DEMONSTRATING THE VALUE OF

FE Colleges in Wales

Analysis of the Social and Economic Impact of Learning

MAIN REPORT

August 2017

Emsi

Preface

Since 2000, Economic Modelling Specialists International (Emsi) has helped address a widespread need in the US and Canada to demonstrate the impact of education. We have conducted more than 1,100 economic impact studies for education institutions in the US and nearly 100 individual and province-wide studies for colleges in Canada.

In 2007, Emsi recognised a similar need in the UK for evidence of the true impact of further education and the expected returns on further investment. Working closely with Warwickshire College, we developed an impact model to quantify such measures, and by the end of 2010 more than 70 colleges had participated in the research.

Emsi set up permanent offices in the UK by early 2012, and we embarked on a second pilot effort to update our model and narrative. The reports underwent a reworking of the organisation and layout, and revisions to the model included the construction of a more robust data collection mechanism and updates to the data and assumptions to reflect the latest economic theory. Throughout this process, we received excellent support from our two pilot colleges, Middlesbrough College and South Staffordshire College, who ensured that the revisions we made reflected the key challenges and issues facing the further education sector. Rachel Jones, Vice Principal at Burton and South Derbyshire College, also provided us with valuable guidance and assistance.

The third version of the model was released in 2017. This coincided with Emsi's new UK Regional I-O Model. Emsi's UK Regional I-O Model allowed for significant improvements to be made to the economic impact model. Major changes include the use of 4-digit UK Standard Industrial Classification (SIC) level data, changes in the measurement of multiplier effects, and updates to background data used in the model given newly available data.

As we release the results of this study, our hope is that they will initiate feedback from all perspectives – whether colleges, policy-makers, inspectors, employers, or learners. We encourage our readers to contact us directly with any questions or comments they may have about the study's findings so that we can continue to keep the public dialogue open about the positive impact of learning.

Acknowledgements

Emsi gratefully acknowledges the excellent support of ColegauCymru-CollegesWales in making this study possible. Special thanks go to Iestyn Davies, Chief Executive Officer, who approved the study, and to the research staff at the colleges who collected and organised much of the data and information requested. Any errors in the report are the responsibility of the authors and not of any of the above-mentioned institutions or individuals.

List of Participating Institutions

Bridgend College

Coleg y Cymoedd

Coleg Sir Gar

Cardiff and Vale College

Coleg Cambria

Workers Education Association Cymru*

YMCA Wales Community College*

Gower College Swansea

Pembrokeshire College

NPTC Group of Colleges

The College Merthyr Tydfil

Coleg Gwent

Grŵp Llandrillo Menai

Data Unavailable for the Following Institutions:

Coleg Ceredigion

St David's Catholic Sixth Form College

*These institutions have since merged to form Adult Learning Wales

Table of Contents

Introduction

FE colleges in Wales create value in many ways. The colleges are committed to putting learners on the path to success and play a key role in helping them increase their employability and achieve their individual potential. With a vast range of courses and apprenticeships, the colleges' provision enables learners to acquire qualifications and develop the skills they need in order to have a fulfilling and prosperous career. The colleges also provide an excellent environment for learners to meet new people and make friends, while participation in college courses improves the learners' self-confidence and promotes their mental health. All of these social and employment-related benefits have a positive influence on the health and well-being of individuals.

However, the contribution of FE colleges in Wales consists of more than solely influencing the lives of learners. The colleges' provision supports a range of employment sectors in Wales and supplies employers with the skilled workers they need to make their businesses more productive. The expenditures of FE colleges in Wales, along with the spending of their staff and learners, further support the local economy through the output and employment generated at local suppliers. Lastly, and just as importantly, the economic impact of FE colleges in Wales extends as far as the Exchequer in terms of increased tax receipts and decreased public sector costs.

Objective of the Report

In this report we assess the economic value of FE colleges in Wales to their key stakeholder groups: learners, society, taxpayers, and the local community. The fact that learning makes a difference to these groups is well known, but comparatively little research has been done to quantify the monetary value of these benefits. Some studies include Fujiwara's (2012)[1] analysis of the impact of adult learning and the March 2010/11 study commissioned by the Department for Business, Innovation and Skills (BIS)[2] on the economic impact of the FE sector. Although the approaches used in these and other similar studies vary, they all contribute valuable information to the growing body of evidence that proves the value of investing in education.

The approach in this study is twofold. We begin with a standard investment analysis to determine how the investments in FE colleges in Wales will perform for a given investor over time. The investors in this case are learners, society, and taxpayers, all of whom pay a certain amount in costs to support the activities at FE colleges in Wales. The learners' investment consists of the tuition fees they pay to attend the colleges plus the opportunity cost of spending time learning as opposed to earning income through

[1] Daniel Fujiwara, 'Valuing the Impact of Adult Learning' (National Institute of Adult Continuing Education: Leicester, 2012).

[2] Rachel Beaven et al, 'Measuring the Economic Impact of Further Education' (Department for Business, Innovation and Skills, BIS Research Paper Number 38: London, March 2011).

employment. Society forgoes government services and increased business output that would have been generated had funds not been allocated to the colleges and learners been employed. Taxpayers contribute their investment through government funding and organisations. In return for these costs, learners receive a lifetime of higher earnings, society gains from higher output and income and a reduced tax burden, while taxpayers benefit from higher tax receipts and avoided public sector costs. To determine the feasibility of the investment, the model projects benefits into the future, discounts them back to their present value, and compares them to their present value costs. Results of the investment analysis for learners, society, and taxpayers are displayed in the following four ways: 1) net present value of benefits, 2) benefit/cost ratio, 3) rate of return, and 4) payback period.

The second component of the study focuses on the economic impacts created by FE colleges in Wales on the local business community in Wales. Regional economic impact analysis is distinct from investment analysis in that it focuses on a single time period and does not project impacts into the future, nor does it factor in costs incurred by stakeholders. To derive results, we rely on a specialised input-output (IO) model to calculate the additional income created in the economy of Wales as a result of the increased consumer spending and added skills generated by FE colleges in Wales and their learners. Results of the regional economic impact analysis are measured in terms of the added income created by the following three impacts: 1) impact of staff and college expenditure, 2) impact of learner expenditure, and 3) impact of the skills acquired by learners still active in the workforce of Wales.

Data and assumptions used in the study are based on several sources, including 2014-15 learner and financial data collected by FE colleges in Wales, industry and employment data from Nomis official labour market statistics, demographic and earnings data from the Office for National Statistics (ONS), and Emsi's input-output model. The study applies a conservative methodology and follows standard practice using only the most recognised indicators of investment effectiveness and economic impact. For more information on the data used to derive the results, we encourage our readers to contact ColegauCymru-CollegesWales.

Organisation of the Report

This report has four chapters and three annexes. Chapter 1 provides an overview of FE colleges in Wales and the regional economy. Chapter 2 provides investment analysis results from learner, social, and taxpayer perspectives. Chapter 3 considers the impact of the colleges on economic growth in Wales. Finally, Chapter 4 provides sensitivity analyses of some of the key variables.

The annexes include a list of resources and references in Annex 1, a glossary of terms in Annex 2, and a discussion of the Emsi input-output model in Annex 3.

Key Findings

The results of this study show that FE colleges in Wales have a significant positive impact on their main stakeholder groups: learners, society, and taxpayers. Using a two-pronged approach that involves an investment analysis and a regional economic impact analysis, we calculate the benefits to each of these groups. Key findings of the study are as follows:

Investment Analysis

Benefits to Learners

- Learners as a whole paid a total of **£66.9 million** to cover the cost of tuition fees and books and supplies at FE colleges in Wales in 2014-15. All learners also forwent **£732.7 million** in earnings that they would have generated had they been working instead of learning.
- In return for the monies that learners invest in FE colleges in Wales (in the form of tuition fees and forgone earnings), they will receive a present value of **£5.5 billion** in increased earnings over their working lives.
- Every £1 that learners pay for their education at FE colleges in Wales yields **£6.90** in higher future wages. This translates to a **20.8%** annual rate of return on their investment.

Benefits to Society

- Society as a whole invested **£1.7 billion** in FE colleges in Wales through direct outlays and the loss of potential output from learners who spent time at the colleges rather than working.
- In return, society in the UK will receive a present value of **£13.3 billion** over the course of the learners' working lives, in the form of an expanded tax base and a variety of social benefits related to lower unemployment, and increased health and well-being, and reduced crime.
- Society will receive **£7.90** in benefits for every £1 invested in FE colleges in Wales. The average annual rate of return on investment is **24.0%**.

Benefits to Taxpayers

- Taxpayers in the UK paid **£374 million** to support the operations of FE colleges in Wales in 2014-15.
- The net present value of the added tax revenue stemming from the learners' higher lifetime incomes and the increased output of businesses amounts to **£2.3 billion** in benefits to taxpayers. Avoided costs to the public sector add another

£86.3 million in benefits due to a reduced demand for government-funded social services in the UK.

- Taxpayers see an average annual return of **20.4%** on their investment in FE colleges in Wales. The corresponding benefit-cost ratio is **£6.30** in benefits returned for every £1 in costs.

Regional Economic Impact Analysis

Impact of Staff and College Expenditure

- FE colleges in Wales employed **8,115** full-time, part-time and agency faculty and staff in 2014-15. Staff costs amounted to **£305.2 million**, much of which was spent in Wales to purchase groceries, clothing, and other household goods and services.
- The colleges are buyers of goods and services and spent **£163.1 million** to support their operations in 2014-15. College expenditure further benefited many local suppliers in Wales.
- The net impact of staff and college expenditure in Wales comes to approximately **£455.5 million** in added income to the economy of Wales each year.

Impact of Learner Expenditure

- Learners at FE colleges in Wales relocate to Wales from outside of the area and spend money at local shops to buy books and supplies, purchase groceries, rent accommodation, pay for transport, attend sporting events and so on.
- The expenditure of learners from outside of Wales attending FE colleges in Wales annually adds approximately **£5.1 million** in income to the economy of Wales.

Impact of Added Workforce Skills

- Many learners attending FE colleges in Wales stay in Wales after attending the institutions. Their enhanced skills and abilities bolster the output of local employers, leading to higher national income and a more robust economy.
- The accumulation of former FE colleges in Wales learners who are currently employed in the national workforce amounts to **£3.5 billion** in added income to the economy of Wales each year.

Total Impact on Local Business Community

- Altogether, the economic impact of FE colleges in Wales to the local business community in Wales is **£4 billion** each year.

- Total added income created by FE colleges in Wales and their learners was approximately equal to **9.1%** of the total economic output of Wales in 2014-15 and roughly **183,530** average wage jobs.

Chapter 1 : Profile of the Colleges and the Regional Economy

The input data in this analysis falls under three categories: data from the colleges, regional economic conditions, and research (e.g., reports, journal articles and data releases conducted by ONS, NHS, etc.). This chapter discusses these data, providing context for the subsequent analysis and assumptions utilised in evaluating FE colleges in Wales.

Data from the Colleges

Data provided by FE colleges in Wales includes information on staff, location, revenue and expenditure, learner demographics, and learner achievements. The colleges' staff data appear in Table 1.1 for full-time and part-time staff, as well as for agency staff. Also shown are aggregated data on place of work and place of residence, which is used to isolate the portion of consumption income that remains in the local economy.

Table 1.1: Staff Data, 2014-15*

	Total / %
Full-time staff (FTE)	5,269
Part-time staff (FTE)	2,749
Agency staff	96
Total staff	*8,115*
% of staff that live in Wales	98%
% of staff that work in Wales	100%

Source: Data supplied by FE colleges in Wales.
*Numbers may not add due to rounding.

Financial Data

Revenues

Table 1.2 shows revenues of FE colleges in Wales by funding source in 2014-15, totaling £470.9 million. Tuition fees from learners represented 7%. Public funding from UK and Welsh government sources represented 79%. Income from other non-UK funding and various private funders, including donors and employer funding, represented the remaining 14%.

Table 1.2: Revenue Data, 2014-15 (£ Thousands)*

Funding Source	Amount	%
Tuition fees from learners	£31,536	7%
Local Authority Funding	£2,791	<1%
Welsh Government (Education Directorate) Core Funding	£358,863	76%
HEFCW funding	£10,010	2%
Other UK government funding	£2,361	<1%
ESF and other non-UK funding	£9,705	2%
Income from non-government sources	£55,597	12%
Total	*£470,864*	*100%*

Source: Data supplied by FE colleges in Wales.
*Numbers may not add due to rounding.

Expenditures

Table 1.3 provides expenditure data, with total expenditures of FE colleges in Wales totaling £468.3 million in 2014-15. Staff costs represented 65%, while non-wage spending amounted to 28% of total expenditures. Depreciation of capital and interest payable on debt composed the final 7%.

Table 1.3: Expenditure Data, 2014-15 (£ Thousands)*

Function	Amount	%
Staff costs	£305,190	65%
Teaching, teaching support, and other support (non-pay)	£56,891	12%
Administrative and central services (non-pay)	£20,377	4%
General education expenditure (non-pay)	£7,216	2%
Premises (non-pay)	£30,641	7%
Catering, residence, conferences (non-pay)	£5,181	1%
Other operating expenses (non-pay)	£11,713	3%
Depreciation	£28,518	6%
Interest payable	£2,548	<1%
Total	*£468,275*	*100%*

Source: Data supplied by FE colleges in Wales.
*Numbers may not add due to rounding.

Learner Demographics

FE colleges in Wales served an unduplicated headcount of 151,244 learners, with an average learner representing roughly 41% of an FTE. As we present later in this section, we recognise that one learner could be enrolled in more than one funding stream. FE colleges in Wales also contracted with other institutions to carry out provisions for 1,119 learners, and subcontracted out provisions to other institutions for 241 learners.

The average age of FE colleges in Wales learners was 26 years old. The breakdown of these learners by gender was 47% male and 53% female, and the breakdown by ethnicity was 92% white and 8% minority. 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.

Learner Achievement

Learner achievement data are used to determine the value of the learning provided by the colleges. To do this, we collected data from the colleges on enrolments by education level and their associated guided contact hours. Note that we exclude learners who withdrew or failed. It is worth noting that the notional level of the learner will not always match the notional level of the guided contact hours they are taking, but all guided contact hours will contribute to the resulting qualification.

Table 1.4 shows the colleges' total enrolments by qualification, with rows representing the notional level of the enrolment categorised by whether the qualification is the enrollee's full qualification or if the enrollee only partially completed the qualification. The table includes enrolments provided by FE colleges in Wales for other contracting FE and HE institutions and does not include enrolments that FE colleges in Wales subcontracted other institutions to provide. Note that in Table 1.4, the sum may be greater than the total unduplicated headcount given above. This is due to possible duplication between the categories, as learners may take courses funded under more than one funding model.

Table 1.4: Enrolments by Qualification, 2014-15*

ENROLMENTS	TOTAL
Full Qualification	
Entry Level	24,302
Level 1	49,862
Level 2	68,357
Level 3	68,910
> Level 3	2,177
Partial Qualification	
Entry Level	78
Level 1	208
Level 2	656
Level 3	593
> Level 3	75
Total	***215,219***

Source: Data supplied by FE colleges in Wales.
*Numbers may not add due to rounding.

Table 1.5 shows the guided contact hours completed by the associated enrolments from Table 1.4. These are guided contact hours provided by FE colleges in Wales instructors. Similar to Table 1.4, this table includes guided contact hours provided by FE colleges in Wales for other contracting FE and HE institutions and does not include guided contact

hours that FE colleges in Wales subcontracted other institutions to provide. This detail on the guided contact hours allows us to capture the economic activity that the colleges' staff provides, and not the activity that the colleges claims for learners served by other FE institutions.

Table 1.5: Guided Contact Hours Activity by Qualification, 2014-15*

GUIDED CONTACT HOURS	TOTAL
Full Qualification	
Entry Level	1,552,200
Level 1	4,240,626
Level 2	7,107,918
Level 3	13,665,586
> Level 3	460,299
Partial Qualification	
Entry Level	11,563
Level 1	52,762
Level 2	198,015
Level 3	192,286
> Level 3	22,541
Total	***27,503,796***

Source: Data supplied by FE colleges in Wales.
*Numbers may not add due to rounding.

Regional Economic Conditions

FE colleges in Wales serve learners in Wales and therefore acts as the backdrop against which the relative impacts of the colleges and their learners are measured. Since FE colleges in Wales first opened their doors, they have been serving Wales by creating jobs and income, providing area residents with easy access to further education opportunities, and preparing learners for highly-skilled, technical professions. The availability of quality education and training in Wales also attracts new industry to the region, thereby generating new businesses and expanding the availability of public investment funds.

Table 1.6 summarises the breakdown of the economy of Wales by major industrial sector, with details on employment and value added for each. Value added refers to the earnings, profits, and taxes that together represent the total value the industrial sector has added. The final column in Table 1.6 shows the percentage of total value added in Wales for which each sector is responsible.

Table 1.6: Employment and Value Added by Major Industrial Sector in Wales, 2014-15*

	Jobs	Value Added (Millions)	% of Total Value Added
Agriculture, forestry and fishing	42,000	£1,019	2%
Mining and quarrying	1,693	£87	<1%
Manufacturing	149,476	£6,590	15%
Electricity, gas, steam and air conditioning supply	6,986	£1,060	2%
Water supply; Sewerage, waste management and remediation activities	9,970	£717	2%
Construction	62,591	£2,876	7%
Wholesale and retail trade; Repair of motor vehicles and motorcycles	185,804	£4,343	10%
Transportation and storage	44,024	£1,635	4%
Accommodation and food service activities	94,124	£1,459	3%
Information and communication	28,481	£1,483	3%
Financial and insurance activities	30,009	£1,549	4%
Real estate activities	19,518	£1,872	4%
Professional, scientific and technical activities	54,103	£2,322	5%
Administrative and support service activities	78,587	£2,240	5%
Public administration and defence; Compulsory social security education	86,086	£3,411	8%
Education	123,954	£3,419	8%
Human health and social work activities	202,166	£5,912	14%
Arts, entertainment and recreation	30,022	£1,047	2%
Other service activities	24,446	£729	2%
Totals	*1,274,039*	*£43,769*	*100%*

Source: Emsi.
*Numbers may not add due to rounding.

In Table 1.7 and Figure 1.1, the average earnings in Wales at the midpoint of an individual's working career are broken down by education level. In return for the costs of education, learners receive a stream of higher future earnings that continues to grow throughout their working lives. Mean income levels at the midpoint of the average-aged worker's career increase as individuals attain higher levels of education. The marginal differences between education levels form the basis for determining the earnings benefits that accrue to learners in return for their education investment. For example, the average Level 3 achiever in Wales will see an increase in earnings of £13,154 each year compared to someone with no formal qualifications. This amounts to approximately £513,023 in higher earnings (undiscounted) over a working lifetime.

Table 1.7: Average Regional Earnings and Unemployment Rates by Education Level in Wales, 2014-15

Education Level	Earnings*	Unemployment
< Entry Level	£12,624	17%
Entry Level	£13,773	14%
Level 1	£21,143	12%
Level 2	£23,092	11%
Level 3	£25,778	8%
> Level 4	£28,626	5%

* Earnings are weighted by gender and ethnicity demographics supplied by FE colleges in Wales.
Source: ONS Labour Force Survey and Nomis Annual Survey of Hours and Earnings.

Figure 1.1: Average Income at Career Midpoint

Just as average earnings increase as they attain more education, employment prospects also increase. Table 1.7 shows the unemployment rate by highest qualification attained in Wales. The highest unemployment rates occur among workers with no qualifications or an entry level qualification.

Research

The data and methodology collected from research largely come from government studies and are usually treated as constants or parameter values in the analysis. The model and report uses Wales specific data where available, however due to some limitations the a few data sources may rely on data from England. For example, *The Green Book* issued by HM Treasury reports the following table in Annex 6.

Table 1.8: 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 2012 Green Book Table 6.1

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

Table 1.9: Research 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
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 of Work and Pension
Obesity	NHS, Department of Health
Learner spending	National Union of Students

Conclusion

This chapter summarises key data and facts on FE colleges in Wales and the region they serve. 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 annexes detail a collection of miscellaneous theory and data issues.

[3] The time horizon does not extend beyond 75 years since it is limited to the learner's working life.

Chapter 2 : Investment Analysis

Investment analysis is the process of evaluating total costs and measuring these against total benefits to determine whether or not a proposed venture will be profitable. If benefits outweigh costs, then the investment is viable. If costs outweigh benefits, then the investment will lose money and is thus considered infeasible.

In this chapter we analyse the benefits and costs of investing in FE colleges in Wales from the perspective of the learners, society at large, and lastly the public sector. The backdrop for the analysis is the UK.

Learner Perspective

Analysing the benefits and costs of education from the perspective of learners is the most obvious—they give up time and money to go to FE colleges in Wales 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 learner incomes and employment probabilities increase as a result of education, while costs comprise all learners' direct outlays (tuition fees and books and supplies) as well as their opportunity costs (wages and income forgone while at the colleges).

Education, Earnings and Employment

The correlation between education, earnings, and employment is well documented and forms the basis for determining the learners' benefits stream and future cash flows. Table 1.7 (Chapter 1) shows the mean income and unemployment rate by education level weighted by the gender and ethnicity of the learner population.[4]

The differences between income levels and unemployment rates begin to define the marginal value of moving from one education level to the next. For example, moving from GCSEs grades A*-C or equivalent to an A-level yields an additional £2,686 per year and increases employment probability by 3%.

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'.[5] 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. Doctors Molitor and Leigh (2005)

[4] Earning and unemployment rates are shown for Wales. Although not all learners settle in this region, the majority does; it is these earnings rates that are used to generate the learner's future cash flows.

[5] 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.

concluded that a 10% reduction in the earnings gain was necessary to account for such innate characteristics of the learners.[6]

Marginal Earnings Value per Planned Learning Hour

Not all learners who attended FE colleges in Wales in the 2014-15 reporting year obtained a qualification or certificate. 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 learners still carries value, though not the weight of a fully completed 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 colleges and learners is through guided contact hours.

It is important to remember that from an economics perspective, learners 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 learners increase their marginal value of product, and thus income, for every guided contact hour 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 learner can generate. Thus, a fully completed 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 learners' guided contact hour production through a process that divides the education ladder into a series of individual steps, each equal to one guided contact hour. We then spread the income differentials from Table 1.7 over the steps required to complete each education level, assigning a unique monetary value to every step in the ladder. Next we map the learners' guided contact hour production to the ladder, depending on their level of achievement and the average number of guided contact hours they achieve. Finally, we multiply the volume of guided contact hours at each step in the ladder by the marginal earnings gain attributable to the corresponding step to arrive at the learners' average annual increase in income. Under this framework the annual change in earnings, ΔE, is computed simply as: $\Delta E = \sum_{i=1}^{n} e_i h_i$ where $i \in 1,\ 2,...n$ and n is the number of steps in the education ladder. Variables e_i and h_i

[6] The BIS adopted the approach of looking at earnings differences between cohorts with similar characteristics but where the educational levels differed. While this approach is useful and does not require explicit discounting, it cannot be used at a regional level since the earnings differ regionally from national averages.

represent the marginal earnings gain and number of guided contact hours completed by the learner body for each step *i*. Total earnings change divided by the total guided contact hours completed by the learners gives the average value per guided contact hour for the 2014-15 learner body.

Table 2.1 displays the aggregate annual higher income for the FE colleges in Wales learner population. Also shown are the total guided contact hours generated by learners and the average value per guided contact hour. 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.

Table 2.1: Higher Annual Earnings, Guided Contact Hour Production, and Value per Guided Contact Hour, 2014-15

Total increase in earnings	£313,003,350
Total completed guided contact hours	27,503,796
Average value per guided contact hour	£11.38

Source: Emsi.

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 2.1 will actually be lower at the start of the learners' careers and higher near the end of them, gradually increasing at differing rates as the learners grow older and advance further in their careers.

Generating the Stream of Cash Flows

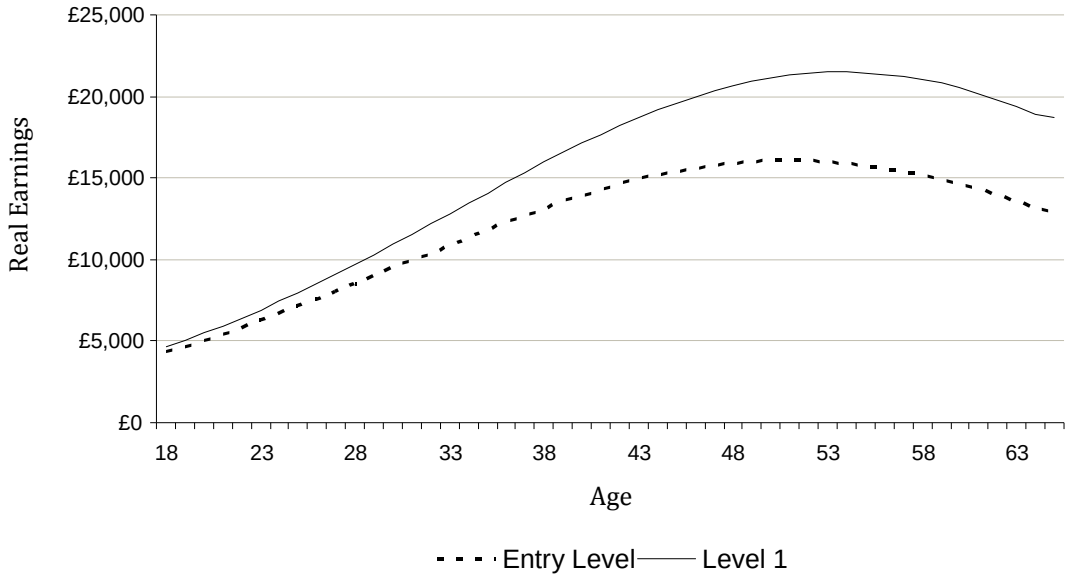
The two names most often associated with human capital theory and its applications are Gary Becker and Jacob Mincer.[7] The standard human capital earnings function developed by Mincer appears as a three-dimensional surface with the key elements being earnings, years of education and experience. Figure 2.1 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 Wales.

Figure 2.1 illustrates several important features of the Mincer function. First, earnings initially grow 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

[7] See Gary S. Becker, *Human Capital: a Theoretical Analysis with Specific Reference to Education* (New York: Columbia College Press for NBER, 1964); Jacob Mincer, 'Schooling, Experience and Earnings' (New York: National Bureau of Economic Research, 1974); and Mincer, 'Investment in Human Capital and Personal Income Distribution,' *Journal of Political Economy,* vol. 66 issue 4, August 1958: 281–302.

of earnings is reached at an older age. And third, the benefits of education, as measured by the difference in earnings for two levels, increase with age.

Figure 2.1: Lifetime Earnings Profile for Entry Level and Level 1 Qualification Recipients



In the model, we employ the Mincer function as a smooth predictor of earnings over time[8] for as long as learners remain active in the workforce. Using earnings at the career midpoint as our base (Table 1.7), we derive a set of scalars from the slope of the Mincer curve to model the learners' 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 learners enter the workforce, come to a peak shortly after the career midpoint, and then dampen slightly as learners approach retirement at age 65.

The benefits stream generated by the Mincer curve is a key component in deriving the learners' rate of return. However, not all learners 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 learners' benefit stream in the first few years of the time horizon to allow time for those who are still studying at the colleges 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 learners who will die, retire or become unemployed over the course of their working careers.[9] The

[8] The Mincer equation is computed based on estimated coefficients presented in Robert J. Willis, 'Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Function' in *Handbook of Labor Economics*, Vol. 1 (Amsterdam: Elsevier Science Publishers, 1986): 525–602. These are adjusted to current year pounds in the usual fashion by applying the GDP implicit price deflator. The function does not factor in temporary economic volatility, such as high growth periods or recessions. In the long run, however, the Mincer function is a reasonable predictor.

[9] These data are based on the ONS life tables and net regional migration data following a log linear trend line.

likelihood that learners will leave the workforce increases as they age—so the older the learner population is, the greater the attrition rate will be. The resulting benefits stream can be found in Table 2.3.

Learner Investment Costs

Having calculated the learners' benefits stream and adjusting it for attrition, we next turn to learner costs. The learners' costs of investment are composed of direct outlays and opportunity costs. Direct outlays represent any out-of-pocket expenses to the learner, such as those for tuition fees, books, and supplies.[10] Some learners incur more out-of-pocket expenses than others, for example adult learners aged 19 and over are more responsible for paying tuition costs whereas those aged 16-18 are fully funded. For the purposes of this analysis, we just look at the total direct outlays incurred by the learner body as a whole, not separated out by funding levels.

Opportunity costs apply to all learners and represent forgone income. We assume that every hour a learner 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 learners and their families directly to FE colleges in Wales, measuring costs and benefits through guided contact hours creates a more accurate representation.

Table 2.2: Learner Investment Costs, 2014-15 (£ Thousands)

	Total
Learner Direct Costs	
Tuition and Fees	£31,536
Books and Supplies	£35,397
Room & Board*	£5,072
Personal Expenses*	£2,849
Transportation*	£775
Working Learners	
Opportunity Costs – Work Based Learners	£70,429
Opportunity Costs - Non-Work Based Learners	£155,049
Non-working Learners	
Opportunity Costs - Non-Work Based Learners	£507,233
*Total Learner Costs**	*£799,644*

* Room and board, personal expenses and transportation are only captured for non-local learners on the impact side and are not included in the investment analysis. Total learner costs therefore exclude those expenses.
Source: Emsi model.

The majority of costs, however, are not captured in the direct outlays of the learners but rather through their opportunity costs. These costs are a function of learner employment rates, the number of guided contact hours taken by the learners, prior education level, and the associated earnings by education level. Recall that Table 1.7 displays earnings at

[10] Learners also spend money on room and board, personal expenses etc. These costs and their associated impacts are discussed more fully in chapter 3.

the midpoint of the individual's working career, not immediately upon exiting the colleges. To arrive at the full earning potential of learners while enrolled, we must condition the earnings levels to the learners' 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 learners actually spend at the colleges since they would only be giving up earnings for the period in which FE colleges in Wales are in session, and then only for the hours they are in class. We use the volume of guided contact hours taken by the learners as a proxy for working hours forgone. Beginning with the conditioned average annual incomes by education level and the learners' education levels at the start of the reporting year, we determine the potential lost income to three distinct categories of learners: apprentices, non-apprentices that are employed while attending FE colleges in Wales, and non-apprentices that are not working. FE colleges in Wales had 16,660 work based learning enrolments, 46,260 working non-work based learning enrolments, and 88,324 non-working learners.

Since learners in both apprentice programmes and those 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. As the majority of the learners are not engaged in the labour force and because they forgo the entirety of their would-be income, it is not surprising that they represent the bulk of the learner body's opportunity costs. Opportunity and auxiliary costs total £732.7 million. Learners employed while attending the colleges 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.

Learner Investment Outcomes

Since the benefits to learners 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* and referenced in chapter one,

> *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.

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.

Column 1 of Table 2.3 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 learners 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 learners.[11] Lastly, Column 6 shows the net cash flows.

The average learner age at FE colleges in Wales while enrolled is 26. Adding one year to this (the analysis year) and subtracting from the retirement age of 65[12] yields a time horizon of 44 years. The last four rows in the table show the FE colleges in Wales learner investment results: net present value (NPV), benefit/cost ratio (B/C), internal rate of return (IRR),[13] and payback period. Equations and definitions of these terms may be found in the glossary provided in Annex 2.

The 2014-15 FE colleges in Wales learner body is expected to see the present value of their lifetime incomes rise by £5.5 billion, while the costs of obtaining these gains is only £799.6 million. This means learners receive a net gain of £4.7 billion and, on average, their benefits are 6.9 times larger than their investment. Put another way, for every £1 learners invest in direct outlays and opportunity costs, they receive £6.90 in return. This translates into a 20.8% average annual rate of return, with all of the learners' costs recovered in 7 years.

[11] The £799.6 million in costs is already in present value since it occurs in the current year and does not need to be discounted.

[12] We recognise that not all learners 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 learner. Additionally, we recognize that the State Pension age is set to rise to 66 by 2020 and 67 by 2028.

[13] 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.

Table 2.3: Learner Perspective (£ Millions), 2014-15*

Year	Gross Higher Earnings	% Active in Workforce	Net Higher Earnings	Cost	Net Cash Flow
0	165.4	9%	15.8	799.6	-783.8
1	176.3	30%	53.3	0.0	53.3
2	187.4	48%	89.7	0.0	89.7
3	198.7	62%	123.5	0.0	123.5
4	210.1	72%	151.3	0.0	151.3
5	221.7	79%	175.7	0.0	175.7
6	233.4	84%	196.5	0.0	196.5
7	245.1	88%	215.0	0.0	215.0
8	256.7	90%	229.8	0.0	229.8
9	268.3	91%	242.7	0.0	242.7
10	279.8	91%	253.9	0.0	253.9
11	291.1	91%	264.0	0.0	264.0
12	302.2	91%	273.8	0.0	273.8
13	313.0	91%	283.2	0.0	283.2
14	323.5	91%	292.4	0.0	292.4
15	333.6	91%	301.1	0.0	301.1
16	343.2	91%	309.5	0.0	309.5
17	352.4	91%	317.3	0.0	317.3
18	361.0	91%	324.6	0.0	324.6
19	369.1	90%	331.3	0.0	331.3
20	376.6	90%	337.4	0.0	337.4
21	377.0	90%	337.6	0.0	337.6
22	383.2	90%	342.5	0.0	342.5
23	388.7	90%	346.7	0.0	346.7
24	393.5	90%	350.1	0.0	350.1
25	397.4	90%	352.7	0.0	352.7
26	400.6	89%	354.5	0.0	354.5
27	403.0	89%	355.6	0.0	355.6
28	404.6	89%	355.8	0.0	355.8
29	405.3	89%	355.2	0.0	355.2
30	405.2	89%	353.8	0.0	353.8
31	404.3	88%	351.5	0.0	351.5
32	390.9	88%	338.8	0.0	338.8
33	388.6	88%	335.2	0.0	335.2
34	385.6	87%	330.8	0.0	330.8
35	378.7	87%	323.0	0.0	323.0
36	374.3	87%	317.2	0.0	317.2
37	369.3	86%	310.7	0.0	310.7
38	317.2	86%	265.5	0.0	265.5
39	140.7	85%	119.0	0.0	119.0
40	138.7	85%	116.4	0.0	116.4
41	109.9	84%	91.8	0.0	91.8
42	60.2	83%	50.3	0.0	50.3
43	59.2	83%	49.0	0.0	49.0
NPV			*£5,539.2*	*£799.6*	*£4,739.5*
B/C ratio					*6.9*
IRR					*20.8%*
Payback (yrs)					*7.0*

*Numbers may not add due to rounding.

Social Perspective

Looking at investment from the social perspective is structurally no different than the learner perspective, although the breadth of the costs and benefits captured is much larger. From society's perspective, we are looking at all costs and benefits due to the operations of FE colleges in Wales, regardless to whom the costs and benefits accrue.

Capturing the social perspective provides proof that FE colleges in Wales act as social enterprises. The higher levels of education their learners gain enable the community to overcome social problems, such as by improving health and lowering crime rates. In particular, FE colleges in Wales improve their learners' life chances by giving them the tools they need to succeed in their careers. The higher incomes the learners 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, while FE colleges in Wales operate as businesses, they ultimately serve a social mission.

Social Costs

Social costs also break down into direct outlays and opportunity costs. Direct outlays to FE colleges in Wales in the analysis year are the sum of operating and non-operating revenues (£470.9 million). Learners, as previously discussed, give up earnings that they could have otherwise earned. Private businesses have a smaller pool of labour to draw from since individuals are engaged in education rather than business sector output, thus GDP is, in the short run, not as large as it may otherwise have been. Similarly, society experiences a loss in government services that would have been undertaken had taxes been collected on the earnings that learners forgo. All of these represent opportunity costs to society as a whole.

Notice the implicit and conservative assumption being made in regards to the opportunity costs. We assume all labour and resources would have been employed (i.e., the assumption of no idle resources). This is a conservative assumption since it increases the costs being captured. We know that in the absence of high-skilled labour, low-skilled, and possibly unemployed labour can be substituted. Alternatively, high-skilled labour could be imported from other countries, increasing output back to 'expected' levels.

These opportunity costs to society all stem from lower labour and output. To capture social opportunity costs then, we take the learner opportunity costs and run them through a multiplier matrix to see what additional labour and non-labour impacts are being forgone. These additional losses stemming from the learners' decision not to be employed in the workforce are added to learner opportunity costs and total revenues of the colleges to derive the total costs to society of £1.7 billion.

Table 2.4: Present Value Social Costs (£ Thousands), 2014-15*

	Total
Direct outlays	£470,864
Opportunity costs of learners	£732,711
All other opportunity costs	£486,714
Total	*£1,690,289*

Source: Emsi model.
*Numbers may not add due to rounding.

Social Benefits

Any benefits that accrue within the UK as a result of FE colleges in Wales—whether they accrue to learners, employers, taxpayers, or private residents—are claimed under the social perspective. These benefits are subdivided into two components: (1) increased income, and (2) social externalities stemming from the improved lifestyles of learners.

Increased Income

Income growth occurs as the output of learners 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 FE colleges in Wales on income growth begins with the projected higher learner income from Table 2.3 above. Not all of these benefits may be counted as benefits to the public, however. Some learners may emigrate during the course of their careers, and any benefits they generate leave with them. To account for this dynamic, we use estimates on migration patterns to calculate the number of learners who leave the workforce over time. Note that death, retirement, and unemployment have already been captured in the learners' NPV calculation.

Next we derive a stream of cash flows that accrue to the public. These comprise the initial effect of FE colleges in Wales on income growth. Multiplier effects occur when learners 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 Regional I-O model, described more fully in Annex 3.

With an increase in labour income (both initial and multiplier effects) 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 initial and multiplier 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 learners' net higher earnings, we adjust for the alternative education variable. This variable looks at the degree to which learners would be able to obtain education and the increased role industry would play in providing workforce training if public funding for education did not exist. That is, FE colleges in Wales learners would substitute towards other educational opportunities (e.g., private education, on-the-job training, etc.) if the colleges did not exist. FE colleges in Wales cannot claim benefits that would still have been generated in their absence. The top row of Table 2.5 below displays the present value of the added income that occurs in the UK over the lifetime of the colleges' learners.

Social Externalities

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

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.

Table 2.5: Present Value Social Benefits (£ Thousands), 2014-15*

	Total
Increased Income	**£13,173,927**
Social Externalities:	**£164,280**
Crime	£93,695
National Insurance	£12,677
Health	£57,909
Smoking	*£13,576*
Obesity	*£5,125*
Mental health	*£39,209*
Total	***£13,338,207***

Source: Emsi model.

*Numbers may not add due to rounding.

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, breaking them out by gender and ethnicity, and adjusting them from national to regional levels. We then spread the probabilities across the education ladder and multiply the marginal differences by the corresponding guided contact hour production at each step. The sum of these effects counts as the upper bound measure of

the number of individuals who, due to the education they received at FE colleges in Wales, 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 studies and surveys. These comprise the overall savings to society. Present value results of the analysis are displayed in Table 2.5 above.

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. Learners' 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 and compares them to public costs (what taxpayers agree to pay) of education.

Social Investment Outcomes

Table 2.6 has the same structure and interpretation as Table 2.3, with the exception that this analysis provides the overall returns to the UK. Column 1 of Table 2.6 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). The time horizon is the same for the social perspective as in the learner perspective. Column 2 shows the gross social benefits received each year in the UK, while Column 3 outlines the portion of benefits estimated to be generated by the learners in the absence of FE colleges in Wales. Column 4 is the difference of Columns 2 and 3, and represents the stream of cash flows used in

generating the outcome metrics. Costs and net cash flows are shown in Columns 5 and 6, respectively. It is also worthy to note that society benefits from the social externalities beyond the 40 years of working life derived from the learners, though these benefits are minor in comparison to the earnings and productivity effects derived from labour.

Table 2.6: Social Perspective (£ Millions), 2014-15

Year	Gross Social Benefits	Alt Ed	Net Benefits	Costs	Net Cash Flow
0	54.6	5.5	49.2	1690.3	-1641.1
1	162.0	16.2	145.8	0.0	145.8
2	265.2	26.5	238.7	0.0	238.7
3	359.7	36.0	323.8	0.0	323.8
4	436.8	43.7	393.1	0.0	393.1
5	503.3	50.3	452.9	0.0	452.9
6	559.1	55.9	503.2	0.0	503.2
7	607.9	60.8	547.1	0.0	547.1
8	646.3	64.6	581.7	0.0	581.7
9	678.7	67.9	610.8	0.0	610.8
10	706.4	70.6	635.7	0.0	635.7
11	730.4	73.0	657.4	0.0	657.4
12	753.6	75.4	678.2	0.0	678.2
13	775.7	77.6	698.1	0.0	698.1
14	796.7	79.7	717.0	0.0	717.0
15	816.4	81.6	734.8	0.0	734.8
16	834.8	83.5	751.3	0.0	751.3
17	851.7	85.2	766.5	0.0	766.5
18	867.0	86.7	780.3	0.0	780.3
19	880.6	88.1	792.5	0.0	792.5
20	892.4	89.2	803.2	0.0	803.2
21	887.3	88.7	798.6	0.0	798.6
22	895.8	89.6	806.3	0.0	806.3
23	902.4	90.2	812.2	0.0	812.2
24	907.0	90.7	816.3	0.0	816.3
25	909.6	91.0	818.6	0.0	818.6
26	910.2	91.0	819.1	0.0	819.1
27	908.7	90.9	817.8	0.0	817.8
28	905.1	90.5	814.6	0.0	814.6
29	899.5	90.0	809.6	0.0	809.6
30	891.9	89.2	802.7	0.0	802.7
31	882.3	88.2	794.0	0.0	794.0
32	850.5	85.0	765.4	0.0	765.4
33	837.8	83.8	754.1	0.0	754.1
34	823.3	82.3	741.0	0.0	741.0
35	799.5	80.0	719.6	0.0	719.6
36	781.8	78.2	703.6	0.0	703.6
37	762.5	76.3	686.3	0.0	686.3
38	666.8	66.7	600.2	0.0	600.2
39	299.7	30.0	269.8	0.0	269.8
40	292.2	29.2	263.0	0.0	263.0
41	242.7	24.3	218.4	0.0	218.4
42	121.0	12.1	108.9	0.0	108.9
43	117.5	11.7	105.7	0.0	105.7
NPV			*£13,338.2*	*£1,690.3*	*£11,647.9*
B/C ratio					*7.9*
IRR					*24.0%*
Payback (yrs)					*6.2*

*Numbers may not add due to rounding.

As demonstrated in Table 2.6, society benefits from the presence of FE colleges in Wales and their learners. The learners themselves see increased wages, businesses see increased output and profits, and government receives higher tax revenues as a result of the broader tax base. Society also saves money as learners engage in more acceptable social behaviours. For example, a reduction in crime reduces the demand for police, freeing public funds to be allocated to other programmes. It will also save money for individuals in the private sector through reduced property damages and various other victim costs. The present value of these benefits is equal to £13.3 billion.

These benefits are achieved through society's £1.7 billion investment in FE colleges in Wales. The net gain to society in present value terms is £11.6 billion. The associated benefit cost ratio is £7.90 for every £1.00 spent and averages a return of 24.0% annually. All costs to society are recovered in 6 years.

Taxpayer Perspective

Benefits and costs under the taxpayer perspective are restricted to the monetary gains and losses accruing to the public (i.e., government) sector. Benefits include increased tax revenues realised as a result of the higher income of learners, and cost savings from social programmes. Whereas total income gains were claimed in the social perspective, only the associated tax revenues are claimed in the taxpayer perspective. The savings that stem from improved learner lifestyles are limited to public sector savings and do not include such things as reductions in private property damages since those savings are not realised by government.

The purpose of this analysis is to treat a public investment as if it were private to analyse whether the government recovers all costs. Even if government did not recover all costs the investment might still be justified under the social perspective since society as a whole is improved by the investment. The case is made much stronger if, by virtue of the investment, the government recovers all costs and can use any excess revenues from the investment to subsidise other publicly desired projects.

Taxpayer Benefits

The same alternative education adjustment applied in the social perspective is applied again in the taxpayer perspective and for the same reason (i.e., taxpayer benefits that would have been realised in the absence of FE colleges in Wales cannot be claimed by the colleges).

The present value of the added tax revenue derived from increased learner and business income amounts to £2.3 billion, roughly £58.1 million annually over the learners' working lifetimes. Avoided social costs extend beyond the learners' working lifetimes and into retirement but tend to be small, only amounting to £86.3 million in present value terms in the case of FE colleges in Wales.

Table 2.7: Taxpayer Benefits (£ Thousands), 2014-15*

	Present Value	Annually
Increased tax receipts	£2,273,249	£58,058
Avoided social costs	£86,310	£2,204
Total	*£2,359,559*	*£60,263*

Source: Emsi.

*Numbers may not add due to rounding.

Taxpayer Costs

Taxpayer costs are limited to pounds withdrawn from local and national treasuries. As per the colleges' revenue table in Chapter 1, taxpayer costs amount to £374 million.

Taxpayer Investment Outcomes

Table 2.8 has the same structure and interpretation as Table 2.6, with the exception that this analysis provides the returns to the government sector. Column 3 of Table 2.6 outlines the portion of benefits estimated to be generated by the learners in the absence of FE colleges in Wales. The difference between Column 2 and Column 3 represents the stream of cash flows used in generating the outcomes and is reflected in Column 4. Columns 5 and 6 show costs and net cash flows.

Table 2.8: Taxpayer Perspective (£ Millions), 2014-15*

Year	Gross Taxpayer Benefits	Alt Ed	Net Benefits	Costs	Net Cash Flow
0	10.5	1.0	9.4	374.0	-364.6
1	29.3	2.9	26.4	0.0	26.4
2	47.5	4.7	42.7	0.0	42.7
3	64.1	6.4	57.7	0.0	57.7
4	77.6	7.8	69.8	0.0	69.8
5	89.3	8.9	80.3	0.0	80.3
6	99.1	9.9	89.2	0.0	89.2
7	107.7	10.8	96.9	0.0	96.9
8	114.4	11.4	103.0	0.0	103.0
9	120.1	12.0	108.1	0.0	108.1
10	124.9	12.5	112.4	0.0	112.4
11	129.2	12.9	116.2	0.0	116.2
12	133.2	13.3	119.9	0.0	119.9
13	137.1	13.7	123.4	0.0	123.4
14	140.8	14.1	126.7	0.0	126.7
15	144.3	14.4	129.8	0.0	129.8
16	147.5	14.7	132.7	0.0	132.7
17	150.4	15.0	135.4	0.0	135.4
18	153.1	15.3	137.8	0.0	137.8
19	155.5	15.6	140.0	0.0	140.0
20	157.6	15.8	141.8	0.0	141.8
21	156.7	15.7	141.0	0.0	141.0
22	158.2	15.8	142.4	0.0	142.4
23	159.3	15.9	143.4	0.0	143.4
24	160.1	16.0	144.1	0.0	144.1
25	160.6	16.1	144.5	0.0	144.5
26	160.7	16.1	144.6	0.0	144.6

27	160.4	16.0	144.4	0.0	144.4
28	159.8	16.0	143.8	0.0	143.8
29	158.8	15.9	142.9	0.0	142.9
30	157.4	15.7	141.7	0.0	141.7
31	155.7	15.6	140.2	0.0	140.2
32	150.1	15.0	135.1	0.0	135.1
33	147.9	14.8	133.1	0.0	133.1
34	145.4	14.5	130.8	0.0	130.8
35	141.2	14.1	127.0	0.0	127.0
36	138.0	13.8	124.2	0.0	124.2
37	134.6	13.5	121.2	0.0	121.2
38	117.8	11.8	106.0	0.0	106.0
39	52.9	5.3	47.6	0.0	47.6
40	51.6	5.2	46.5	0.0	46.5
41	42.9	4.3	38.6	0.0	38.6
42	21.4	2.1	19.2	0.0	19.2
43	20.8	2.1	18.7	0.0	18.7
NPV			*£2,359.6*	*£374.0*	*£1,985.5*
B/C ratio					*6.3*
IRR					*20.4%*
Payback (yrs)					*7.0*

*Numbers may not add due to rounding.

Even under the more narrowly defined scope of the taxpayer perspective, the returns are positive. The public sector recovers the investment of £374 million in 7 years and generates an additional £2 billion (NPV) over the remainder of the learners' working life. The average annual return to the Exchequer is 20.4%, which exceeds many public investments (e.g., public parks) from a financial perspective. The important thing to note with the benefit-cost ratio is that for every public pound invested in FE colleges in Wales, a total of £6.30 is returned. This return can then be used for other investments, meaning that FE colleges in Wales subsidise other public services.

Conclusion

The major stakeholders in FE colleges in Wales see reasonable returns on their investments of time and money. Learners are more productive and realise increased earnings as a result of their time spent at the colleges. Businesses that are able to hire locally trained individuals see increased productivity and profits without having to import labour. 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.

Chapter 3 : Regional Economic Impact Analysis

FE colleges in Wales promote economic growth in Wales in a variety of ways. The colleges are employers and buyers of goods and services, while the living expenses of learners from outside of Wales benefit local businesses. In addition, FE colleges in Wales are primary sources of education to local residents and suppliers of trained workers to local industry.

In this section we examine the economic impacts of FE colleges in Wales on the local business community through the increased consumer spending and enhanced business productivity generated by the colleges and their learners. The impacts reflect the economic relationships among industries in Wales and are calculated using Emsi's proprietary input-output (IO) model. The model uses national data from the Office for National Statistics' (ONS) Supply and Use Tables (SUTs), as well as regional (Wales) and national (UK) 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 are known as the knock-on (multiplier) effects. For more information on the Emsi Regional I-O model, please refer to Annex 3.

We express the results in terms of income, as opposed to sales, in order to present a more accurate picture of the colleges' actual impacts. While sales tend to be the more common measurement, they do not account for monies that leave the local economy and therefore overstate the results. Income, on the other hand, only captures the monies remaining in Wales, providing a more conservative calculation of the colleges' true impacts in Wales.

The following pages present the results of the analysis broken down according to the following three impacts: 1) impact of staff and college expenditure, 2) impact of the expenditure of learners who relocate to Wales to attend the colleges, and 3) impact of the added skills of former learners from FE colleges in Wales still employed in the workforce of Wales.

Impact of Staff and College Expenditure

FE colleges in Wales are important employers in Wales, providing jobs for a wide range of staff across a number of occupations. In 2014-15, the colleges employed 8,115 full-time and part-time staff, including agency staff. Of these, 100% of employees worked within Wales, and around 98% were Wales residents. Total staff costs at FE colleges in Wales in 2014-15 amounted to £305.2 million and contributed to the economy of Wales. Staff expenditure on groceries, eating out, clothing, and other household costs also helped support local shops and businesses.

In addition to their staff, FE colleges in Wales are large-scale buyers of goods and services. In 2014-15, the colleges spent £163.1 million to support their operations. Much

of this expenditure benefited local suppliers in Wales, creating a multiplier effect that generated additional employment and income throughout the economy of Wales.

Calculating the Impacts

The impact of the colleges' payroll and purchases is subdivided into the following four effects: the initial, direct, indirect, and induced effects. The initial effect comprises the colleges' payroll and employee benefits, less monies paid to individuals working outside of the region. As seen in Table 3.1, this amounted to £305.2 million. The multiplier effects refer to the additional income created in the economy as employees and suppliers of FE colleges in Wales spend money in Wales to purchase even more supplies and services.

To calculate the multiplier effects, we first remove any expenditures occurring outside of Wales. We calculate this through regional purchase coefficients (RPCs) derived from the IO model, which are based on the Welsh economic characteristics and tell us the proportion of goods and services purchased in Wales. For example, an RPC for a particular industry of .90 tells us that 90% of the demand for that industry is purchased from within Wales; the remaining 10% is imported into Wales. In other words, we can say that 90% of the colleges' expenditures for that industry stay within Wales, whereas the remaining 10% leaks outside of Wales.

We map these remaining expenditures occurring within Wales to the 563 industries as classified by the 2007 UK Standard Industrial Classification (SIC), which classifies industries according to the type of economic activity they engage in. We use these same sectors to classify industries in our IO model. In the mapping process, we take general categories provided by the colleges of their typical expenditures and place them into the SIC sectors.

For example, the expenditures of the colleges on electricity and natural gas are mapped into the SIC code 3513, *Distribution of Electricity*. Overall, this mapping process enables us to funnel the colleges' expenditures through the IO model's multiplier matrix so we can estimate how the spending of the colleges and staff affects the output of other industries in Wales.

Since expenditures of FE colleges in Wales funnelled through the IO model are in sales terms, the model initially reports the impacts in sales terms. As mentioned above, sales tend to overstate impacts (see textbox), so we convert the sales figures to income. We do this through value added-to-sales ratios for each sector, also provided by the IO model.

Sales vs. Earnings example

Two visitors spend £50,000 each in the economic region. One visits a local auto dealer and purchases a new luxury automobile. The other undergoes a medical procedure at the local hospital. In terms of direct economic impact, both have spent £50,000. However, the expenditures will likely have very different meanings to the local economy. Of the £50,000 spent for the luxury automobile, perhaps £10,000 remains in the region as salesperson commissions and auto dealer income (part of

the economic region's overall earnings), while the other £40,000 leaves the area as wholesale payment for the new automobile, ending up in Japan or the U.S. perhaps. Contrast this to the hospital expenditure. Here perhaps £40,000 appears as physician, nurse, and assorted hospital employee wages (part of the region's overall earnings), while only £10,000 leaves the area to pay for hospital supplies, or to help amortise building and equipment loans. In terms of sales, both have the same impact, while in terms of earnings, the former has one-fourth the impact of the latter.

Table 3.1 shows the results, equal to £478 million in gross impacts attributable to the initial effect of staff costs plus the direct, indirect, and induced effects that occur as the colleges and their staff spend money in the region.

Table 3.1: Impact of Staff and College Expenditure (£ Thousands), 2014-15*

	Total
Total income in Wales	£43,768,808,102
Initial effect of staff costs	£305,190
Direct effect	£51,865
Indirect effect	£13,948
Induced effect	£106,984
Gross total impact	***£477,988***
Alternative use of funds adjustment	-£22,459
Net total impact	***£455,529***

Source: Emsi model.

*Numbers may not add due to rounding.

One adjustment must be made to the gross impact before deriving the net impact of staff and college expenditure. FE colleges in Wales received an estimated 14.7% of funding from local sources in Wales, whether from local residents (e.g., in the form of tuition fees) or from other private and public sources located in the region. Given this phenomenon, a portion of the income that the colleges create in the economy of Wales is offset by the income that they withdraw from the economy. As such, not all of the impacts generated by FE colleges in Wales and their staff can be considered new monies brought to the region.

To determine the 'net' impact of FE colleges in Wales payroll and purchases, we convert the portion of college funding that originated from local sources to spending. We do this by summing together two specific components. The first component involves the amount of local funding the colleges received from residents in Wales that they could have used instead for their own consumption. Here we use the amount of funding the colleges received from government funding bodies that was paid by taxpayers in Wales. We multiply this total local taxpayer funding by the average propensity to consume as reported by the ONS to find the amount they could have used instead for consumption. The second component looks at non-taxpayer local sources of college funding. This includes the amount of tuition paid by learners originating from within Wales, as well as private (non-governmental) revenue. For the private revenue, we assume that 50%

reported by the colleges comes from local sources. The total amount of these two components amounts to £69.2 million.

Since we assume the local residents in Wales would have used the £69.2 million for their own consumption, we funnel this spending through the consumption vector of the IO model to calculate the multiplier effect for the individual sectors. Again, this is in sales terms at this point, therefore we convert the amounts to income using the value-added-to-sales ratios for each industry. The result, equal to £22.5 million, allows us to see what income would have been created in Wales even if FE colleges in Wales did not exist.

Subtracting the £22.5 million in alternative uses of funds from the £478 million in gross impacts yields a net impact of £455.5 million in added income in the regional economy. This value appears in the bottom row of Table 3.1. Assuming that FE colleges in Wales employ approximately the same number of people and spend approximately the same amount each year, this value may be considered an annual figure.

Impact of Learner Expenditure

About 1.4% of learners relocate to Wales to attend FE colleges in Wales. These learners spend money at local shops to buy books and supplies, purchase groceries, rent accommodation, pay for transport, attend sporting events, and so on. The expenditure of non-local learners attending FE colleges in Wales supports local suppliers and creates multiplier effects, thereby generating income and a need for further jobs. Note that we exclude the expenses of in-commuters since they spend little in the region compared to those who live in Wales.

In order to calculate the multiplier effects of learners from outside of Wales, we begin by estimating their gross expenditure in 2014-15. Given the lack of available data from the colleges, we use estimates prepared by the National Union of Students to find that an average learner moving into Wales to attend one of the colleges spends around £4,320 per year for accommodation, personal expenses, and transportation. This £4,320 multiplied by the 1.4% of learners moving into the region yields gross expenditures of approximately £8.7 million.

Table 3.2: Non-local Learner Expenditures, 2014-15

Spending Category	Total
Room & board	£2,520
Personal expenses	£1,415
Transportation	£385
Total	**£4,320**

Source: Emsi model.

This £8.7 million is in terms of sales, not income, and represents the initial sales effect. The initial income effect, however, is £0 because the income impact of learners from outside of Wales only occurs when they spend part of their earnings to make a purchase at a regional business. The multiplier effects therefore account for the entire impact of learners from outside of Wales expenditures.

We calculate the multiplier effects by mapping the £8.7 million in sales to the industries in the IO model. For example, we place spending for room and board within the *Renting and operating of owned or leased real estate* industry. We adjust these sales to account for leakage, again using RPCs from the IO model, and convert them to income by applying value added-to-sales ratios. Through this process, we estimate the direct effect of the colleges' learners from outside of Wales to be around £3.6 million.

The indirect and induced effects comprise the additional income created as the businesses patronised by the colleges' learners from outside of Wales also spend money in Wales and incomes rise and hiring increases. We derive this effect in a similar fashion to the way we found the indirect and induced effects for staff and colleges expenditures. That is, we run the same sales mapping of the £8.7 million used above through the multiplier effect matrix of the IO model, then again apply value added-to-sales ratios to convert the results to income. This amounts to an indirect effect of out-of-region learner expenditures of around £872.6 thousand and an induced effect of £677 thousand.

Summing together the direct, indirect, and induced effects we estimate that the spending of learners from outside of Wales attending FE colleges in Wales annually adds approximately £5.1 million in income to the economy of Wales. Since we are capturing the impacts of only those learners that relocate to the region (thereby injecting new monies into the economy of Wales), we do not have to adjust for the alternative use of funds as we did for the staff and college expenditures in the previous section. All of the results leading to this impact are presented in Table 3.3.

Table 3.3: Impact of Learners from Outside of Wales Expenditures (£ Thousands), 2014-15*

	Total
Total income in Wales	£43,768,808,102
Initial effect of learner expenditure	£0
Direct effect	£3,575
Indirect effect	£873
Induced effect	£677
Total impact	£5,124

Source: Emsi model.

*Numbers may not add due to rounding.

Impact of Added Workforce Skills

The strong focus of FE colleges in Wales on workforce development manifests itself at all levels of the colleges' provision. In addition to delivering specific training and consultancy solutions to businesses, the colleges maintain close links with local employers in order to target the type of employee training that best meets their growth strategies. Further, the colleges' vocational learning programmes and apprenticeships allow employers and the colleges to work together to develop industry-specific training schemes that benefit both the learners and employers. All of these services provide

valuable resources to businesses and help sharpen the skills of the existing Welsh labour force.

Employee training and development is just one way that employers benefit from the presence of FE colleges in Wales. By aligning their provision with key employment sectors in the region, FE colleges in Wales help produce the skilled workers that are needed to support the Welsh labour market. Table 3.4 presents the percentage breakdown of the colleges' instructional activity by top-level sector categories. Preparation for Life and Work comprises the highest percentage of instructional activity (28%). Preparation for life and work includes qualifications such as, English, Math, English for non-native speakers, and ICT. Preparation for Life and Work is followed by Health, Public Services and Care (13%) and Engineering and Manufacturing Technologies (9%).

Table 3.4: Breakdown of Instructional Activity by Sector, 2014-15*

Sector Subject Area	% of Total
Preparation for Life and Work	28%
Health, Public Services and Care	13%
Engineering and Manufacturing Technologies	9%
Arts, Media and Publishing	8%
Construction, Planning and the Built Environment	7%
Business, Administration and Law	7%
Retail and Commercial Enterprise	6%
Information and Communication Technology	4%
Science and Mathematics	4%
Leisure, Travel and Tourism	4%
Languages, Literature and Culture	3%
Agriculture, Horticulture and Animal Care	2%
Education and Training	2%
Social Sciences	1%
History, Philosophy and Theology	1%
Total	100%

Source: Data supplied by FE colleges in Wales.
*Numbers may not add due to rounding.

Many learners from FE colleges in Wales stay in Wales and are more productive because of the quality education they attained at the colleges. Over time, the skills of former FE colleges in Wales learners accumulate, steadily increasing the training level and experience of the workforce of Wales. As the skills embodied by former learners stockpile, a chain reaction occurs: higher learner incomes generate additional rounds of consumer spending, while new skills and training translate to increased business output and higher property income, causing still more consumer purchases and regional multiplier effects. The sum of all these initial and multiplier effects comprises the total impact of the learners' added skills in the economy of Wales.

Note that this total impact of the additional learner skills is unique from the previously discussed impact of college and staff expenditures. Hypothetically speaking, if FE colleges in Wales were to cease their operations, then the impacts from staff and college

expenditures would immediately disappear. However, the impact from additional learner skills would continue to contribute to the economic growth of the economy of Wales as former learners remain actively engaged in the regional workforce. While the supply of learner skills would slowly dissipate over time, it would be several years before all learner impacts would fully disappear.

Calculating the Initial Effect

Assigning a monetary value to the added skills acquired by learners still active in the workforce of Wales requires data on the historical enrolments and corresponding achievement levels of FE colleges in Wales learners over the past 15-year period. Guided contact hours are used to determine the achievement levels of FE colleges in Wales learners, and serve as a proxy for the level of skills learners contribute to the regional workforce. If the colleges are unable to provide us with historical enrolment data over the past 15-year period, our model projects the historical enrolment for the missing years using data from the available years.

Of course, not all learners remain in the workforce until retirement age, nor do all learners enter the workforce immediately upon exiting the colleges. Other learners leave Wales and find employment outside the region. 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 the colleges to estimate the number of learners who leave Wales over time. This allows us to estimate the net number of former and current learners from FE colleges in Wales still active in the workforce of Wales in the 2014-15 analysis year, as displayed in Table 3.5.

Table 3.5: Number of Guided Contact Hours Still Active in the Workforce of Wales, 2014-15*

Year	Active enrolments, region	Active guided contact hours, region
2001	160,509	21,472,267
2002	163,101	21,671,952
2003	164,536	21,803,455
2004	164,448	21,843,443
2005	165,385	21,956,234
2006	165,228	21,947,371
2007	161,637	21,670,911
2008	157,070	20,871,979
2009	147,160	19,381,731
2010	142,333	18,576,840
2011	130,066	17,046,853
2012	111,258	14,150,950
2013	86,585	11,174,204
2014	54,017	7,388,118
2015	15,305	2,067,941
Total, gross	1,988,640	263,024,249
Alternative education adjustment (10%)		(26,302,425)
Substitution effect adjustment (10%)		(26,302,425)
Number of guided contact hours in workforce, net		210,419,399

Source: Emsi model.
*Numbers may not add due to rounding.

The next step is to multiply the net number of former learners still working in Wales by the average number of guided contact hours achieved per learner per year. According to data received from the colleges, the average guided contact hours per enrolment was around 128 guided contact hours in 2014-15. We use this average as a starting point for estimating the average guided contact hours per learner over the previous 15-years. Using this methodology, the estimated number of guided contact hours in the regional workforce comes to 263 million (see Table 3.5). These are the guided contact hours that accumulated in the workforce over the past 15-year period and were still active in the 2014-15 analysis year.

Next we reduce the gross number of active guided contact hours to account for the learners' alternative education opportunities. For this analysis, we assume an alternative education variable of 10%, meaning that 10% of the learner population at FE colleges in Wales would have generated benefits even without the colleges. Since the majority of institutions in the UK receive public funding, we assume learners would have to leave the country to receive a private 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 26.3 million the gross total of guided contact hours in the regional workforce.

We make one more adjustment to the gross number of guided contact hours by reducing this figure by 10% to account for substitution effects, *i.e.*, the substitution of out-of-area workers for in-area workers. The reason for this is that if FE colleges in Wales did not

exist and there were fewer skilled workers in the region, businesses could still recruit and hire some of their employees from outside Wales. As with the alternative education variable, there is no way to precisely determine how many workers could have been recruited from outside of the region if FE colleges in Wales did not exist.[14] With the 10% adjustment, the gross number of guided contact hours is reduced by another 26.3 million (as shown in Table 3.5). The net number of guided contact hours still active in the workforce thus amounts to 210.4 million.

Table 3.6 demonstrates the total initial added income to the regional economy due to the added skills from the colleges' former learners. First, we find the initial labour income. This calculation begins by taking the average value per guided contact hour of £7.32 and multiplying it by the roughly 210.4 million guided contact hours in the regional workforce. This yields a value of £1.5 billion in added labour income.

Added to the initial effect on labour income is another £886 million in non-labour income, representing the higher property values and increased investment income stemming from the initial income of learners and enhanced productivity of the businesses that employ them. Non-labour income attributable to past learner skills is obtained by disaggregating higher learner income to the industrial sectors of the IO model 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 learner skills equal to approximately £2.4 billion in 2014-15.

Table 3.6: Initial Added Labour Income (£ Thousands), 2014-15*

	Total
Initial labour income	£1,560,056
Initial non-labour income	£885,778
Total initial income	£2,445,834

Source: Emsi model.

*Numbers may not add due to rounding.

Calculating the Multiplier Effects

Economic growth stemming from a skilled workforce does not stop with the initial effect. Multiplier effects occur as learners generate an increased demand for consumer goods and services through the expenditure of their higher wages. Further, as the industries where learners from FE colleges in Wales are employed 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 learners from FE colleges in Wales.

[14] For a sensitivity analysis of the alternative education variable and the substitution variable, please see Chapter 4.

The next few rows of Table 3.7 show the multiplier effects of learners' added skills.

To estimate multiplier effects, we convert the industry-specific income figures generated through the initial effect to regional sales using sales-to-income ratios from the UK Regional I-O model. We then run the values through the UK Regional I-O model's multiplier matrix to determine the corresponding increases in industry output that occur in the region. Finally, we convert all increases in regional sales back to income using the income-to-sales ratios supplied by the UK Regional I-O model. The final results are £683.4 million in earnings and £404.3 million in other income, for an overall total of £1.1 billion in multiplier effects. The grand total impact of alumni thus comes to £3.5 billion, the sum of all initial and multiplier effects. The total figures appear in the last row of Table 3.7.

Table 3.7: Impact of Added Skills (£ thousands), 2014-15*

	Total
Total income in Wales	£43,768,808,102
Initial effect of added skills	£2,445,834
Direct effect	£467,060
Indirect effect	£153,496
Induced effect	£467,150
Total impact	**£3,533,539**

Source: Emsi model.

*Numbers may not add due to rounding.

Note that the £3.5 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.

Total Impact on the Regional Economy

Table 3.8 displays the grand total of the colleges' impact on Wales in 2014-15. Altogether, the results of this study show that the economic impact of FE colleges in Wales to the local community in Wales is around £4 billion each year. This is approximately equal to 9.1% of the total economy of Wales and represents roughly 183,530 average wage jobs.

Table 3.8: Total Impact of FE colleges in Wales (£ Thousands), 2014-15*

	Total
Total income in Wales	£43,768,808,102
Impact of staff and college expenditure	£455,529
Impact of expenditure of non-local learners	£5,124
Impact of added skills	£3,533,539
Total impact	**£3,994,192**

Source: Emsi model.

*Numbers may not add due to rounding.

Conclusion

These results demonstrate several important points. First, FE colleges in Wales promote regional economic growth through their own operations spending, through the spending of their learners from outside of Wales, and through the increase in productivity as former learners from FE colleges in Wales remain active in the regional workforce. Second, the impact of added skills in the national workforce is by far the largest and most important impact of FE colleges in Wales, stemming from higher incomes of learners and their employers. And third, national income in Wales would be substantially lower without the educational activities of FE colleges in Wales.

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 colleges' investment viability and regional impacts. The sensitivity analysis covers six variables. For the investment perspective, we test the alternative education variable and the discount rate. On the impact side, we test the alternative education variables again, value per guided contact hour, substitution effects, alternative use of funds, and learner costs.

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 learners in the absence of public funding, the discount rate comes to us from *The Green Book*. These rates are calculated by HMS Treasury, but they do vary by individual and are closely related 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.

Learner Perspective

The alternative education variable does not affect the learners' stream of cash flows from Table 2.3 and thus is not included here. However, the discount rate for learners will vary far more than it will for the social and taxpayer perspectives. As can be seen, Table 4.1 below alters the assumed 'base case' values for the discount rate by first reducing it by 25% and 50% and then increasing it by the same.

Table 4.1: Learner Perspective Discount Rate

	-50%	-25%	Base Case	25%	50%
Discount Rate	1.8%	2.6%	3.5%	4.4%	5.3%
NPV (£ millions)	£6,959	£5,726	£4,740	£3,944	£3,297
B/C	9.7	8.2	6.9	5.9	5.1

Source: Emsi.

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 NPV ranges from £3.3 billion to £7 billion and the B/C from 5.1 to 9.7. Even with a much higher discount rate, learners still see a return above the threshold of 1.0, receiving £5.10 for every pound of their investment.

Social Perspective

As can be seen in Table 4.2, reducing the alternative education variable increases the returns since more of the benefits may be claimed by FE colleges in Wales. Similarly, reducing the discount rate increases the net present value and the benefit/cost ratio since future pounds are not discounted as heavily.

Table 4.2: Social Perspective Alternative Education Variable

	-50%	-25%	Base Case	25%	50%
Alternative Education Variable	5.0%	7.5%	10.0%	12.5%	15.0%
NPV (£ millions)	£14,079	£12,018	£11,648	£11,277	£10,907
B/C	8.3	8.1	7.9	7.7	7.5
IRR	24.9%	24.5%	24.0%	23.5%	23.0%

Source: Emsi.

Table 4.3: Social Perspective Discount Rate

	-50%	-25%	Base Case	25%	50%
Discount Rate	1.8%	2.6%	3.5%	4.4%	5.3%
NPV (£ millions)	£16,831	£13,955	£11,648	£9,781	£8,258
B/C	11.0	9.3	7.9	6.8	5.9

Source: Emsi.

If our assumption of the alternative education variable is off by 50% in either direction, the expected social NPV will range between £14.1 billion and £10.9 billion. The associated B/C ranges between 8.3 and 7.5, while the IRR occurs within 24.9% and 23.0%. 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 NPV is greater than £8.3 billion and less than £16.9 billion, while the B/C is between 5.9 and 11.0.

Taxpayer Perspective

The taxpayer sensitivity analysis shows similar trends to those of the social perspective, though with a smaller magnitude of variance in results since the benefits are a subset of those seen in the social analysis.

Table 4.4: Taxpayer Perspective Alternative Education Variable

	-50%	-25%	Base Case	25%	50%
Alternative Education Variable	5.0%	7.5%	10.0%	12.5%	15.0%
NPV (£ millions)	£2,117	£2,051	£1,986	£1,920	£1,854
B/C	6.7	6.5	6.3	6.1	6.0
IRR	21.2%	20.8%	20.4%	20.0%	19.5%

Source: Emsi.

Table 4.5: Taxpayer Perspective Discount Rate

	-50%	-25%	Base Case	25%	50%
Discount Rate	1.8%	2.6%	3.5%	4.4%	5.3%
NPV (£ millions)	£2,901	£2,393	£1,986	£1,656	£1,387
B/C	8.8	7.4	6.3	5.4	4.7

Source: Emsi.

As seen above, taxpayer investments in FE colleges in Wales are still viable investments with extremely high discount rates and large alternative education adjustments. Under the most conservative conditions, the alternative education variable will generate NPV, B/C, and IRR of £1.9 billion, 6.0, and 19.5%, respectively. Under the most favourable assumptions on the alternative education variable, taxpayers will see a NPV of £2.1 billion, B/C of 6.7, and IRR of 21.2%. Again the results are more sensitive to the discount rate, with the NPV ranging from £1.4 billion to £2.9 billion and the B/C ratio from 4.7 to 8.8.

Sensitivity Analysis of Impact Assumptions

Impact of Added Workforce Skills

Three assumptions feed into the primary impact measure of the impact of added workforce skills. The alternative education variable accounts for the growth in impacts that would have been generated in Wales even if FE colleges in Wales had never been established. The value per guided contact hour, though calculated based on regional earnings, may vary from year to year and is highly dependent on current economic conditions. The substitution effect assumes that some of the productivity in Wales would have occurred without the colleges through the importation of non-local labour. This is in contrast to the alternative education variable, where local labour is able to obtain some education in the absence of FE colleges in Wales.

Table 4.6: Added Workforce Skills Assumptions

	-50%	-25%	Base Case	25%	50%
Alternative Education Variable	5.0%	7.5%	10.0%	12.5%	15.0%
Impact (£ thousands)	£3,729,847	£3,631,693	£3,533,539	£3,435,386	£3,337,232
Value Per Guided Contact Hour	£2.75	£5.49	£7.32	£9.15	£13.73
Impact (£ thousands)	£1,325,077	£2,650,155	£3,533,539	£4,416,924	£6,625,386
Substitution Variable	5.0%	7.5%	10.0%	12.5%	15.0%
Impact (£ thousands)	£3,729,847	£3,631,693	£3,533,539	£3,435,386	£3,337,232

Source: Emsi.

Since the alternative education variable and substitution effects are the same rate, they move together. More interesting is the sensitivity of the results to the value per guided contact hour. 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 data specific to Wales rather than national earnings figures that are also weighted by the learner body demographics.

Impact of Staff and College Expenditure

We only perform a sensitivity analysis on one variable in regards to the operations of FE colleges in Wales. The portion of the colleges' revenues received by local sources (e.g., resident tuition fees and the portion of national taxes derived from local sources) may have been spent in a variety of ways, with different multiplier effects associated with that spending.

Table 4.7: Staff and College Expenditure Alternative Use of Funds

	-50%	-25%	Base Case	25%	50%
Alternative Use of Funds	7.4%	11.0%	14.7%	18.4%	22.1%
Impact (£ thousands)	£466,758	£461,143	£455,529	£449,914	£444,299

Source: Emsi.

Table 4.7 varies the amount of revenues received by FE colleges in Wales from local sources. In the base case scenario, 14.7% of the colleges' revenues were derived from local sources. The larger the percentage, i.e. the more revenues derived from local sources, the lower the staff and college expenditures impact will be since a larger portion of the colleges' spending is not new money in the economy.

Impact of Learner Expenditure

The sensitivity analysis on this variable simply alters the additional costs the learners incur through their college attendance. We vary the costs of books and supplies, room and board, personal expenses, and transportation as reported in Table 3.2. Here, if costs increase and the volume of learners from outside of Wales remain unaffected, impacts will rise since raw injections of money into Wales generate increased local earnings.

Table 4.8: Learner Expenditures

	-50%	-25%	Base Case	25%	50%
Learner Costs	£2,160	£3,240	£4,320	£5,400	£6,480
Impact (£ thousands)	£2,563	£3,844	£5,124	£6,406	£7,688

Source: Emsi.

Conclusion

Even if the most conservative assumptions for each of the variables pertaining to the impacts of FE colleges in Wales were adopted, the total impact on the economy of Wales would still be £3.6 billion, equivalent to 148,609 average wage jobs in the region.

Based on this sensitivity analysis, the returns to learners, the public, and the government are reasonable. They even remain above investment profitability thresholds when the most conservative assumptions are in place. Similarly, the regional impact analysis continues to generate modest results even when limiting by half the benefits that FE colleges in Wales can claim.

Annex 1: Resources and References

Action on Smoking and Health. 'Tobacco Economics'. Ash Fact Sheets, March 2017. http://ash.org.uk/category/information-and-resources/fact-sheets/ (accessed June 2017).

Beaven, Rachel *et al.* 'Measuring the Economic Impact of Further Education'. (Department for Business, Innovation and Skills, BIS Research Paper Number 38: London, March 2011).

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 (accessed January 2013).

Christaller, Walter. *Central Places in Southern Germany*. Translated by C.W. Baskins. Englewood Cliffs, NJ: Prentice-Hall, 1966.

Christophersen, Kjell A. and M. Henry Robison. 'The Socioeconomic Benefits of Community Colleges, Illustrated with Case Studies of Everett Community College and Walla Walla Community College in Washington State'. Volume 1: Summary Report. Emsi, Consulting Economists. Moscow, ID: by the authors, 2000.

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 (accessed June 2017).

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 (accessed June 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).

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 (accessed June 2017).

Economic Modelling Specialists, Inc. 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 (accessed January 2013).

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.

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.

Grubb, W. Norton. 'The Economic Benefits of Sub-Baccalaureate Education: Results from National Studies'. CCRC Brief No. 2, ISSN 1526-2049. New York, NY: Community College Research Center, June 1999.

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; (accessed January 2012).

Henderson, James M. and Richard E. Quandt. *Microeconomic Theory: A Mathematical Approach*. New York: McGraw-Hill Book Company, 1971.

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 (accessed June 2017).

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 (accessed December 2009).

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 (accessed June 2017).

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 (accessed January 2013).

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. 'Prison Population Figures 2016'. https://www.gov.uk/government/statistics/prison-population-figures-2016 (Accessed June 2017)

Mishan, E. J. (1976), Misgivings about economic growth. Higher Education Quarterly, 31: 5–36. doi:10.1111/j.1468-2273.1976.tb01955.x

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 (accessed January 2013)

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 (accessed January 2013).

National Union of Students. 'Press Pack 2007-2008: Higher Education Student Finance'. London: NUS, September 2007.

NOMIS. 'Annual Population Survey'. https://www.nomisweb.co.uk/articles/932.aspx (accessed June 2017).

NOMIS. 'Claimant count – seasonally adjusted'. https://www.nomisweb.co.uk/articles/931.aspx (accessed June 2017).

NOMIS. 'Department for Work and Pensions. Benefit payments 5% data – jobseekers allowance'. https://www.nomisweb.co.uk/home/release_group.asp?g=15 (accessed June 2017)

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 (accessed June 2017).

_____. Labour Market Statistics. 'Claimant count levels and rates.' https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?opt=3&theme=&subgrp= (accessed June 2017).

Office for National Statistics. 'Publication: MM23 Consumer Price Indices'. https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7g7/mm23 (accessed June 2017).

Office for National Statistics. 'Life Tables'. http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Life+Tables (accessed June 2017).

Office for National Statistics. Statistical Bulletin, November 2011. 'Annual Survey of Hours and Earnings'. https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2016provisionalresults/relateddata (accessed June 2017)

Office for National Statistics. Quarterly Labour Force Survey, 2016. http://nesstar.ukdataservice.ac.uk/webview/index.jsp?v=2&mode=documentation&submode=abstract&study=http://nesstar.ukdataservice.ac.uk:80/obj/fStudy/7985&top=yes (accessed June 2017).

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 (accessed January 2013).

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 (accessed January 2013).

_____. 'Quarterly National Accounts time series dataset'. https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/quarterlynationalaccounts (accessed June 2017).

_____. Mid-2015 Population Estimates. https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2015 (accessed June 2017).

_____. '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 (accessed January 2013).

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.

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.

Annex 2: Glossary of Terms

Alternative education	A 'with' and 'without' measure of the percent of learners who would still be able to avail themselves of education if the publicly funded colleges and universities in the UK did not exist. An estimate of 10%, for example, means that 10% of learners do not depend directly on the existence of the colleges in order to obtain their education.
Alternative use of funds	A measure of how monies that are currently used to fund the colleges might have been spent if the colleges did not exist.
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 learners leave the workforce due to such factors as out-migration, retirement, or death.
Benefit/cost ratio:	Present value of benefits divided by present value of costs. 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 (learner 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 (learner 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. Colleges do not receive compensation for these benefits, even though education statistically correlates with improved social behaviours.
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 institutions and their learners.
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 colleges pay staff and spend money for supplies in the local economy, they also generate earnings in all sectors of the economy, thereby increasing the demand for goods, services, and jobs. Moreover, as learners 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:	Measure of overall local earnings per pound of college earnings (i.e., on- and off-campus earnings divided by on-campus earnings). Multiplier effects are the result of in-area spending for goods and services and of everyday spending by college staff. The analysis also includes added local earnings attributable to past learners still active in the workforce. The local economy is larger because of learner skills, added spending associated with higher learner incomes, and enlarged output of industries where past learners are employed.
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 that 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 college, 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 college.
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: Payback period = cost of investment/net return per period.

Annex 3: Emsi Input-Output Model

Introduction and Data Sources

Emsi's UK Regional 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 down to the local authority.

Our primary data sources are the following:

1. Regional and national jobs-by-industry totals, and national sales-to-jobs ratios (derived from Emsi's industry employment and earnings data process).
2. The Office for National Statistics' (ONS) Supply and Use Tables (SUTs).
3. UK Business Counts (ONS)
4. Subsidies and Tax Breakouts (ONS)
5. Commuting Flow – Location of Usual Residence and Place of Work by Sex (2011 Census)

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.

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

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*). 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.

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.

Table A3.2: Sample 'A' matrix

	Industry 1	*Industry 2*	. . .	*Industry 645*
Industry 1	.001	.112	. . .	.035
Industry 2	.097	0	. . .	.065
. . .	. . .	. . .	. . .	. . .
Industry 645	.002	.076	. . .	0

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 work of University of West England economist A.T. Flegg[15] and uses cross-industry location quotients. In general, location quotients

[15] 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'

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:

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

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	.12	. . .	.47
Industry 2	.98	1	. . .	.09
. . .	. . .	. . .	. . .	. . .
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

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.

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:

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

Where:

$\otimes$ = Hadamard multiplication
A^N = UK IO coefficients matrix
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.