

costs in areas such as exercise for people receiving treatment for cancer and healthy ageing.

Crime savings consist of reduced security expenditure and insurance administration, lower victim costs, and reduced criminal justice system expenditures. While the public purse will benefit from reduced costs on security expenditures, citizens across the UK will benefit from reduced costs of crime, such as damage or theft of property. Savings accruing to the public purse amount to a present value of £34.4 million while savings to the rest of society equal a present value of £141.8 million. Together, the AY 2016-17 SES students will save the public purse and the rest of society a present value of £176.2 million over their working lives from crime related costs.

Unemployment savings comprise the reduced demand for unemployment benefits, which is a direct saving to the public purse. The public purse will realise savings amounting to a present value of £2.1 million



Benefits to the public purse CASE STUDY HIGHLIGHT

Reducing the risk of secondary stroke through physical activity

University of Winchester



Image courtesy of the University of Winchester

In partnership with Hampshire Hospitals NHS Foundation Trust and Hobbs Rehabilitation, the University of Winchester recently launched the HELP (Health Enhancing Lifestyle Programme) Hampshire Stroke Clinic, a community-based and low-cost programme for those living with the effects of stroke. By providing exercise classes and lifestyle advice sessions from experts and students at the University, the Clinic will increase physical activity for stroke patients, thereby reducing their risk of secondary stroke while improving their physical and social quality of life and reducing the burden on the NHS. The newly-launched programme reports it has already seen more applicants than anticipated, boding well for its effectiveness in reaching a large number of people living with stroke in the local area.

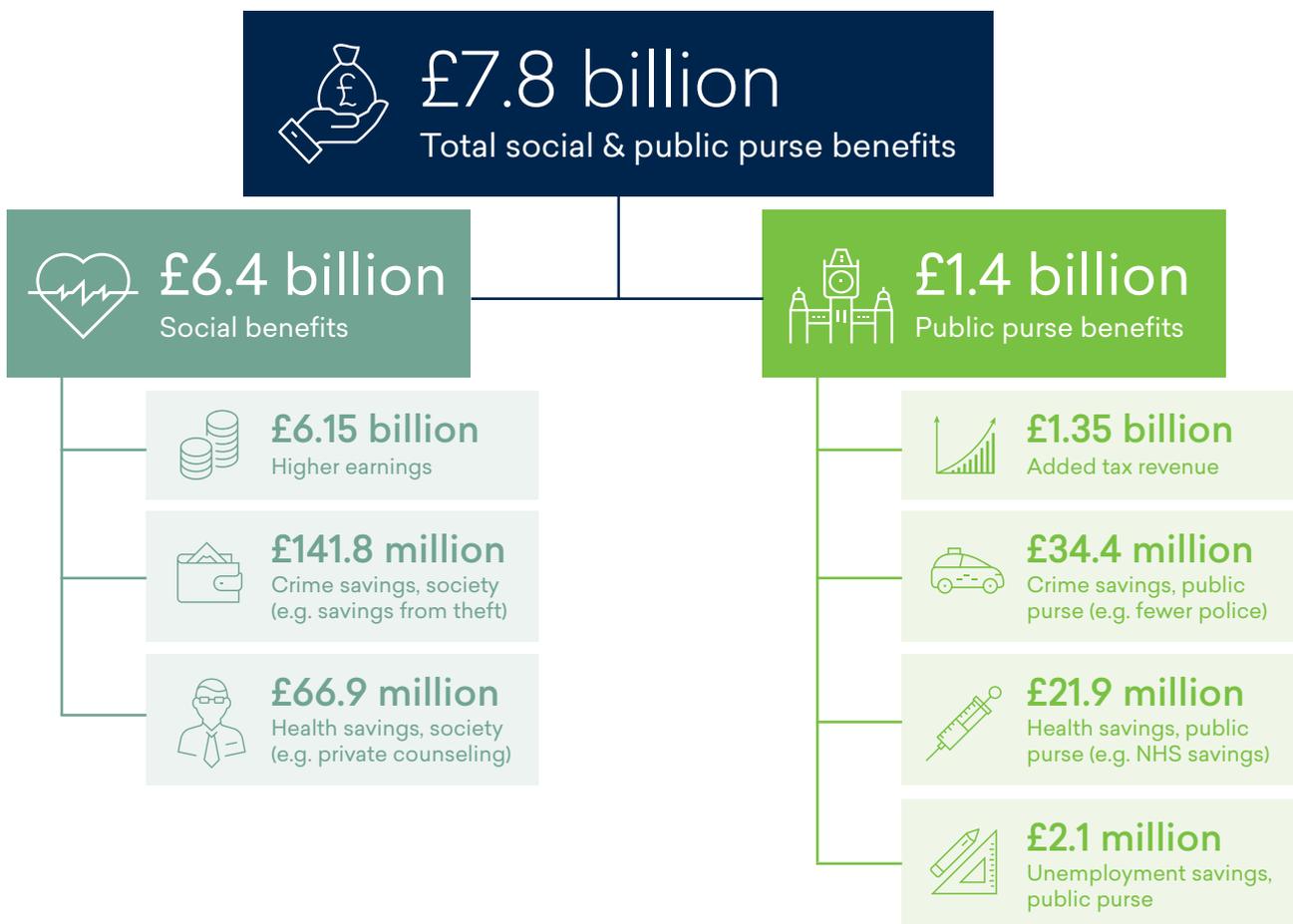
due to lower unemployment over the course of the AY 2016-17 SES students' working lives.

Altogether, the social and public purse savings of AY 2016-17 SES students, accumulated across their working lives, equal a present value of £267.1 million related to health, crime, and unemployment benefits in the UK. When added to the previously discussed £7.5 billion in higher earnings and increased tax revenues, total benefits to society and the public purse amount to £7.8 billion. Present value results of the analysis, divided between benefits to society and benefits to the public purse, are displayed in Figure 3.2.

Conclusion

The major stakeholders of SES higher education see significant benefits. Students are more productive and realise increased earnings as a result. Businesses that can hire UK graduates see increased productivity and profits. Society benefits from a broadened tax base, lower crime and other improved long run social behaviours. The increased tax receipts and reduced social burden frees the government to invest in new and more diverse ways.

FIGURE 3.2: PRESENT VALUE BENEFITS TO SOCIETY AND THE PUBLIC PURSE



Source: Emsi model.



Benefits to the public purse CASE STUDY HIGHLIGHT

Collaboration to benefit the local community

Bishop Grosseteste University

Since 2008, Bishop Grosseteste University in Lincolnshire has pursued a productive collaboration with the County Sports Partnership (Active Lincolnshire) to provide its students hands-on experience by participating in county sport and exercise projects. By working with the Partnership to support various programmes, especially summer and winter School Games, students at Levels 4 through to 6 support, train with, and volunteer in positions related to their study and careers. They also make a valuable contribution to the success of highly visible county events and develop ongoing relationships in the community. In the last five years, nearly 200 students have spent time working with the Partnership to deliver 15 different sports to pupils from 100 regional schools.



Benefits to the public purse CASE STUDY HIGHLIGHT

Health and exercise testing increase participation in long distance running

University of Suffolk

In 2018, the University of Suffolk's Great East Run Sport Science Support programme conducted significant research investigating the benefits of exercise by evaluating previously inactive community members who were planning to participate in the Great East Run half-marathon. Using the resources of the University's Human Performance Laboratory, the team's scientists offered free health and exercise testing to evaluate runners' body composition and ability to cope with physical effort, using the finest equipment available. Many of those studied showed significant progress, including several "super responders" who went beyond the half-marathon to sign up for full marathons, and participants reported seeing quantifiable changes in performance measures was very motivational. This case study evidence shows offering sport science support to the general public can greatly enhance their experience when taking up exercise as a previously inactive person.

Chapter 4: Sensitivity Analysis

The purpose of a sensitivity analysis is to 1) see how sensitive the results are to a change in the primary assumptions, and 2) provide the reader with a plausible range wherein the true results will fall. Since we are not providing a statistical analysis of the assumptions, we will not provide a 90% confidence interval, but the concept is similar in that the range generated by the sensitivity analysis gives the most probable outcome.

These types of studies often use assumptions that do not stand up to rigorous peer scrutiny and generate results that overstate benefits. The approach here is to set this study apart from those undertaken strictly for advocacy purposes and provide a true economic audit of the economic value of SES. The sensitivity analysis covers three variables. On the impact side we test the alternative education variable and the value per credit. For the benefits perspective, we test the alternative education variable again and the discount rate.

is highly dependent on current economic conditions. As can be seen, Table 4.1 below alters the assumed 'base case' values for both variables by first reducing them by 25% and 50% and then increasing them by the same.

Most interesting is the sensitivity of the results to the value per credit. The magnitude of change this variable has on the final results is large, demonstrating this variable's calculation is crucial to the analysis. It also proves why it is so critical to use earnings figures that are based on SES students' actual earnings outcomes.

Sensitivity analysis of impact assumptions

GRADUATE IMPACT

Two assumptions feed into the graduate impact. The alternative education variable accounts for the growth in impacts that would have been generated in the UK even if no institutions provided SES training. The value per credit, though calculated based on salaries of recent graduates, may vary from year to year and

Sensitivity analysis of investment assumptions

It is worth noting that while the alternative education variable is an assumption based on the educational potential of the students in the absence of formal SES training, the discount rate comes to us from The Green Book. These rates are calculated by HM Treasury, but they do vary by individual and are closely related

TABLE 4.1: GRADUATE IMPACT ASSUMPTIONS

	-50%	-25%	Base Case	25%	50%
Alternative Education Variable	7.5%	11.3%	15.0%	18.8%	22.5%
Impact (£ thousands)	£4,232,417	£4,060,832	£3,889,248	£3,717,664	£3,546,079
Value Per Credit	£8.83	£17.66	£23.54	£29.43	£44.14
Impact (£ thousands)	£1,458,468	£2,916,936	£3,889,248	£4,861,560	£7,292,340

Source: Emsi model.

TABLE 4.2: STUDENT PERSPECTIVE DISCOUNT RATE

	-50%	-25%	Base Case	25%	50%
Discount Rate	1.8%	2.6%	3.5%	4.4%	5.3%
PV (£ millions)	£5,341.9	£4,510.1	£3,849.5	£3,320.0	£2,891.4
B/C	7.6	6.4	5.5	4.7	4.1

Source: Emsi model.

TABLE 4.3: SOCIAL AND PUBLIC PURSE PERSPECTIVE ALTERNATIVE EDUCATION VARIABLE

	-50%	-25%	Base Case	25%	50%
Alternative Education Variable	7.5%	11.3%	15.0%	18.8%	22.5%
PV (£ millions)	£8,446.6	£8,104.2	£7,761.7	£7,419.3	£7,076.9

Source: Emsi model.

TABLE 4.4: SOCIAL AND PUBLIC PURSE PERSPECTIVE DISCOUNT RATE

	-50%	-25%	Base Case	25%	50%
Discount Rate	1.8%	2.6%	3.5%	4.4%	5.3%
PV (£ millions)	£10,759.4	£9,088.7	£7,761.7	£6,697.9	£5,836.9

Source: Emsi model.

TABLE 4.5: PUBLIC PURSE PERSPECTIVE ALTERNATIVE EDUCATION VARIABLE

	-50%	-25%	Base Case	25%	50%
Alternative Education Variable	7.5%	11.3%	15.0%	18.8%	22.5%
PV (£ millions)	£1,530.3	£1,468.3	£1,406.3	£1,344.2	£1,282.2

Source: Emsi model.

to an entity's risk aversion. So, while these data are published and incorporate the public's willingness to accept risk, we still provide a sensitivity analysis since different regions and sub-cultures in the UK may have different risk tolerances.

STUDENT PERSPECTIVE

The alternative education variable does not affect the students' stream of cash flows from Table 3.3 and thus is not included here. However, the discount rate for students will vary more than it will for the social and public purse perspectives.

The IRR is not shown here because it is unaffected by the discount rate (see E.J. Mishan 1976). As the discount rate is varied, the present value ranges from £2.9 billion to £5.3 billion and the B/C from 4.1 to 7.6. Even with a much higher discount rate, students still see a return above the threshold of 1.0, receiving £4.10 for every pound of their investment.

SOCIAL AND PUBLIC PURSE PERSPECTIVE

As can be seen in Table 4.3, reducing the alternative education variable increases the returns since more of the benefits may be claimed by SES provision. Similarly, reducing the discount rate increases the present value since future dollars are not discounted as heavily.

If our assumption of the alternative education variable is off by 50% in either direction, the expected social present value will range between £7.1 billion and £8.4 billion. The magnitude of the range is smaller than that of the discount rate, implying that the results are less sensitive to the alternative education variable. When varying the discount rate between plus or minus 50% of the base case, the present value is greater than £5.8 billion and less than £10.8 billion.

The public purse sensitivity analysis shows similar trends to those of the social perspective, though with a smaller magnitude of variance in results since

TABLE 4.6: PUBLIC PURSE PERSPECTIVE DISCOUNT RATE

	-50%	-25%	Base Case	25%	50%
Discount Rate	1.8%	2.6%	3.5%	4.4%	5.3%
PV (£ millions)	£1,948.9	£1,646.5	£1,406.3	£1,213.6	£1,057.8

Source: Emsi model.

the benefits are a subset of those seen in the social analysis.

As seen above, under the most conservative conditions, the alternative education variable will generate a present value of £1.3 billion. Under the most favourable assumptions on the alternative education variable, the public purse will see a present value of £1.5 billion. Again, the results are more sensitive to the discount rate, with the present value ranging from £1.1 billion to £1.9 billion.

Conclusion

Based on this sensitivity analysis, the benefits to students, the public, and the government are reasonable even when the most conservative assumptions are in place. Similarly, the economic impact analysis continues to generate modest results even when limiting by half the benefits that SES can claim.

Appendix 1: Resources and References

- Action on Smoking and Health. 'The Economics of Tobacco'. Ash Fact Sheets, August 2012. http://ash.org.uk/files/documents/ASH_121.pdf
- Action on Smoking and Health. 'Tobacco Economics'. Ash Facts at a Glance, May 2012. http://www.ash.org.uk/files/documents/ASH_95.pdf
- Becker, Gary S. Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education. New York: Columbia University Press for NBER, 1964.
- Bils, M. and P.J. Klenow. 'Does Schooling Cause Growth?' American Economic Review 90 no. 5 (2000): 1160-1183.
- Borts, G. H. and J. L. Stein. Economic Growth in a Free Market. New York: Columbia University Press, 1964.
- Carpenter, Hannah. 'Repeat Jobseeker's Allowance spells'. Department for Work and Pensions: BMRB Social Research, 2006. http://statistics.dwp.gov.uk/asd/asd5/report_abstracts/rr_abstracts/rra_394.asp
- Christaller, Walter. Central Places in Southern Germany. Translated by C.W. Baskins. Englewood Cliffs, NJ: Prentice-Hall, 1966.
- Clark, Christina and George Dugdale. 'Literacy Changes Lives: The role of literacy in offending behaviour'. London: National Literacy Trust, November 2008.
- Cooper, Claudia and Paul Bebbington. 'Mental Health'. Office for National Statistics, Focus on Health, 2006. <http://www.ons.gov.uk/ons/rel/disability-and-health-measurement/focus-on-health/2005-edition/index.html>
- Coulthard, Melissa et al. 'Tobacco, Alcohol and Drug Use and Mental Health'. Office for National Statistics, Social Survey Division, 2002. <http://www.ons.gov.uk/ons/rel/psychiatric-morbidity/tobacco-alcohol-and-drug-use-and-mental-health/2000/tobacco--alcohol-and-drug-use-and-mental-health---tobacco--alcohol-and-drug-use-and-mental-health.pdf>
- Crawford, Claire et al. 'Estimating the Public Cost of Student Loans'. Institute for Fiscal Studies, IFS Report R94, 2014. <http://www.ifs.org.uk/comms/r94.pdf>
- Department for Business Innovation & Skills. BIS Research Paper Number 115: "Student Income and Expenditure Survey 2011/12" https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/301467/bis-14-723-student-income-expenditure-survey-2011-12.pdf
- "Department for Education Consolidated Annual Report and Accounts: For the Year Ended 31 March 2017." Department of Education, 19 July 2017.
- Dickerson, Andy and Anna Vignoles. 'The Distribution and Returns to Qualifications in the Sector Skills Councils'. Sector Skills Development Agency, Research Report 21, April 2007.
- Drake, R. L. 'A Shortcut to Estimates of Regional Input-Output Multipliers: Methodology and Evaluation'. International Regional Science Review 1 no. 2 (Fall 1976).
- Drinkwater, Stephen and Derek Leslie. 'Adding Earnings Variables to the SARs: Accounting for the Ethnicity Effect', SARs Newsletter, No. 8, September 1996.
- Dubourg, Richard et al. 'Estimates of the economic and social costs of crime in England and Wales: Costs of crime against individuals and households, 2003/04'. Home Office Online Report 30/05, June 2005. <http://webarchive.nationalarchives.gov.uk/20110220105210/http://rds.homeoffice.gov.uk/rds/pdfs05/rdsolr3005.pdf>
- Emsi Regional Input-Output Modelling System (data and software). Moscow, ID: annual. Database on-line. <http://www.economicmodeling.com>.
- Feinstein, Leon. 'Quantitative Estimates of the Social Benefits of Learning, 2: Health (Depression and Obesity)'. Centre for Research on the Wider Benefits of Learning, Research Report No. 6, October 2002. <http://www.learningbenefits.net/Publications/ResReps/ResRep6.pdf>

- Fujita, Masahisa, Paul Krugman, and Anthony Venables. *The Spatial Economy: Cities, Regions, and International Trade*. Cambridge: Massachusetts Institute of Technology, 1999.
- Fujiwara, Daniel. *Valuing the Impact of Adult Learning*. Leicester: National Institute of Adult Continuing Education, 2012.
- Governor's Office of Planning and Budget, Demographic and Economic Analysis Section, and Consulting Economists. 'The Base Period 1992 Utah Multiregional Input-Output (UMRIO-92) Model: Overview, Data Sources, and Methods'. Utah State and Local Government Fiscal Impact Model, Working Paper Series 94-1. Salt Lake City, UT: Demographic and Economic Analysis (DEA), June 1994.
- "Graduate and Non-Graduate Earnings Pay Progression by Highest Qualification." *Graduates in the UK Labour Market: 2017*, Office for National Statistics, 24 Nov. 2017, www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/graduatesintheuklabourmarket/2017.
- Hamilton, J. R., N. K. Whittlesey, M. H. Robison, and J. Ellis. 'Economic Impacts, Value Added and Benefits in Regional Project Analysis'. *American Journal of Agricultural Economics* 31 no. 2 (1991): 334-344.
- Health and Safety Executive. 'Table STRGOR1E-2006/07: Estimated prevalence and rates of self-reported stress, depression, and anxiety caused or made worse by work, by country and government office region within England, for people ever employed'. <http://www.hse.gov.uk/statistics/lfs/0607/strgor1e.htm>; Internet.
- Henderson, James M. and Richard E. Quandt. *Microeconomic Theory: A Mathematical Approach*. New York: McGraw-Hill Book Company, 1971.
- Higher Education Statistics Agency. *HESA Destinations of Leavers Survey and Student Record 2016/17* (Received March 2019).
- HM Treasury. 'The Green Book: Appraisal and Evaluation in Central Government'. London: The Stationery Office, 2003. http://www.hm-treasury.gov.uk/d/green_book_complete.pdf.
- HM Treasury. 'Budget 2010'. London: The Stationery Office, June 2010.
- . GDP deflators. http://www.hm-treasury.gov.uk/economic_data_and_tools/gdp_deflators/data_gdp_fig.cfm.
- Home Office. 'Table 3 Recorded offences by offence group, by police force area, English regions and Wales, rates per 1,000 population' in 'Crime in England & Wales 2010/11: Police Force Area tables'. London: Home Office, July 2011.
- Inside Government. 'Retirement age'. <https://www.gov.uk/retirement-age>.
- Kirsanova, Tatiana and James Sefton. Table 2. Savings Rates in 'A Comparison of National Savings Rates in the UK, US and Italy'. London: National Institute of Economics and Social Research, July 2006.
- Losch, August. *The Economics of Location*. Translated by W. H. Woglom and W. F. Stolper. New Haven: Yale University Press, 1954.
- McCormick, B., I. Stone and Corporate Analytical Team. 'Economic costs of obesity and the case for government intervention'. London: Department of Health, 2007. <http://www.dti.gov.uk/assets/foresight/docs/obesity/161-164.pdf>.
- Melia, Ed et al. 'The case for adult learning: Findings from NIACE's Big Conversation'. NIACE, November 2006.
- Miller, Ron and Peter Blair. *Input-Output Analysis: Foundations and Extensions*. Englewood Cliffs, NJ: Prentice Hall, 1985.
- Mincer, Jacob. *Schooling, Experience and Earnings*. New York: National Bureau of Economic Research, 1974.
- Mincer, Jacob. 'Investment in Human Capital and Personal Income Distribution'. *Journal of Political Economy* 66, no. 4 (August 1958): 281-302.
- Ministry of Justice, National Offender Management Service. 'Population and Capacity Briefing for Friday 06/01/2012'. Prisons and probation, prison population (weekly).
- Molitor, Chris and Duane Leigh. 'Estimating the Returns to Schooling: Calculating the Difference Between Correlation and Causation'. Pullman, WA: by the authors, March 2001.

- Molitor, Christopher J. and Duane E. Leigh. 'In-school Work Experience and the Returns to Two-year and Four-year Colleges'. *Economics of Education Review*, 24 (2005): 459-468.
- National Health Service Information Centre, Lifestyles Statistics. 'Statistics on obesity, physical activity and diet: England, 2010'. The Health and Social Care Information Centre, February 2010. http://www.aso.org.uk/wpcontent/uploads/downloads/2012/02/Statistics_on_Obesity_Physical_Activity_and_Diet_England_2010.pdf
- National Health Service Information Centre. 'Table 2.10 Cigarette smoking status by gender, country and Government Office Region of England, 2009' in *Statistics on Smoking: England, 2011*. The Health and Social Care Information Centre, August 2011. <https://catalogue.ic.nhs.uk/publications/public-health/smoking/smok-eng-2011/smok-eng-2011-rep.pdf>
- 'Table 2.10 Cigarette smoking status by gender, country and Government Office Region of England, 2009' in 'Statistics on Smoking: England, 2011'. The Health and Social Care Information Centre, August 2011.
- NOMIS. 'Annual Population Survey'. <http://www.nomisweb.co.uk/query/asv2xls.aspx>
- NOMIS. 'Claimant count – seasonally adjusted'. <http://www.nomisweb.co.uk/articles/604.aspx>
- NOMIS. 'Department for Work and Pensions. Benefit payments 5% data – jobseekers allowance'. <http://www.nomisweb.co.uk/query/asv2xls.aspx>
- Office for National Statistics. 'All Releases of Population Estimates for UK, England and Wales, Scotland and Northern Ireland'. <http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Life+Tables>
- Labour Market Statistics. 'Claimant count levels and rates.' <http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-222441>
- Office for National Statistics. 'Publication: MM23 Consumer Price Indices'. <http://www.ons.gov.uk/ons/datasets-and-tables/downloads/xls-download.xls?dataset=mm23&cdid=D7BT>
- Office for National Statistics. 'Life Tables'. <http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Life+Tables>
- Office for National Statistics. Statistical Bulletin, November 2011. 'Annual Survey of Hours and Earnings'. http://www.ons.gov.uk/ons/dcp171778_241497.pdf
- Office for National Statistics. Labour Force Survey, October 2011. <http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-222441>
- Office for National Statistics. Labour Force Survey Headline Indicators, June-August 2011. <http://www.nomisweb.co.uk/articles/604.aspx>
- Office for National Statistics. Labour Market Statistics, October 2011. 'Claimant count levels and rates'. <http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-222441>
- Office for National Statistics. Labour Market Statistics, October 2011. 'Claimant count by age and duration'. <http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-222441>
- 'National Accounts: GDP by category of income'. <http://www.statistics.gov.uk/STATBASE/tsdataset.asp?vlnk=574&More=N&All=Y>
- Mid-2010 Population Estimates. <http://www.statistics.gov.uk/statbase/Product.asp?vlnk=15106>
- 'Regional analysis of public sector employment 2010'. ONS, 2010.
- Parr, J.B. 'Regional Economic Development: An Export Stages Framework', *Land Economics* 77, no. 1 (1999): 94-114.
- Robison, M. H. 'Community Input-Output Models for Rural Area Analysis: With an Example from Central Idaho'. *Annals of Regional Science* 31 no. 3 (1997): 325-351.
- Rutgers, State College of New Jersey, et al. 'The Impact of EDA RLF Loans on Economic Restructuring'. Paper prepared for U.S. Department of Commerce, Economic Development Administration. New Brunswick: Rutgers State College of New Jersey, 2002.

Sainsbury Centre for Mental Health. Policy Paper 3. 'The economic and social costs of mental illness'. London, June 2003. http://www.centreformentalhealth.org.uk/pdfs/costs_of_mental_illness_policy_paper_3.pdf

Stevens, B. H., G. I. Treyz, D. J. Ehrlich, and J. R. Bower. 'A New Technique for the Construction of Non-Survey Regional Input-Output Models'. *International Regional Science Review* 8 no. 3 (1983): 271-186.

Walker, Ian, et al. 'The Impact of University Degrees on the Lifecycle of Earnings: Some Further Analysis'.

(Department for Business, Innovation and Skills, BIS Research Paper Number 112: London, August 2013).

Walsh, J.R. 'Capital Concepts Applied to Man'. *The Quarterly Journal of Economics*, 49 (1935): 255-285

Willis, Robert J. 'Wage Determinants: A Survey and Reinterpretation of Human Capital

Earnings Function'. In *Handbook of Labour Economics*, Vol. 1. Edited by Kenneth J. Arrow and Michael D. Intriligator. Amsterdam: Elsevier Science Publishers, 1986: 525-602.

Appendix 2: Full Glossary of Terms

Alternative education: A 'with' and 'without' measure of the percent of students who would still be able to avail themselves of education if formal SES training in the UK did not exist. An estimate of 10%, for example, means that 10% of students do not depend directly on the existence of SES focused universities in order to obtain their education.

Asset value: Capitalised value of a stream of future returns. Asset value measures what someone would have to pay today for an instrument that provides the same stream of future revenues.

Attrition rate: Rate at which students leave the workforce due to such factors as out-migration, retirement, or death.

Benefit/cost ratio: Dividing the benefits by costs yields the benefit-cost ratio. It demonstrates how many pounds are returned in increased earnings for each £1 invested. If the benefit/cost ratio is greater than one, then benefits exceed costs and the investment is feasible.

Demand: Relationship between the market price of education and the volume of education demanded (expressed in terms of enrolment). The law of the downward-sloping demand curve is related to the fact that enrolment increases only if the price (student tuition fees) is lowered, or conversely, enrolment decreases if price increases.

Direct effect: Additional economic activity that occurs as the industries affected by the initial effect spend money to purchase goods and services from their supply chain industries.

Discounting: Expressing future revenues and costs in present value terms.

Economics: Study of the allocation of scarce resources among alternative and competing ends. Economics is not normative (what ought to be done), but positive (describes what is, or how people are likely to behave in response to economic changes).

Elasticity of demand: Degree of responsiveness of the quantity of education demanded (enrolment) to changes in market prices (student tuition fees).

If a decrease in fees increases total revenues, demand is elastic. If it decreases total revenues, demand is inelastic. If total revenues remain the same, elasticity of demand is unitary.

Externalities: Impacts (positive and negative) for which there is no compensation. Positive externalities of education include improved social behaviours such as lower crime, reduced unemployment, and improved health. Universities do not receive compensation for these benefits, even though education statistically correlates with improved social behaviours.

Graduate impact: Graduate impact refers to the SES graduates' higher wages, increased productivity, and associated multiplier effects in AY 2016-17. This is an annual impact.

Gross Domestic Product: Measure of the final value of all goods and services produced. Alternatively, GDP equals the combined incomes of all factors of production, e.g., labour, land, and capital. These include wages, salaries, profits, rents, and other.

Indirect effect: Economic activity that occurs as the supply chain of the initial industries creates even more activity in the economy through their own inter-industry spending.

Induced effect: Economic activity created by the household sector as the businesses affected by the initial, direct, and indirect effects raise salaries or hire more people.

Initial effect: Income generated by the initial injection of monies into the economy through the expenditures of the SES students.

Input-output analysis: Relationship between a given set of demands for final goods and services, and the implied amounts of manufactured inputs, raw materials, and labour this requires. In an educational setting, as students enter or rejoin the workforce with added skills, they earn higher salaries and wages. In turn, this generates more consumption and spending in other sectors of the economy.

Internal rate of return: Rate of interest which, when used to discount cash flows associated with investing in education, reduces the net present value to zero (i.e., where the present value of revenues accruing from the investment are just equal to the present value of costs incurred). This, in effect, is the breakeven rate of return since it shows the highest rate of interest at which the investment makes neither a profit nor a loss.

Labour income: Income which is received as a result of labour, e.g., wages.

Multiplier effect: Multiplier effects refer to the additional income and jobs that are created due to the impacts of SES graduates. For example, as an SES graduate earns more money, they create additional demand for goods and services across the wider economy due to their increased spending.

Net cash flow: Benefits minus costs, i.e., the sum of revenues accruing from an investment minus costs incurred.

Net present value: Net cash flow discounted to the present. All future cash flows are, in this way, collapsed into one number, which, if positive, indicates feasibility. The result is expressed as a monetary measure.

Non-labour income: Income which is received from investments (such as rent, interest, and

dividends) and transfer payments (payments from governments to individuals).

Opportunity cost: Benefits forgone from alternative B once a decision is made to allocate resources to alternative A. For example, if an individual chooses not to attend university, he or she forgoes higher future earnings associated with further education. The benefit of education, therefore, is the 'price tag' of choosing not to attend university.

Payback period: Length of time required to recover an investment – the shorter the period, the more attractive the investment. The formula for computing the payback period is:

$$\text{Payback period} = \frac{\text{cost of investment}}{\text{net return per period}}.$$

Present value: Present value refers to expressing projected future revenues and costs in today's terms. In other words, £1 today is not worth the same as £1 five years from now.

Rate of return: The rate of return is the annual percentage return to SES graduates in terms of increased earnings over their career.

Social benefits: Social benefits, also referred to as benefits to society, are benefits accruing to the public purse and private UK citizens over time as a result of graduates receiving an SES education. They are measured in terms of higher earnings, added tax revenues, social savings, and public purse savings.

Appendix 3: Emsi Input-Output Model

INTRODUCTION AND DATA SOURCES

Emsi's UK Input-Output model represents the economic relationships among a region's industries, with particular reference to how much each industry purchases from each other industry. Using a complex, automated process, we can create regionalised models for any geographic area comprised of NUTS 3 areas.

Our primary data sources are the following:

- Regional and national jobs-by-industry totals, and national sales-to-jobs ratios (derived from Emsi's industry employment and earnings data process).
- The Office for National Statistics' (ONS) Supply and Use Tables (SUTs).

CREATION OF THE Z MATRIX

The SUTs show which industries make or use which commodity types. These two tables are combined to replace the industry-commodity-industry relationships with simple industry-industry relationships. This is called the national 'Z' matrix, which shows the total amount (£) each industry purchases from others. Industry purchases run down the columns, while industry sales run across the rows.

In looking at the table above, the value 1,532.5 means that Industry 2 purchases £1,532,500,000 worth of commodities and/or services from Industry 1. In other words, the whole table is basically an economic double-entry accounting system, configured so that all money inflows have corresponding outflows elsewhere. All regular industries (such as 'oil and gas

exploration,' 'machinery manufacturing,' 'supermarkets,' 'hospitals,' and so on) are captured in the Z matrix.

DISAGGREGATION OF THE Z MATRIX

The initial national Z matrix is then 'disaggregated' (or extended) from around 120 industries to approximately 645 industries. The disaggregation is performed by using probability matrices that allow us to estimate industry transactions for the more detailed sectors based on the known transactions of their parent sectors. The probability matrix is created from detailed Emsi industry earnings data, which are available for the approximately 645 industries and generated using a separate process.

CREATION OF THE A MATRIX

The national disaggregated 'Z' matrix is then 'normalised' to show purchases as percentages of each industry's output rather than total £ amounts. This is called the national 'A' matrix.

Each cell value represents the percentage of a column industry's total input purchases that goes toward purchasing inputs from each row industry. Thus, the cell containing .112 means that Industry 2 spends 11.2% of its total input purchases to obtain inputs from Industry 1.

REGIONALISATION OF THE A MATRIX

To create a regional input-output model so that each region can be analysed on its own, we regionalise the national A matrix using that region's industry mix. The core regionalisation method is based on the

TABLE A3.1: SAMPLE Z MATRIX (£ MILLIONS)

	Industry 1	Industry 2	...	Industry 645
Industry 1	3.3	1,532.5	...	232.1
Industry 2	9.2	23.0	...	1,982.7
...
Industry 645	819.3	2,395.6	...	0

TABLE A3.2: SAMPLE 'A' MATRIX

	Industry 1	Industry 2	...	Industry 645
Industry 1	.001	.112035
Industry 2	.097	0065
...
Industry 645	.002	.076	...	0

work of University of West England economist A.T. Flegg¹⁸ and uses cross-industry location quotients. In general, location quotients provide regional insight by determining the proportion of regional employment in a specific sector compared to the proportion of national employment in that same sector. In an effort to produce the best estimates, we calibrated the Flegg location quotients (FLQs) in our model with respect to 2007 data from the Scottish Government Input-Output Model. We calculate the FLQs using the following equation:

$$FLQ_{i,j} = \left(\frac{\frac{J_i^R}{J^R}}{\frac{J_i^N}{J^N}} \right) \times \left(\log_2 \left(1 + \frac{\sum J^R}{\sum J^N} \right) \right)^{0.1}$$

Where:

J = jobs

i = row industry

j = column industry

R = region

N = nation

0.1 = Calibration

We create a separate matrix for the FLQs of all industries, as displayed below in Table A3.3. For example, the cell containing the FLQ of .12 was calculated by using Industry 1 as the row industry (or *i* in the equation above) and Industry 2 as the column industry (or *j* in the equation above).

TABLE A3.3: SAMPLE FLQ MATRIX

	Industry 1	Industry 2	...	Industry 645
Industry 1	1	.1247
Industry 2	.98	109
...
Industry 645	.20	.76	...	1

One other important aspect of the FLQ matrix is that we can use each FLQ as a regional purchase

coefficient (RPC). RPCs are useful in estimating the percentage of industry demand that is met by purchases from other industries within the region. In this way, we can see how much money for industry purchases stays within the region and how much leaks out of the region.

Since the FLQ matrix has the same dimensions as the *A* matrix, it can be used to scale the national *A* matrix to the region using the Hadamard (i.e., element-by-element) product. The result is the regionalised *A* matrix, represented by the following equation:

$$A^R = A^N \circ F^R$$

Where:

\circ = Hadamard (element-by-element) multiplication

A^N = national IO coefficients matrix (i.e., technical coefficients)

F^R = FLQ matrix

A^R = regional IO coefficients matrix

The *A*-matrix regionalisation process is automated for any given region for which industry data are available. Although partially derived from national figures, the regional *A* matrix offers a best possible estimate of regional values without resorting to costly and time-consuming survey techniques, which in most cases are completely infeasible.

Creating multiplier effects and using the *A* matrix

Finally, we convert the regional *A* matrix to a regional *B* matrix using the standard Leontief inverse:

$$B^R = (I - A^R)^{-1}$$

The *B* matrix consists of inter-industry sales multiplier effects, which can be converted to jobs or earnings multiplier effects using per-industry jobs-to-sales or earnings-to-sales ratios. The resulting tables and vectors from this process are then used in the actual end-user software to calculate regional requirements, calculate regional economic base, estimate sales multiplier effects, and run impact scenarios.

18 Flegg, A.T. and C.D. Webber, 2000. 'Regional Size, Regional Specialisation and the FLQ Formula,' *Regional Studies* 34(6): 563-569; Flegg, A.T. and C.D. Webber, 1997. 'Regional Size, Industrial Location and Input-Output Expenditure Coefficients,' *Regional Studies* 32(5):435-444; Flegg, A.T. and C.D. Webber, 1997. 'On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables: Reply' *Regional Studies* 31(8): 795-805; Flegg, A.T. and C.D. Webber, 1994. 'On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables' *Regional Studies* 29(6): 547-561.

Appendix 4: Industry to Industry Sector Map

SIC Code	SIC Description	Total Impact (Thousands)	Industry Sector
9312	Activities of sport clubs	£ 480,087	Sport, tourism, leisure, and culture
9319	Other sports activities	£ 266,418	Sport, tourism, leisure, and culture
9313	Fitness facilities	£ 230,929	Sport facilities
9311	Operation of sports facilities	£ 198,590	Sport facilities
8531	General secondary education	£ 160,591	Education and research
4711	Retail sale in non-specialised stores with food, beverages or tobacco predominating	£ 148,638	Retail
8542	Tertiary education	£ 121,307	Education and research
8551	Sports and recreation education	£ 119,332	Education and research
8400	Public administration and defence; compulsory social security	£ 105,255	Public sector
5610	Restaurants and mobile food service activities	£ 100,294	Retail
5630	Beverage serving activities	£ 95,664	Retail
8520	Primary education	£ 79,326	Education and research
8610	Hospital activities	£ 74,530	Health and social care
8690	Other human health activities	£ 71,077	Health and social care
6500	Insurance, reinsurance and pension funding, except compulsory social security	£ 65,670	Finance
5510	Hotels and similar accommodation	£ 62,093	Sport, tourism, leisure, and culture
7810	Activities of employment placement agencies	£ 62,003	Services and legal services
7820	Temporary employment agency activities	£ 54,872	Services and legal services
6820	Renting and operating of own or leased real estate	£ 51,988	Services and legal services
9604	Physical well-being activities	£ 51,510	Sport, tourism, leisure, and culture
4764	Retail sale of sporting equipment in specialised stores	£ 49,951	Retail
8559	Other education n.e.c.	£ 48,167	Education and research
4771	Retail sale of clothing in specialised stores	£ 46,411	Retail
6400	Financial service activities, except insurance and pension funding	£ 40,565	Finance
4719	Other retail sale in non-specialised stores	£ 36,094	Retail
8622	Specialist medical practice activities	£ 33,815	Health and social care
9200	Gambling and betting activities	£ 32,471	Sport, tourism, leisure, and culture
9329	Other amusement and recreation activities	£ 30,922	Sport, tourism, leisure, and culture
8899	Other social work activities without accommodation n.e.c.	£ 28,918	Health and social care
8541	Post-secondary non-tertiary education	£ 28,549	Education and research
4120	Construction of residential and non-residential buildings	£ 28,486	Construction and manufacturing
3514	Trade of electricity	£ 28,094	Retail
7311	Advertising agencies	£ 21,498	Services and legal services
4791	Retail sale via mail order houses or via Internet	£ 21,246	Retail
6831	Real estate agencies	£ 20,981	Services and legal services
6190	Other telecommunications activities	£ 17,326	Telecommunications and digital technology
4778	Other retail sale of new goods in specialised stores	£ 16,561	Retail
4772	Retail sale of footwear and leather goods in specialised stores	£ 15,554	Retail
7711	Renting and leasing of cars and light motor vehicles	£ 15,259	Retail

SIC Code	SIC Description	Total Impact (Thousands)	Industry Sector
3511	Production of electricity	£ 14,104	Energy and farming
3513	Distribution of electricity	£ 14,033	Energy and farming
5520	Holiday and other short-stay accommodation	£ 13,754	Sport, tourism, leisure, and culture
9609	Other personal service activities n.e.c.	£ 13,680	Services and legal services
6910	Legal activities	£ 13,195	Services and legal services
4752	Retail sale of hardware, paints and glass in specialised stores	£ 13,180	Retail
6201	Computer programming activities	£ 12,833	Telecommunications and digital technology
2910	Manufacture of motor vehicles	£ 12,624	Construction and manufacturing
8810	Social work activities without accommodation for the elderly and disabled	£ 12,449	Health and social care
8220	Activities of call centres	£ 12,328	Services and legal services
8621	General medical practice activities	£ 11,228	Health and social care
4742	Retail sale of telecommunications equipment in specialised stores	£ 10,242	Retail
6600	Activities auxiliary to financial services and insurance activities	£ 10,104	Finance
8299	Other business support service activities n.e.c.	£ 10,096	Services and legal services
8130	Landscape service activities	£ 9,503	Services and legal services
6920	Accounting, bookkeeping and auditing activities; tax consultancy	£ 9,393	Finance
4511	Sale of cars and light motor vehicles	£ 9,287	Transport
9499	Activities of other membership organisations n.e.c.	£ 9,167	Services and legal services
8010	Private security activities	£ 9,107	Services and legal services
6209	Other information technology and computer service activities	£ 8,623	Services and legal services
9004	Operation of arts facilities	£ 8,590	Sport, tourism, leisure, and culture
4334	Painting and glazing	£ 7,759	Construction and manufacturing
3299	Other manufacturing n.e.c.	£ 7,707	Construction and manufacturing
7912	Tour operator activities	£ 7,668	Sport, tourism, leisure, and culture
9321	Activities of amusement parks and theme parks	£ 7,647	Sport, tourism, leisure, and culture
3250	Manufacture of medical and dental instruments and supplies	£ 7,571	Health and social care
5914	Motion picture projection activities	£ 7,520	Sport, tourism, leisure, and culture
8230	Organisation of conventions and trade shows	£ 7,429	Services and legal services
3522	Distribution of gaseous fuels through mains	£ 7,413	Energy and farming
4322	Plumbing, heat and air-conditioning installation	£ 7,409	Energy and farming
4399	Other specialised construction activities n.e.c.	£ 7,397	Construction and manufacturing
5911	Motion picture, video and television programme production activities	£ 7,331	Sport, tourism, leisure, and culture
4321	Electrical installation	£ 7,278	Energy and farming
5320	Other postal and courier activities	£ 7,102	Telecommunications and digital technology
5621	Event catering activities	£ 7,040	Services and legal services
6311	Data processing, hosting and related activities	£ 6,794	Telecommunications and digital technology
5310	Postal activities under universal service obligation	£ 6,699	Telecommunications and digital technology
6202	Computer consultancy activities	£ 6,418	Telecommunications and digital technology
8891	Child day-care activities	£ 6,275	Education and research
8790	Other residential care activities	£ 6,234	Health and social care
7729	Renting and leasing of other personal and household goods	£ 5,992	Services and legal services

SIC Code	SIC Description	Total Impact (Thousands)	Industry Sector
1812	Other printing	£ 5,812	Services and legal services
8110	Combined facilities support activities	£ 5,674	Services and legal services
1107	Manufacture of soft drinks; production of mineral waters and other bottled waters	£ 5,662	Construction and manufacturing
9491	Activities of religious organisations	£ 5,538	Services and legal services
4690	Non-specialised wholesale trade	£ 5,428	Retail
4724	Retail sale of bread, cakes, flour confectionery and sugar confectionery in specialised stores	£ 5,352	Retail
4941	Freight transport by road	£ 5,350	Transport
3600	Water collection, treatment and supply	£ 5,306	Services and legal services
4754	Retail sale of electrical household appliances in specialised stores	£ 5,263	Retail
4673	Wholesale of wood, construction materials and sanitary equipment	£ 5,240	Retail
4730	Retail sale of automotive fuel in specialised stores	£ 5,237	Retail
4639	Non-specialised wholesale of food, beverages and tobacco	£ 5,222	Retail
4773	Dispensing chemist in specialised stores	£ 5,201	Health and social care
7022	Business and other management consultancy activities	£ 5,189	Services and legal services
1051	Operation of dairies and cheese making	£ 5,154	Energy and farming
5229	Other transportation support activities	£ 5,106	Transport
7911	Travel agency activities	£ 5,095	Sport, tourism, leisure, and culture
7490	Other professional, scientific and technical activities n.e.c.	£ 5,043	Services and legal services
5210	Warehousing and storage	£ 5,025	Services and legal services
8291	Activities of collection agencies and credit bureaus	£ 4,969	Finance
2410	Manufacture of basic iron and steel and of ferro-alloys	£ 4,946	Construction and manufacturing
9602	Hairdressing and other beauty treatment	£ 4,840	Services and legal services
7120	Technical testing and analysis	£ 4,667	Education and research
8510	Pre-primary education	£ 4,534	Education and research
2110	Manufacture of basic pharmaceutical products	£ 4,517	Construction and manufacturing
9603	Funeral and related activities	£ 4,456	Services and legal services
01A0	Growing of crops, market gardening, horticulture; Farming of animals	£ 4,414	Energy and farming
8730	Residential care activities for the elderly and disabled	£ 4,168	Health and social care
9001	Performing arts	£ 4,068	Sport, tourism, leisure, and culture
1623	Manufacture of other builders' carpentry and joinery	£ 3,942	Construction and manufacturing
4333	Floor and wall covering	£ 3,848	Construction and manufacturing
4391	Roofing activities	£ 3,827	Construction and manufacturing
4110	Development of building projects	£ 3,787	Construction and manufacturing
9002	Support activities to performing arts	£ 3,766	Sport, tourism, leisure, and culture
4339	Other building completion and finishing	£ 3,734	Construction and manufacturing
3811	Collection of non-hazardous waste	£ 3,640	Services and legal services
4299	Construction of other civil engineering projects n.e.c.	£ 3,583	Construction and manufacturing
6020	Television programming and broadcasting activities	£ 3,582	Sport, tourism, leisure, and culture
4329	Other construction installation	£ 3,561	Construction and manufacturing
3030	Manufacture of air and spacecraft and related machinery	£ 3,548	Construction and manufacturing
6010	Radio broadcasting	£ 3,536	Sport, tourism, leisure, and culture
6110	Wired telecommunications activities	£ 3,529	Telecommunications and digital technology

SIC Code	SIC Description	Total Impact (Thousands)	Industry Sector
6120	Wireless telecommunications activities	£ 3,505	Telecommunications and digital technology
5010	Sea and coastal passenger water transport	£ 3,497	Transport
3040	Manufacture of military fighting vehicles	£ 3,427	Construction and manufacturing
1413	Manufacture of other outerwear	£ 3,358	Construction and manufacturing
3109	Manufacture of other furniture	£ 3,260	Construction and manufacturing
1089	Manufacture of other food products n.e.c.	£ 3,204	Construction and manufacturing
7211	Research and experimental development on biotechnology	£ 3,154	Education and research
8552	Cultural education	£ 3,008	Education and research
6832	Management of real estate on a fee or contract basis	£ 2,994	Services and legal services
4799	Other retail sale not in stores, stalls or markets	£ 2,974	Retail
2229	Manufacture of other plastic products	£ 2,963	Construction and manufacturing
2892	Manufacture of machinery for mining, quarrying and construction	£ 2,894	Construction and manufacturing
8129	Other cleaning activities	£ 2,881	Services and legal services
8121	General cleaning of buildings	£ 2,858	Services and legal services
4932	Taxi operation	£ 2,845	Transport
5819	Other publishing activities	£ 2,832	Services and legal services
4762	Retail sale of newspapers and stationery in specialised stores	£ 2,799	Retail
4677	Wholesale of waste and scrap	£ 2,798	Retail
2651	Manufacture of instruments and appliances for measuring, testing and navigation	£ 2,798	Construction and manufacturing
5829	Other software publishing	£ 2,777	Services and legal services
4729	Other retail sale of food in specialised stores	£ 2,770	Retail
4776	Retail sale of flowers, plants, seeds, fertilisers, pet animals and pet food in specialised stores	£ 2,770	Retail
4761	Retail sale of books in specialised stores	£ 2,683	Retail
7320	Market research and public opinion polling	£ 2,666	Services and legal services
4779	Retail sale of second-hand goods in stores	£ 2,664	Retail
4777	Retail sale of watches and jewellery in specialised stores	£ 2,660	Retail
4759	Retail sale of furniture, lighting equipment and other household articles in specialised stores	£ 2,656	Retail
4631	Wholesale of fruit and vegetables	£ 2,654	Retail
4649	Wholesale of other household goods	£ 2,642	Retail
4669	Wholesale of other machinery and equipment	£ 2,625	Retail
4652	Wholesale of electronic and telecommunications equipment and parts	£ 2,611	Retail
4646	Wholesale of pharmaceutical goods	£ 2,611	Health and social care
7990	Other reservation service and related activities	£ 2,610	Services and legal services
4651	Wholesale of computers, computer peripheral equipment and software	£ 2,605	Retail
4642	Wholesale of clothing and footwear	£ 2,602	Retail
4643	Wholesale of electrical household appliances	£ 2,602	Retail
4931	Urban and suburban passenger land transport	£ 2,598	Transport
7021	Public relations and communication activities	£ 2,588	Services and legal services
5222	Service activities incidental to water transportation	£ 2,576	Transport
4741	Retail sale of computers, peripheral units and software in specialised stores	£ 2,568	Retail
4774	Retail sale of medical and orthopaedic goods in specialised stores	£ 2,559	Retail
4775	Retail sale of cosmetic and toilet articles in specialised stores	£ 2,549	Retail

SIC Code	SIC Description	Total Impact (Thousands)	Industry Sector
5223	Service activities incidental to air transportation	£ 2,543	Transport
5221	Service activities incidental to land transportation	£ 2,540	Transport
7111	Architectural activities	£ 2,464	Construction and manufacturing
4520	Maintenance and repair of motor vehicles	£ 2,449	Transport
2511	Manufacture of metal structures and parts of structures	£ 2,447	Construction and manufacturing
7410	Specialised design activities	£ 2,382	Transport
7112	Engineering activities and related technical consultancy	£ 2,336	Construction and manufacturing
4532	Retail trade of motor vehicle parts and accessories	£ 2,327	Transport
5629	Other food service activities	£ 2,314	Retail
6399	Other information service activities n.e.c.	£ 2,302	Services and legal services
8623	Dental practice activities	£ 2,155	Health and social care
8720	Residential care activities for learning disabilities, mental health and substance abuse	£ 2,098	Health and social care
9412	Activities of professional membership organisations	£ 1,851	Services and legal services
9104	Botanical and zoological gardens and nature reserve activities	£ 1,631	Sport, tourism, leisure, and culture
9103	Operation of historical sites and buildings and similar visitor attractions	£ 1,611	Sport, tourism, leisure, and culture
8560	Educational support activities	£ 1,503	Education and research

