

The sub-regional impact of HEI's

Potentials and problems of simulating HEI demand-impacts on the Glasgow
economy

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Contents

1. INTRODUCTION	1
2. GLASGOW HEIS	1
3. HEI IMPACTS LITERATURE	3
IMPACT ANALYSIS – OVERVIEW	4
<i>Use of Input-Output (IO) modelling</i>	5
<i>The multiplier concept</i>	5
<i>Determining the multiplier</i>	6
<i>Critical assumptions of IO analysis</i>	7
<i>Shutting down of a complete sector</i>	8
WHAT SPENDING TO INCLUDE IN AN IMPACT ANALYSIS OF HEIS?	8
<i>Estimating the different sources of spending</i>	9
SUB-REGIONAL IMPACTS	11
SENSITIVITY TO ASSUMPTIONS	12
4. GLASGOW IO	13
LQ APPROACHES	14
<i>Simple location quotient (SLQ)</i>	15
<i>Cross industry location quotient</i>	16
<i>Other LQ methods</i>	16
CONSTRUCTION OF GLASGOW CITY IO	17
<i>Step 1: Sector gross output totals for Glasgow</i>	18
<i>Step 2: Sector primary inputs for Glasgow</i>	18
<i>Step 3: Technical coefficients for Glasgow</i>	19
<i>Step 4: Final demand totals</i>	19
<i>Step 5: Balancing</i>	20
GLASGOW CITY IO	20
HEIS SHUTDOWN SIMULATION	22
STUDENT IMPACTS	23
TOTAL SPENDING IMPACT ON THE CITY OF GLASGOW	25
SENSITIVITY ANALYSIS	25
5. CONCLUSION	27
REFERENCES	28
APPENDIX: SPATIAL INTERACTIONS OF GLASGOW HEIS	31
STUDENT TERM TIME ACCOMMODATION	33
DESTINATION OF LEAVERS	33
SPATIAL DISAGGREGATION OF HEI SPENDING	34
IMPLICATIONS FOR MODEL DEVELOPMENT	36

1. Introduction

Considerable attention has been given to the impact a higher education institution (HEI) has on its local economy. For this paper we have constructed Input-Output accounts for the sub-region of Glasgow City council area, which are used to look at the spending or demand-side impact of the five HEIs in the City of Glasgow¹. The first section of this paper gives a brief description of the spending profile of Glasgow's HEIs. The second part summarizes the findings of past literature on the economic impacts of HEIs and the use of IO modelling in impact analysis. In the third section we describe the construction of the IO accounts and use them to estimate the impact of HEIs on the Glasgow economy.

The results presented here are the first milestone in implementing a research agenda aimed at modelling the overall economic impact of HEIs at a sub-regional level in Scotland. In Appendix we present a descriptive analysis, based on recently obtained data, of the interaction of HEIs in Glasgow over space and discuss the next steps in our undertaking.

2. Glasgow HEIs

Within the boundaries of Glasgow City Council there are five HEIs, differing in their size and nature: Glasgow Caledonian University, Glasgow School of Arts, Glasgow University, The Royal Scottish Academy of Music and Drama and the University of Strathclyde. In terms of spending Glasgow University is biggest, however in terms of student number Strathclyde is the biggest in Glasgow (and in Scotland).

When it comes to income and expenditure these two biggest of Glasgow's HEIs differ significantly from the others in that a larger share of their activity is funded by research grants and contracts.

¹ This is part of ongoing work to assess the overall impact of HEIs on regional economies in the UK and is one of nine projects within the ESRC backed Impact of Higher Education Institutions on Regional Economies Initiative. For the work underlying this project funding from the Centre for Public Policy for Regions is gratefully acknowledged.

Table 1: Income of Glasgow's HEIs by source 2005/06, £ thousands. (HESA, 2007)

	Glasgow Caledonian University	Glasgow School of Art	The University of Glasgow	RSAMD	The University of Strathclyde	Total Glasgow
Funding Council grants	53,130	9,897	130,934	6,096	85,883	285,940
Tuition fees & education grants & contracts	23,026	3,694	53,205	2,276	51,097	133,298
Research grants & contracts	4,262	609	75,439	114	29,398	109,822
Other income	17,123	1,459	47,447	1,490	20,910	88,429
Endowment & investment income	103	140	5,347	402	3,766	9,758
Total income	97,644	15,799	312,372	10,378	191,054	627,247
Funding Council grants	54%	63%	42%	59%	45%	46%
Tuition fees & education grants & contracts	24%	23%	17%	22%	27%	21%
Research grants & contracts	4%	4%	24%	1%	15%	18%
Other income	18%	9%	15%	14%	11%	14%
Endowment & investment income	0%	1%	2%	4%	2%	2%
Total	100%	100%	100%	100%	100%	100%

Table 2: Expenditure of Glasgow's HEIs by activity 2005/06, £ thousands. (HESA, 2007)

	Glasgow Caledonian University	Glasgow School of Art	The University of Glasgow	RSAMD	The University of Strathclyde
Academic departments	49,799	8,200	127,139	5,506	85,000
Academic services	11,058	1,552	16,236	714	17,123
Administration & central services	13,577	1,996	36,054	1,846	19,068
Premises	12,518	2,961	36,383	1,394	25,258
Residences & catering operations (including conferences)	817	369	14,334	392	6,187
Research grants & contracts	5,863	609	63,146	184	24,842
Other expenditure	3,118	489	17,109	141	6,893
Total	96,750	16,176	310,401	10,177	184,371
Academic departments	51%	51%	41%	54%	46%
Academic services	11%	10%	5%	7%	9%
Administration & central services	14%	12%	12%	18%	10%
Premises	13%	18%	12%	14%	14%
Residences & catering operations (including conferences)	1%	2%	5%	4%	3%
Research grants & contracts	6%	4%	20%	2%	13%
Other expenditure	3%	3%	6%	1%	4%
Total	100%	100%	100%	100%	100%

In terms of FTE's the Glasgow HEIs employ roughly ten thousand staff, of which about 4.300 are academic professionals. The table below gives details of how staff is distributed among different activities of the HEIs.

Table 3: Staff FTE by activity 2005/06, £ thousands. (HESA, 2007)

	Glasgow Caledonian University	Glasgow School of Art	The University of Glasgow	RSAMD	The University of Strathclyde	Total Glasgow
Academic professionals	833	117	2,047	46	1,258	4,300
Non-academic professionals	83	14	366	8	139	610
Technical support, student support, library	431	90	1,028	42	757	2,348
Other support	116	22	720	36	478	1,373
Housekeeping	102	29	393	4	381	908
Atypical staff	62	33	36	56	60	247
Total all staff FTE	1,708	321	4,681	201	3,090	10,002

3. HEI impacts literature

In this paper we leave the potential supply side impacts aside and consider the regional impact of HEI spending. It is fair to say that the spending impact of HEIs is quite well understood, far better than the supply-side impacts. When assessing the impact we can progress from a quantifiable starting point, the direct spending of the institution and its students, trace this spending through the regional economy and work out an overall impact. Many studies of this kind have been published over a period of more than 3 decades and the methodology has been continuously refined.

From this restricted view, HEIs can be seen principally as a source of fiscal stimulus in their location. However, as we will see the spending of HEIs have a significant impact. The spending of HEIs and their students are much favoured in regional development and more generally, as pointed out by Westlund (2004), job opportunities that are financed externally are always welcomed locally.

As we will see, the multiplier effects of direct spending of HEIs do vary, as the size of the multiplier depends on the nature of the region in question, the nature of the HEI and definitions underlying the impact assessment. Furthermore the credibility of the results is contingent upon the accuracy of primary spending data and the methods used to derive multiplier values.

In the following section we outline the broad methodology applied in impact studies in general and issues particularly relevant when assessing HEI impacts. We start by reviewing how the direct impact is assessed and the various complications that arise in that process. Secondly we examine the methods used to derive subsequent (multiplier) impacts using IO tables.

Impact analysis – Overview

There is an extensive literature that assesses the impact of HEI spending on the host economy solely through demand side effects. Florax (1992) identified over 40 studies of the regional economic impact of HEI expenditure and much has been published since. McGregor et al (2006) summarise the methods and findings of the main UK studies. Almost all of these studies have been conducted using models that are based on assumptions of an entirely demand driven economy with a passive supply side. Most, especially earlier ones, are based on Keynesian income-expenditure models e.g. Brownrigg (1973), Bleaney et al (1992), Armstrong (1993) and Battu, et al (1998) while a few are based on income-output modelling and extensions thereof, e.g. Harris (1997) and Kelly et al (2004).

McGregor et al (2006) argue that although less frequently applied, the IO analysis is methodologically superior to Keynesian income-expenditure models. However the latter might be used in circumstances where rough estimates are considered sufficient or IO accounts are not available or cannot be constructed with the resources available.

The fundamental relationships on which demand driven models rest is the interrelation between local businesses and households and their links to the rest of the economy. Imagine a new university being founded. This will bring a fresh injection of spending into a region. It will buy supplies, either locally (from suppliers who themselves have a certain propensity to import) or import them directly from external suppliers. Most of the universities staff will reside locally and spend a part of their income on local services, which in turn will generate more activity. Furthermore a university will attract students from outwith the region whose spending will be a fresh source of demand. In this way it is easy to see the way in which an injection of expenditure works its way through the regional economy.

We will not give a detailed account of the whole range of demand driven models². However we will give an overview of the use of IO-models in impact assessment before proceeding to a closer look at relevant issues that arise when assessing the impacts of HEIs using this approach.

² As they are well known in the economics literature and further information is readily available in textbooks (e.g. Armstrong & Taylor, 2000).

Use of Input-Output (IO) modelling

Input-Output (IO) tables are a set of accounts that identify the interaction (sales and purchases) between different sectors within the economy and between those sectors and elements of final demand (consumption, government, investment and exports) over a particular time span.

A set of IO accounts allows us to estimate the overall impact on regional output from a change in final demand for an individual sector. In addition to the impact from the direct spending, there are additional impacts (often referred to as multiplier or “knock on” effects) from subsequent flows from that sector. For the purposes of this paper an IO table will be used to derive the multiplier impacts of direct spending related to Scottish HEIs. Furthermore a shut-down simulation will be conducted where we estimate the impact upon the Scottish economy if the entire sector of HEIs were to stop operating. These approaches will be outlined in the remainder of this section³.

The multiplier concept

An increase in the demand for the output of a particular sector in the economy will generate knock on effects in other sectors. There will be an increase in the demand for intermediate inputs plus increased consumption demand as employment and household income rise. These further sources of expansion are known as the indirect (intermediate demand) and induced (consumption demand) effects. Type I multipliers incorporate only indirect effects whilst Type II multipliers encompass both indirect and induced impacts. In this report we focus primarily on Type II multipliers.

The first round increase in demand will set in train corresponding second round increases in the intermediate and consumption demand for the output of other sectors, which will generate further increased demand and so on. A multiplier process is thereby set up, where the increase in output in each round gets smaller and smaller as some expenditure leaks out of the region or nation in the form of imports, taxes and savings in each round. This additional activity sums to a finite number.

The IO accounts can be used to calculate various types of multipliers. These can relate exogenous changes usually in demand⁴ to outcomes such as Employment,

³ For a more thorough discussion of the fundamentals of input-output analysis there are comprehensive textbooks available, e.g. Miller & Blair (1985) and Raa (2005).

⁴ Input-output analysis can also be undertaken from a supply-side perspective. See for example Ch. 9-1 in Miller & Blair (1985)

Income, Gross Output or GDP. The multipliers can then be used for comparison across sectors or to analyse a single sector. Injection can in one sector or across a number of sectors and the impact can be viewed sector by sector or aggregate. In context of an exogenous change upon a single sector the output multiplier value is the increase in total output of the economy that would be generated by a unit increase in the demand for that sector.

Determining the multiplier

The underlying idea behind multipliers is that some independent (exogenous) disturbance occurring in one part of the economy can have subsequent “knock on” impacts in other parts of the economy and therefore on the economy as a whole.

A key characteristic of the procedure for determining the demand-driven multiplier values is to identify those elements of demand taken to be exogenous and those taken to be endogenous. The exogenous elements are those fixed independently of the level of activity within the economy. The endogenous demands are those determined by the level of activity in the economy. In conventional I-O demand-driven analysis, final demand, such as exports, government expenditure, investment and stock building are exogenous. Intermediate demand, including imports, is endogenous. Conventionally, consumption expenditure can be classified as either exogenous or endogenous. This is because it is not linked to production output through fixed production coefficients, but through behavioural relationships that assert that domestic consumption will rise in line with wage income.

When consumption expenditure is taken to be exogenous, the multiplier simply identifies the change in activity generated in the economy by changes in intermediate demand for goods and services. The multiplier is called a Type I multiplier. It is made up of the direct effects of the initial change in exogenous demand plus the indirect effects of the additional expenditure on intermediate goods and services. Where consumption demand is endogenous, and made to vary proportionately with wage income, the effects of induced consumption expenditure on activity is also included in the multiplier effect. This is called a Type II multiplier. It covers the direct and indirect impacts that are quantified in the Type I multiplier but adds the induced effect of additional consumption. In this report, unless stated otherwise, we report Type II multiplier values.

Critical assumptions of IO analysis

In using I-O analysis to calculate multipliers the following assumptions are made: constant-returns to scale, fixed coefficient production technology; Constant coefficients in consumption (where Type II multipliers are calculated); no supply constraints.

In calculating the multipliers, it is assumed that all inputs into production in a particular sector change in strict proportion to the change in the output of that sector. Therefore if output increases by 10%, all inputs similarly increase by 10%. This implies constant returns to scale in production. It also implies that there is no substitution between inputs as output changes. This assumption is usually interpreted as implying that production is characterised by a fixed-coefficients technology. However, an alternative is that substitution is possible but input prices do not change, so that the cost minimising choice of technique does not vary as output varies (McGregor et al, 1996).

Where induced consumption is incorporated into the multiplier values, in conventional models the consumption of all commodities changes in line with changes in wage income.

A key assumption in the use of I-O multipliers, is that there must be available labour and productive capacity to meet any increase in demand in any sector. Similarly there must be no key fixed natural resources which are presently fully utilised. Supply must therefore react passively to demand so that there is no crowding out of some demands by others and no changes in production techniques to economise on scarce resources or commodities.

Essentially a Type II demand-driven I-O multiplier is a sophisticated Keynesian multiplier. It operates in an identical way but provides greater sector disaggregation. Imports and intermediate demands are also better identified. It shares with the Keynesian multiplier the requirement that the supply-side of the economy plays a totally passive role. This might be appropriate in the short run for an economy with unemployment problems or for a regional economy in the long run where inter-regional migration and additional investment can relax labour market and capacity constraints. Clearly, the application to the UK national economy should be treated with some care as the notion that the UK economy has no supply constraints is clearly unrealistic (McGregor et al, 1999).

Shutting down of a complete sector

In the demand-driven I-O approach, the complete closure of a particular sector is modelled as if all the domestic demands for that commodity were transferred to imports. There is no implied change in technology or tastes in so far as commodities are concerned. The relevant expenditure is now met by imports rather than domestic production. The viability of other sectors is not threatened through breaking supply links, but the output of sectors directly or indirectly supplying the closed sectors will clearly be reduced. From the discussion above, adjusting for increased imports typically requires changes both to the final demands for the commodity and the relevant domestic production coefficients, which, in principle, affects all the multiplier values.

The impact of the complete closure of a sector is identified by calculating the total gross output, employment, income and value-added generated with the I-O system characterised by the new set of final demands and multiplier values, and subtract these from the corresponding original figures.

Two notes of caution should be sounded about the estimates of the impact of the complete closure of the sector. The first is that these estimates cannot be taken to be a form of accounting or attribution. That is to say, each sector could be removed, independently, and the impact of removing that sector quantified as outlined above. If all these individual impacts were then summed, the total lost output and employment would be greater than the initial total output and employment. However a similar procedure removing only final demands would provide a result where the sum of the impacts would equal initial output and employment.

A second problem is that the total measured affect will vary, depending on whether a Type I or Type II approach is taken to the calculation of the new activity variables. In this procedure, however, it is not necessarily the case that a Type II calculation will give a bigger result than a Type I one. It seems more reasonable to count consumption as endogenous, and, if so, a Type II approach would be preferred.

What spending to include in an impact analysis of HEIs?

Many studies e.g. Bleaney et al (1992) divide the direct spending impact of universities into two categories, University expenditure and student expenditures. Some studies have added to this as a category the spending of relevant visitors, typically delegates on conferences related to the institution in question. As an example of this the Greater Glasgow & Clyde Tourist Board has estimated that 50% of its convention

sales are linked to the Ambassadors Programme, which is a programme designed to encourage and support prominent professionals, particularly academics, in persuading international learned societies to bring their conferences to Glasgow. (Universities UK, 2006, pp. 28).

In terms of scale, the institutions' own spending is usually found to have the most significant impact, followed by that of its students, while HEI generated 'tourism activity' has been of lesser importance. This however does not hold in all cases and depends on circumstances and the assumptions underlying the impact study⁵

Estimating the different sources of spending

In the following subsection we will explore how previous studies have estimated the direct spending impact of HEIs, their students and visitors. For this our focus will be on two UK IO based studies of Portsmouth University (Harris, 1996) and of Strathclyde University (Kelly et al, 2004). Both fall within the category of the most elaborate and methodologically advanced to date. However they differ in geographic scope, the first estimating the impact on a sub-region while the second has its primary focus on a region⁶, which significantly affects the results.

Both studies used accounting data to determine the geographic destination of their spending and how it was distributed among sectors. Therefore they were able to construct an accurate expenditure vector in the input-output tables for the institution being examined. However a university's gross expenditure on wages within its host region is in itself not representative of the local economic impact of staff spending. People spend based on their disposable income, they may save and only a part of the spending is within the local economy. Furthermore Harris points out that if the university were shut down not all the employers would leave the local area – some might stay behind and claim unemployment benefits. Of the £16m spent on wages to employees living within the Portsmouth travel to work area, Harris concludes that £6.75m can be considered net expenditure in the Portsmouth travel to work area which

⁵ For the University of Portsmouth Harris (1997) found that the most significant impact was from student spending, which generated roughly four times the output of the university's spending.

⁶ Kelly et al also examined impacts in terms of a narrower geographic scope of the City of Glasgow and as expected found them to be less profound.

would be lost if the university did not exist.⁷ However this must be considered in the context of the narrow geographic scope of the study.

Student spending

Often when assessing the impact of student spending only students from outwith the area being examined are counted. However it can be argued that at least a part of the local student population would have left for study elsewhere had the HEI in question not existed and therefore their spending should be counted to some extent⁸. Kelly et al acknowledge this argument but do not attempt to solve it; instead they consider only the spending of students from outside Scotland. In the absence of survey data on expenditure of international students it was assumed their spending was in line with that of students from the rest of the UK. The per capita figure was assumed to be the median academic year expenditure of a student studying outside London as found in Callender & Wilkinson (2003)⁹. This they assume to be a conservative figure as many postgraduate students reside on a full year basis. The expenditure vector was based on that observed previously for other UK HE students.

Harris (1996) takes the opposite view that every student at the University of Portsmouth would be studying somewhere else, and therefore not contributing to the Portsmouth economy, if the University did not exist. Using student data he derived the number of students residing within the Portsmouth travel to work area. Furthermore he derives the number of students who will commute into Portsmouth for courses at the University, as they will have an impact as well although of a smaller scale. These raw numbers were then converted into FTE's. To obtain the level of spending Portsmouth University students were surveyed. The result was that 10,902 FTE students living within the Portsmouth TTA spend £32m and 1,951 FTE students living elsewhere spent £1.66m within the area. Of that £23.8m are estimated to be spent on products and services sourced within the local economy.

⁷ To arrive at the net expenditure figure, three adjustments were made to net disposable income: Savings were subtracted; Spending of staff who would remain local residents and claim unemployment benefits was omitted; as was expenditure on imported goods and services. For details see Harris (1997, p. 616).

⁸ Another line of argument is that in the absence of the HEI some of the local students would have been more active in the labour market and therefore had a more profound impact than as students.

⁹ Tuition fees are excluded to avoid double counting as they form an HEIs income and therefore get counted as HEI spending.

Conference visitors and other spending

Kelly et al (2004) argue that a conservative estimate of visitor activity related to the University of Strathclyde can be derived based on information on number of external visitors staying on campus. Information from the Residence and Catering Department reveals 93,305 bed nights were provided for external visitors. Furthermore it was possible to divide this up by the origin and nature (business leisure) of the visitor. Based on survey information they were able to assign value to the spending of each category of visitor and arrive at a total impact. In this all payments by visitors to the university have been subtracted to avoid double counting. They conclude that external visitors generated £9m output in the Scottish economy and supported 120 FTE jobs.

Sub-regional impacts

Due to the availability of the Scottish input-output tables Kelly et al are able to estimate the economic impact of Strathclyde University upon the region of Scotland by creating a Strathclyde expenditure vector in the tables and using information on its direct spending as a starting point. However a more uphill task is to estimate its economic impact on a sub-region of Scotland, like the City of Glasgow. In that case complications arise as to defining more accurately the geography of expenditures and allowing for imports and exports between Glasgow and the rest of Scotland.

In the absence of an input-output model of the City of Glasgow Kelly et al arrive at an estimate of the output generated within Glasgow by scaling down the overall impact on Scotland using location quotients. They defined several sectors as 'local' due to the nature of their services, i.e. hotels, catering and pubs. For these sectors the total output impact on Scotland was assumed to be fully captured within Glasgow. For other sectors Glasgow's share of the output was assumed to be proportional to the Glasgow city output of that sector relative to its output in Scotland as a whole. They conclude that the total output created within the city amounts to £210m while the overall impact on Scotland is £305m.

Harris (1996) in his study of economic impacts of Portsmouth University upon the Portsmouth travel to work area operates with a sub-region from the outset. In the absence of a survey based Input-Output model of the area he constructs what he refers to as a hybrid model for this purpose. Local industries were surveyed to provide for information on inter industry linkages, imports, exports and compensation of employees. This is done in order to avoid underestimating local imports and exports as

is typically the case with purely estimated tables (Harris & Liu, 1998). For other parts of the table local employment figures were used to estimate final demand columns.

Sensitivity to assumptions

As can be seen from this comparison of two methodologically advanced studies, the results of regional impact studies are highly sensitive to the underlying assumptions. A case in point is the difference in treatment of student spending. For Strathclyde University student spending is found to be of secondary importance as only those students that are from outside Scotland are counted. However for Portsmouth student spending is of central importance as all the students living there are only assumed to be there because of attending the University. It is possible to motivate both views depending on local circumstances.

Furthermore the impact of direct spending of Portsmouth University is of lesser importance due the limited geographic scope of the study, as much of it impacts outside the study area. Therefore it can be seen that the geographic scope of the study greatly affects its outcome.

For regional policy makers the magnitude of the multiplier is of fundamental interest and as pointed out by Armstrong (1993) this hinges on several dimensions. For one the chosen study area or the geographical definition of the analysis is an important variable as generally it holds that the larger the geographic and economic scale the larger is the multiplier. Furthermore the more diversified and developed a local economy the larger the multiplier is likely to be (Armstrong, 1993). Simply put the more inputs that are sourced within the region the less are the leakages and the spending multiplier bigger.

As an example Armstrong examined the local impact of Lancaster University in a study of quite narrow geographical scope and found the local income multiplier to be 0.82. Such was the leakage that for every pound spent on Lancaster University only 0.82p of local income was generated. Similarly he calculated a local employment multiplier of only 1.08 as many of the staff commuted into Lancaster and therefore fell outwith the boundaries of the survey.

The nature of the institution also plays a role in the size of the multiplier effect. Westlund (2004) reports significant differences in local effect of Swedish higher education institutions. He points out that the local employment multiplier for Borås University was found to be 2 while for the University of Umeå it was found to be at

least 1.38. He argues that the main explanation for this is the difference in staff/student ratio between the two institutions. While in Umeå full time students living in town per member were 3 the subsequent number for Borås was 13. As this example reveals, generally teaching intensive institution will show a bigger multiplier effect on direct spending as there is more student spending per unit of university spending.

4. Glasgow IO

In this section we will develop a set of input-output accounts for the city of Glasgow and use them to estimate the output impact of the cities HEIs. We will begin by briefly illustrating the construction of the accounts before presenting our impact estimates. Finally we will consider possible improvements of the IO-accounts and summarise weaknesses of the analysis that cannot be accommodated within the IO-framework.

When conducting economic analysis using input-output accounts the methodologically preferred option is to work with surveyed accounts such as those constructed for the UK or Scotland. These are however rarely available for sub-regional economies, such as the city of Glasgow, and resource constraints typically make constructing them from a survey infeasible.

A more affordable alternative is to use a published (surveyed) regional table as a starting point for deriving a sub-regional table using what is commonly known as location quotient (LQ) methods. A variety of such techniques have been suggested in the literature, where technical coefficients are adjusted on the basis of published information on regional employment¹⁰. In brief a sub-regional LQ table can be thought of as a sub-section of the original table where available data on local characteristics is used to scale the regional table to an output level and structure compatible with local benchmarks.

It is clear that because of some of the assumptions a LQ table is built on (in particular the imposition of a spatially homogenous technical structure) it will not be entirely accurate for a sub-region. However the method has been adopted as a practical way to conduct sub-regional impact analysis in the absence of better information.

Comparison of IO tables estimated with different methods (Harris & Liu, 1998) has revealed that traditional LQ tables have a systematic bias towards underestimating

¹⁰ See for example Miller & Blair, 1985, pp. 295

the openness of the sub-regional economy, i.e. they underestimate imports and exports and overestimate local intermediate transactions. Comparison of estimated and surveyed tables suggests the former overstate regional multipliers by a magnitude of 15-30%, through their under estimation of interregional trade. However they point out that this bias is more acute for traded sectors such as manufacturing than for services. Harris (1996) points out that this can be countered by a synthesis of methods where the LQ approach is supplemented by surveying for some characteristics of the local economy, in particular import and export propensities of local industries. This approach, although more expensive, removes the bias and brings results more in line with that of fully surveyed tables.

Although we hope to augment the Glasgow IO accounts with primary data on local imports and exports later on in our research process, this task has not yet been undertaken. Therefore we have to accept the possibility that the Glasgow IO model overestimates local multipliers by a magnitude of possibly 15-30%. However for two reasons, within the context of the impact study of Glasgow HEIs, this may not be as problematic as the potential magnitude of the bias suggests. Firstly, because of parallel work on the impact of HEIs in Scotland we know the spending impact each Glasgow institution has at a Scottish level, based on the fully surveyed official Scottish IO table. Therefore any overestimation of their impact upon the city of Glasgow can be seen rather as an error of attribution of their Scottish level impact between Glasgow and the rest of Scotland, than an overstatement of their impact. Secondly the spending of HEIs and their students is more concentrated on service sectors, which tend to be less sensitive to the overestimation biases of un-augmented LQ approaches.

LQ approaches

Various LQ methods have been suggested in the literature and some attempt to rectify the problem of overstating intermediate transactions by modifying the mechanics of the LQ's to reflect the openness of the smaller scale sub-regional economies. Miller & Blair (1985) review development of non survey techniques. Debate concerning the most appropriate adjustment is still ongoing with recent work (Flegg et al, 1995, Flegg & Webber, 1997, 2000, Brand 1997, McCann & Dewhurst, 1998). In the remainder of this section we will illustrate how the simple location quotient is derived and take a brief look at a few of the subsequent developments.

In general LQ approaches adjust the national technical coefficient to take account of the potential for satisfying input needs locally. A regional Input-Output coefficient can be defined as:

$$a_{ij}^{RR} = LQ_i^R(a_{ij}^N)$$

Where a_{ij}^{RR} is the regional IO technical coefficient, LQ_i^R is the location quotient and a_{ij}^N is the national technical coefficient¹¹.

Simple location quotient (SLQ)

The simple location quotient for sector i in region R is defined (Miller & Blair, 1985) as:

$$LQ = \left[\frac{E_i^R / E^R}{E_i^N / E^N} \right]$$

Where E_i^R and E^R are employment in sector i in region R and total employment in region R respectively and E_i^N and E^N are employment in sector i and total employment in the nation as a whole.

Where LQ_i is greater than one (less than one), we can say that sector i is more (less) concentrated in region R than in the nation as a whole. Where the location quotient is less than one, we view the region as being less able to satisfy regional demand for its output, and the national coefficients are adjusted by multiplying them by the location quotient for sector in region R. Where the sector is more concentrated in the region than the nation at large ($LQ_i > 1$), it is assumed that the regional sector has the same coefficients as the nation as a whole. Therefore for row i of the regional table,

$$a_{ij}^{RR} = \begin{cases} a_{ij}^{RR}(LQ_i^R) & \text{if } LQ_i^R < 1 \\ a_{ij}^N & \text{if } LQ_i^R \geq 1 \end{cases}$$

¹¹ Which shows the required input of commodity i per unit of output of commodity j.

Cross industry location quotient

A criticism of the simple location quotient is that it does not take into account the relative size of the sectors engaged in intermediate transactions. The argument goes that if a sector which is relatively small locally is supplying a sector which is relatively big, this should imply a need for imports to satisfy intermediate demand, and vice versa. This is addressed with cross industry location quotients (QILC). The CILQ for sectors i and j can be defined as:

$$LQ = \frac{LQ_i \left[\frac{E_i^R / E_i^N}{E_j^R / E_j^N} \right]}{LQ_j}$$

Where sector i is assumed to be supplying inputs to sector j . As with the SLQ national coefficients are not adjusted if $CILQ_{ij}^R \geq 1$ as it is assumed that intermediate demand can be met within the economy.

Other LQ methods

Various other LQ methods have been proposed including Rounds Semi Logarithmic Location Quotient (RLQ) (Round, 1978) and Flegg, Webber and Elliot's Location Quotient (FLQ) (Flegg et al, 1995), with subsequent refinement (Flegg et al, 1997) following Brand's (1997) criticism. These formulas are more complex and in the case of FLQ require arbitrary assumptions about their coefficients. Empirical testing of these methods has not yielded a clear favourite. Therefore it is dubious what extra value is gained from utilising every LQ that has been put down on paper. The stance taken here is that using LQ's is a proxy method, which should be kept as transparent and intuitive as possible and whose limitations should be accepted up front. We hope to improve the accuracy of our estimates later on by incorporating hybrid techniques¹² but do not expect added value from manipulating the location quotients. However we accept that this may overstate the economic impact by underestimating trade.

¹² Typically this would involve augmenting the IO-table with survey data on interregional trade, e.g. as suggested by Harris & Liu (1998). An alternative approach is described by Riddington et al (2004), who use a gravity model to estimate interregional trade.

Construction of Glasgow City IO

A Glasgow City IO table was estimated using what is known as Simple Location Quotients¹³. The Glasgow City Council jurisdiction spans an area of 175 km², an area that included 580 thousand inhabitants in 2007. Roughly 410 thousand people are employed in Glasgow, which is approximately 17% of total employment in Scotland¹⁴. data sources used for this were a Scottish input-output table for the year 2006¹⁵ and data from the Annual Business Inquiry (via NOMIS) that provides us with employment numbers for Glasgow. Estimation of the table drew heavily on methods applied by Allan et al (2007).

The table was initially estimated fully disaggregated with 128 sectors. The IO sectors in the Scottish table refer to specific SIC categories and therefore employment levels for Scotland and Glasgow could be matched to each. However the sectors refer to SIC categories at different levels of aggregation with some referring to a single 2 digit SIC category while others may be a combination of 3 or 4 digit categories. Therefore we started out with employment data from NOMIS split into 2 digit categories and proceeded stepwise disaggregating relevant sectors according to 3 digit and 4 digit classifications until they matched the IO categories. Once LQ's had been derived based on employment data a five step process was used to estimate a Glasgow IO table corresponding to the 128 sectors of the Scottish IO table, with further disaggregation of the education sector to represent each HEI individually. Once the Glasgow IO table had been estimated and balanced it was aggregated to 25 sectors to allow for easier presentation and interpretation.

¹³ See for example Miller & Blair (1985, pp. 296). Since this paper is a first report of ongoing work to develop a model of the Glasgow City economy (in order to estimate the impacts of local HEIs) and the research agenda envisages developing subsequently more sophisticated models to compare their results, the simplest technique available was seen as a natural starting point – even though further developments may reveal its deficiencies.

¹⁴ However Glasgow City counts only about 11% of the Scottish population, which suggests substantial in-commuting. Indeed the Glasgow conurbation is estimated to hold approximately 1.7 million inhabitants.

¹⁵ The Scottish input-output table for 2004 has been rolled forward to 2006 volumes and prices. The table was developed for use in ESRC funded project overall impact of HEIs, and has a special row and column for each of the Scottish HEIs.

Following is a step by step account of the methods used to derive the Glasgow IO table:

1. Estimate sector gross output totals
2. Estimate primary inputs
3. Estimate technical coefficients
4. Estimate final demands
5. Balancing the table

Step 1: Sector gross output totals for Glasgow

Sector gross output totals were estimated following the method of Riddington et al (2004) where employment data are used to disaggregate the national output information from the Scottish input output table:

$$Q_i^G = Q_i^S \left[\frac{E_i^G}{E_i^S} \right]$$

Where Q_i^G and Q_i^S refer to output of sector i in Glasgow and Scotland respectively and E_i^G and E_i^S denote employment in that sector at the two geographical levels. Under this method if for instance 20% of Scottish wide employment in a particular sector is located in Glasgow, then Glasgow's gross output total is 20% of the Scottish gross output total for that sector.

Step 2: Sector primary inputs for Glasgow

With the gross output totals known, these need to be split between intermediate and primary inputs. This allocation was based on the assumption that Glasgow firms have the same needs for inputs as Scottish firms in general. Therefore if 10% of the inputs to a particular sector at a Scottish level were compensation of employees then this was assumed to hold for Glasgow as well. The primary inputs estimated in this way were: Imports from Rest of UK, Imports from Rest of World, Taxes on products, and Taxes less subsidies on production, Compensation of employees and Gross operating surplus. More formally this can be written as:

$$P_{ji}^G = P_{ji}^S \left[\frac{E_i^G}{E_i^S} \right]$$

Where P stands for primary input of source j (labour, other valued added, etc.) into sector i, for Glasgow (G) and Scotland (S) and E stands for employment in sector i in Glasgow and Scotland.

Step 3: Technical coefficients for Glasgow

Having estimated primary input values from step 2 and gross input/output values from step 1, the difference can be attributed to sector intermediate purchases. We assume for each Glasgow production sector that the structure of its purchases is the same as for Scottish firms. This assumption is necessary as we don't have purchasing information available at the local level.

This provided estimates of purchases by Glasgow firms, but they need to be split between purchases from other Glasgow-based firms and purchases from firms based in the Rest of Scotland.

To estimate Glasgow firms' purchases of inputs from other Glasgow-based firms, we took the Glasgow firms' purchases from each sector, and multiplied this by the sectors simple location quotient.

The remainder is allocated as imports from the Rest of Scotland (outside the Glasgow area).

This process was repeated for all the intermediate purchases by Glasgow firms to estimate intra-Glasgow purchases and those intermediate imports from the rest of Scotland.

Step 4: Final demand totals

For the Glasgow Input-Output table we need to estimate final demand that occurs within the Glasgow economy. A simple procedure was used to estimate final demands for the Glasgow economy. For all final demand categories (except exports to the rest of Scotland) it was assumed that demand for each sector was proportional to the share of Scotland wide employment in that sector found in Glasgow. More elaborate methods were not seen to add much value for the purposes of the impact study as input/output totals have already been determined this way and by definition final demand needs to support that output. For the purposes of the impact study no

additional value is seen in potentially more accurate estimates of the origin of final demand.

Step 5: Balancing

The rows and columns of the table were balanced via imports and exports from the rest of Scotland. Firstly row and column totals were compared so that any demand deficiencies were entered as export demand from the rest of Scotland. Any remaining imbalances where column totals exceed row totals can not be balanced via ROS exports as that would imply negative exports. Instead imports from ROS were decreased so that total inputs would equal total outputs.

Glasgow City IO

The Glasgow Input Output table was based on a previously estimated Input Output table of Scotland (Scottish Government, 2007), which had been augmented with detailed information about the spending of Scottish HEIs. This included information from JCAPC¹⁶, which showed the import propensity of Scottish HEIs to be 10.8%. As can be seen from the table below all sectors show substantially lower output multiplier values for Glasgow than for Scotland; this is in line with what was expected. When we move to the smaller scale of Glasgow we see a more open economy. Fewer demands can be satisfied within Glasgow council limits than within the whole of Scotland so at that level we see more imports. In addition to imports from rest of the world and rest of the UK, Glasgow sectors import from the rest of Scotland. Conversely less output can be sustained within Glasgow than from the whole of Scotland so sectors are more export dependent at the Glasgow level. Again they export to the rest of Scotland in addition to the rest of the UK and rest of the world.

We can also see that in comparison to most other sectors Glasgow's HEIs source a large share of their inputs from within the city limits and therefore show a relatively large output multiplier. This is due to the cost structure of HEIs, where a large proportion of expenses are the compensation of employees, which usually reside locally¹⁷.

¹⁶ Purchasing consortium of HEIs in Scotland and Wales.

¹⁷ However it must be noted that in this analysis it is assumed all employers spend their wages within Glasgow city limits. This causes an upwards bias to all output multipliers.

Table 4: Income-expenditure profiles of Glasgow HEIs in IO accounts

	£ m.	Glasgow Caledonian University	Glasgow School of Art	The University of Glasgow	The Royal Scottish Academy of Music and Drama	The University of Strathclyde
Final demand	Intermediate demand	3	0	8	0	5
	Households	11	2	34	1	22
	Public	56	9	165	6	104
	Exports	28	4	104	3	59
	Total demand for products	98	16	312	10	191
Final demand	Intermediate demand	3%	3%	3%	3%	3%
	Households	12%	12%	11%	12%	11%
	Public	57%	58%	53%	57%	55%
	Exports	12%	12%	11%	12%	11%
	Total demand for products	100%	100%	100%	100%	100%

Table 5: Comparison of multiplier values and import propensities for Glasgow and Scotland Input-Output tables

	Glasgow IO table			Scotland IO table		
	Output		Import propensity	Output		Import propensity
	multipliers			multipliers		
	Type I	Type II	Type I	Type II		
Primary	1.03	1.45	58%	1.54	2.47	27%
Food drinks and tobacco manufacturing	1.05	1.63	58%	1.47	2.37	37%
Textiles, wood and paper	1.03	1.76	57%	1.39	2.39	38%
Printing and publishing	1.03	2.03	40%	1.25	2.55	26%
Chemicals, Rubber, plastic, glass and metal	1.03	1.89	52%	1.44	2.45	35%
Production of machinery, transport equipment and consumer products	1.03	1.92	45%	1.29	2.22	37%
Utilities	1.11	1.38	59%	2.00	2.69	14%
Construction	1.05	1.77	48%	1.53	2.71	16%
Distribution and retail	1.05	1.93	35%	1.35	2.56	15%
Hotels, Catering, Pubs, etc	1.02	2.16	19%	1.16	2.55	11%
Transport	1.07	1.77	56%	1.56	2.74	20%
Post and communications services	1.05	1.93	33%	1.30	2.56	15%
Banking and financial services	1.11	1.52	51%	1.58	2.39	20%
House letting and real estate services	1.04	1.21	24%	1.35	1.79	6%
Business services	1.06	2.03	37%	1.37	2.72	17%
Public administration	1.06	1.85	46%	1.39	2.55	24%
Public services	1.04	2.19	29%	1.27	2.80	13%
Education other	1.01	2.79	15%	1.16	3.21	8%
Glasgow Caledonian University	1.04	2.50	27%	1.28	3.10	11%
Glasgow School of Art	1.04	2.51	26%	1.27	3.11	11%
The University of Glasgow	1.05	2.45	29%	1.32	3.10	11%
The Royal Scottish Academy of Music and Drama	1.05	2.44	29%	1.32	3.10	11%
The University of Strathclyde	1.05	2.40	31%	1.36	3.10	11%
Recreational services	1.06	1.85	42%	1.41	2.64	17%
Other services and self employed	1.02	2.63	13%	1.12	3.04	5%

HEIs Shutdown Simulation

The Glasgow City Input Output table was used to simulate the local impacts of its HEIs by a method of hypothetical extraction¹⁸. It is assumed that the institutions are shut down completely. This involves two steps, nullifying final demand for their services and their intermediate outputs. The first implies that an amount equal to the output impact of the HEIs is lost from the Glasgow economy. If a similar process was carried out for all sectors the total impact would equal total output of the Glasgow economy. The second step creates a further loss as output from the HEIs is not available as input for other sectors.

Table 6: Economic impact of “shutting down” Glasgow HEIs

University	Output impact £m.	
	Glasgow	Scotland
Glasgow Caledonian University	161	206
Glasgow School of Art	26	33
The University of Glasgow	510	663
The Royal Scottish Academy of Music and Drama	17	22
The University of Strathclyde	308	409
Total	1,022	1,333

The total impact of Glasgow HEIs within the Glasgow economy is estimated at around 1,000 £ m. while the impact on the economy of Scotland as whole is estimated at 1,333 £ m. The input-output table estimates total output of the Glasgow City economy at around 30£ b., thereof HEIs support approximately 3.4%.

The total output impact of Glasgow HEIs on the Scottish economy is fairly robust in the sense that it is based on a surveyed Input-Output table. However our estimation for the part of that which is realised entirely within the Glasgow City economy should be seen as more roundabout since it is based on an estimated table. We hope to subsequently improve the accuracy of this estimate as we incorporate more “first hand” data to augment the Glasgow Input-Output table.

¹⁸ This is identical to the shutdown simulation conducted by the same authors in a paper on the impact of HEIs on Scotland. For details of the methodology and the Scotland wide results see: The Economic Impact of HEIs on Scotland.

Student impacts

In order to calculate the impact of student expenditure we had to generate a column of final demands that corresponds to the expenditure of students that would not take place in the absence of a particular institution. The assumption being made is that students from Scotland, the rest of the UK and rest of the World would not study in Glasgow had the university not been there. Therefore we hypothetically extract their expenditure. The student expenditure is allocated to IO sectors in accordance to the column coefficients that were estimated by Kelly et al (2004). As a proxy for student expenditure in Glasgow we use a student expenditure survey available for Scotland in the year 2004/2005 (Scottish Government, 2007 B). There the average expenditure is estimated to be £6,604 for full time student¹⁹. In order to derive the impact of student expenditure we need the total number of students for each university. The implicit assumption here is that these students would not choose another Glasgow university but they would study outside the city if their institution of study did not exist. So, the estimated annual expenditure per student is multiplied by the total number of students in order to give us the total student expenditure which is an injection to the local economy due to the presence of the university.

There are two technical points to be made here. Like other data from HESA, student expenditure is treated as though it is occurring over the calendar year, although it is actually taking place over the academic year. In addition the figure of £6,604 has to be adjusted for inflation, which brings it to £ 6,756 (inflation in 2006 was 2.30%).

Furthermore, we need to make some additional assumptions about how student expenditure takes place. There will be some initial leakage as a proportion of their expenditure will be direct imports. The remainder will then constitute final demand for Glasgow sectors (where additional leakage will occur) as determined by the student expenditure vector. A precise estimate is unfortunately not available for student expenditure in Glasgow so we conduct the simulation assuming both 32% import

¹⁹ This is £ 2,168 less than students in England and Wales spend according to a survey conducted by the National Centre of Social Research and the Institute of Employment. However the Scottish estimate is based on less elaborate and robust survey methods and therefore we shall explore alternative assumptions of student spending in sensitivity analysis. Whereas the study of England and Wales is based upon day to day spending diaries in addition to a survey the study of Scotland relies on survey data only.

propensity, which is equal to that of household spending in the official Scottish IO table.

Table 7: Glasgow’s student population

University				Origin			
	Scotland	RUK	ROW	Total	Scotland	RUK	ROW
Glasgow Caledonian University	14,970	855	1,220	17,045	88%	5%	7%
Glasgow School of Art	820	435	300	1,555	53%	28%	19%
The University of Glasgow	18,630	2,540	2,420	23,590	79%	11%	10%
The Royal Scottish Academy of Music and Drama	440	130	110	680	65%	19%	16%
The University of Strathclyde	21,535	985	2,585	25,105	86%	4%	10%
	56,395	4,945	6,635	67,975	83%	7%	10%

The impacts of student expenditure are shown below. Again the size of the impacts reflects relative student numbers.

Table 8: Spending impact of students at HEIs in Glasgow, £ m.

University	Origin				
	Scotland	RUK	ROW	Total	Non Scottish only
Glasgow Caledonian University	90	5	7	102	12
Glasgow School of Art	5	3	2	9	4
The University of Glasgow	112	15	15	141	30
The Royal Scottish Academy of Music and Drama	3	1	1	4	1
The University of Strathclyde	129	6	16	151	21
Total	338	30	40	408	69
<i>% of total output in Glasgow</i>	<i>1.1%</i>	<i>0.1%</i>	<i>0.1%</i>	<i>1.4%</i>	<i>0.2%</i>

In the impact results above we count all the output that can be attributed to spending of students in Glasgow HEIs. In the case of students from the rest of the UK and the rest of the world it is clear that if the HEIs weren’t there, they wouldn’t be in Glasgow and therefore the impact of their spending wouldn’t be felt. However in the case of Scottish students it is an open question if they would be living and spending money in the City of Glasgow in the absence of these institutions and therefore if their impact can be attributed to the existence of the HEIs. It is quite conceivable that some of the current students would simply have entered the labour market or sought unemployment benefits had the HEIs not been there and yet it is quite likely that others might have decided to study elsewhere, either at neighbouring Scottish institutions, in the rest of the UK or the rest of the world. Deriving a credible estimate of the

proportions of the two groups is not feasible. There we will explore possible scenarios in a sensitivity analysis.

Total spending impact on the City of Glasgow

As can be seen from the table below the spending of Glasgow HEIs and their staff constitutes roughly two thirds of the impact on the cities output with just under a third sustained by spending of the student population. However, as we will see the impact of student spending is quite sensitive to the assumptions it is based on.

Table 9: Total output and GDP impact of Glasgow HEIs

University	Output			GDP		
	Institutions and staff spending	All student spending	Total	Institutions and staff spending	All student spending	Total
Glasgow Caledonian University	161	102	264	102	57	159
Glasgow School of Art	26	9	36	17	5	22
The University of Glasgow	510	141	651	314	79	393
The Royal Scottish Academy of Music and Drama	17	4	21	10	2	13
The University of Strathclyde	308	151	458	184	84	269
Total	1,022	408	1,430	628	228	856
<i>% of total output/GDP</i>	<i>3.4%</i>	<i>1.4%</i>	<i>4.8%</i>	<i>4.1%</i>	<i>1.5%</i>	<i>5.6%</i>

Sensitivity analysis

It is difficult to anchor some of the key assumptions of the preceding simulation without conducting expensive surveys explicitly for that purpose. We shall attempt to compensate for this lack of robustness of the assumptions by examining how sensitive our results are to their changes.

The figure for student spending is based on a survey of students in Scotland. This is without a doubt the best information available. However when compared to a study of student spending in England and Wales for the same period (Finch et al, 2006) it appears that Scottish students spend £ 2,168 less than students in England and Wales. This might well be the case; however, the Scottish estimate is based on survey data only whereas the study of England and Wales is based upon day to day spending diaries in addition to a survey.

We have accurate data on the number of students at Glasgow's HEIs. We know that students who move to the city especially to study are a net addition to local demand. For this we have accurate data on students coming from abroad and the rest of

the UK. However, it is more difficult to determine how big a proportion of Scottish students would not reside in Glasgow if it weren't for the HEIs. First of all, we do not have information on the number of Scottish students from outwith Glasgow who move to the city to study. Secondly it is an open question if the Glaswegians studying at the city's HEIs can be taking for granted. The absence of tuition gives an incentive to stay in Scotland, however at a sub-regional level there are limited hindrances for students to attend neighbouring HEIs if the competitiveness of Glasgow or its HEIs were to deteriorate. Here we only assess the sensitivity of number of students upon the impact of student spending. However, if the number of students at HEIs were to fall so would the institutions spending due to the link between student numbers and funding.

Table 10: Sensitivity analysis of student impacts

Variable	Optimistic		Base value		Pessimistic
Student spending £	8,525	7,641	6,756	5,872	4,987
Student spending initial leakage	23%	27%	32%	37%	42%
% of Scottish domiciled students who stay in Glasgow because of the HEIs	100%	100%	100%	50%	25%

Impact £ m.	Optimistic		Base value		Pessimistic
Student spending	514	461	408	354	301
Student spending initial leakage	461	436	408	379	346
% of Scottish domiciled students who stay in Glasgow because of the HEIs	408	408	408	239	154

As can be seen from the table above new information about spending behaviour could significantly affect the output impact of student spending. For instance if we take a pessimistic stance and assume we have overestimated the amount of spending per student the impact could be reduced by £ m. 107 from base value. Similarly if we take the view that spending leakage is underestimated this could reduce the impact by £ m. 62.

The output impact of student spending is however most sensitive to the number of Scottish students counted as a source of additional demand in the Glasgow economy. It is extremely difficult to make meaningful assumptions as to where these people would reside if there were no HEIs in Glasgow. Some might not have pursued higher education and entered the Glasgow labour market instead – therefore they should not be counted as additional impact on the Glasgow economy. Others however might have moved to enrol at HEIs further away. Even without taking onboard the unrealistic

counterfactual of a complete shutdown of the HEI sector in Glasgow it might well be expected that the student population could decrease at some point. A 1% reduction in the number of Scottish domiciled students in Glasgow would result in 563 fewer students in the city and a loss of output amounting £ m. 3.4. A 25% decline in student numbers would therefore result in lost output amounting to £ m. 85.

5. Conclusion

In this paper we have explored the impacts of HEIs on the Glasgow City Economy as well as the impacts of the expenditure of students. Glasgow universities employ 10,000 staff, which amounts to approximately 2.5% of total employment in the city. Furthermore they retain students within the city and attract a considerable number of outside students. In order to estimate these impacts we have used location quotients to construct an Input –Output table for Glasgow for the year 2006 where we have treated HEIs as separate sectors. Our estimates show that the (Type 2) impact of Scottish universities is approximately £1.4bn. Furthermore the impact of (all) student expenditure is estimated to be £ 408m. As was expected impacts of individual institutions are closely related to their size in terms of funding, while the order of impacts of student expenditure depends on the number of students attending. Output impacts of individual universities range from £17m for the RSAMD to £510m for the University of Glasgow. Output impacts of student expenditure for individual universities range from £4m for the RSAMD and to £141m for the University of Strathclyde. The impact of the HEIs accounts for approximately two thirds of the total output impact while student spending is just under a third.

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Appendix: Spatial interactions of Glasgow HEIs

So far we have analysed the impact of Glasgow HEIs solely as a source of demand for the economy of Glasgow City. However, the interactions of HEIs with local and regional economies over space are more complex. Recently obtained data allows us to present a spatially disaggregated description of the direct impact of Glasgow's HEIs. This is a prerequisite for further stages of the research project where we intend to analyse the demand impact in a multiregional framework and simulate supply side impacts in a GGE model.

We will begin by examining how Scottish domiciled students are distributed among UK HEIs. Then we will examine the origins of students at HEIs in Glasgow and use results from HESA²⁰ Destination of Leavers from Higher Education survey to obtain an indication of where the students head to after graduation. Finally we will use accounting data from Strathclyde University to show how its direct spending impact is distributed over space.

Table 11: Higher education students of Scottish domicile

HEIs	Full time students		Headcount	
The University of Glasgow	12,993	12%	17,017	11.8%
The University of Strathclyde	12,780	12%	17,659	12.2%
The University of Edinburgh	9,779	9%	11,192	7.7%
Glasgow Caledonian University	9,165	8%	11,060	7.6%
The University of Dundee	8,383	8%	9,368	6.5%
The University of Aberdeen	7,683	7%	9,043	6.2%
Napier University	6,606	6%	8,597	5.9%
The University of Paisley	5,740	5%	10,454	7.2%
The Robert Gordon University	5,586	5%	6,519	4.5%
The University of Stirling	5,515	5%	6,846	4.7%
Heriot-Watt University	3,403	3%	4,355	3.0%
Bell College	2,854	3%	5,026	3.5%
UHI Millennium Institute	2,836	3%	3,469	2.4%
University of Abertay Dundee	2,408	2%	2,663	1.8%
The University of St Andrews	2,273	2%	2,591	1.8%
Queen Margaret University, Edinburgh	2,193	2%	3,639	2.5%
Glasgow School of Art	644	1%	790	0.5%
Edinburgh College of Art	591	1%	792	0.5%
Scottish Agricultural College	587	1%	689	0.5%
The Royal Scottish Academy of Music and Drama	438	0%	444	0.3%
Other	6,710	6%	12,541	8.7%
Total	109,167	100%	144,754	100.0%

²⁰ Higher Education Statistics Agency.

The table above is based on HESA's student database and shows the distribution of Scottish domiciled students among UK HEIs. As can be seen from the table 94% of full time students attend HEIs within Scotland. If all active students are included we see that 91% attend HEIs within Scotland. To a great extent this difference is due to a large number of Scottish part time students attending the Open University.

Table 12: Number of students at HEIs in Glasgow by domicile

Origin	Caledonian	GSA	RSAMD	Glasgow	Strathclyde	All HEIs	%
Glasgow City	2,663	194	82	4,419	4,308	11,666	19%
Rest of Scotland	8,293	582	353	12,338	12,879	34,445	56%
Scottish Borders	50	17	3	141	88	299	0%
Central	403	34	18	662	681	1,798	3%
Dumfries and Galloway	157	11	7	478	284	937	2%
Fife	142	17	21	359	201	740	1%
Grampian	199	41	28	606	385	1,259	2%
Highland	219	17	22	454	436	1,148	2%
Lothian	329	95	57	1,124	617	2,222	4%
Orkney Islands	20	1	1	27	28	77	0%
Shetland Islands	19		3	44	32	98	0%
Strathclyde, (Rest of)	6,623	341	171	8,174	9,900	25,209	41%
Eilean Siar	70	1	4	98	105	278	0%
Tayside	62	7	18	171	122	380	1%
Rest of UK	604	460	143	2,559	799	4,565	7%
Channel Islands	4			14	2	20	0%
England	263	394	115	1,722	477	2,971	5%
Isle of Man	3	1	1	5	3	13	0%
N-Ireland	306	61	23	760	302	1,452	2%
Wales	28	4	4	58	15	109	0%
Rest of world	1,580	471	144	4,093	4,662	10,950	18%
Total	13,140	1,707	722	23,409	22,648	61,626	100%

The table above was constructed using data for the year 2006 from HESA's student database. Home address post codes were used to disaggregate the number of higher education students in Glasgow according to local authority of origin. The above numbers are based on all full time, part time and sandwich students. From the table it is clear that HEIs in Glasgow draw heavily on students from the West of Scotland. Of the roughly 61,000 students counted here approximately 20% come from Glasgow City and 40% from the rest of the Strathclyde area. Students from other regions in Scotland make up 16% of the attendance while 7% come from the rest of the UK and 18% from abroad. It is reasonable to assume that 60-65% of the student population lives within a commutable distance of the HEIs²¹.

²¹ Approximately an hours travel by public transport.

Student term time accommodation

Our dataset does not allow us to track where students stay during their period of study. However we are able to see in what type of accommodation they live. In broad terms about half of Scottish domiciled students seem to live on their own during their period of study at Glasgow's HEIs while just under half stays at home. Although information on where students living independently chose to reside is not available it seems a fair expectation that they are more concentrated in Glasgow City than in surrounding commuter towns, due to willingness to stay close to the institution of study and student amenities.

Table 13: Term time accommodation of Scottish students at Glasgow HEIs

Term time accommodation	Caledonian	GSA	RSAMD	Glasgow	Strathclyde	Total	%
Institution maintained property	250	60	20	934	823	2,067	4.4%
Other/Not known	830	236	37	1,216	1,238	3,964	8.4%
Own home/Private rental	3,390	252	192	8,942	7,746	20,330	43.3%
Parental/Guardian home	6,590	242	195	5,925	7,852	20,609	43.9%
Total	11,060	790	444	17,017	17,659	46,970	100.0%

Table 14: Term time accommodation of all students at Glasgow HEIs

Term time accommodation	Caledonian	GSA	RSAMD	Glasgow	Strathclyde	Total	%
Institution maintained property	492	291	79	2,351	2,019	5,213	8.4%
Other/Not known	1,305	619	90	2,476	1,996	6,999	11.3%
Own home/Private rental	4,201	535	338	12,540	10,323	27,745	44.9%
Parental/Guardian home	7,142	262	214	6,042	8,310	21,775	35.3%
Total	13,140	1,707	722	23,409	22,648	61,732	100.0%

When we look at the entire student population we see that about 35% stay at home, while 53% are recorded to be living independently. That number can be revised upwards at least about 3 percentage points, as we can safely assume that the vast majority of students coming from further afield, whose accommodation type we do not have specific knowledge about are living on their own. If the remainder of the cohort we don't have specific information about is split proportionately among the two groups we can conclude that approximately 40% of the students at Glasgow HEIs stay at home while about 60% live independently.

Destination of leavers

UK graduates of HEIs are surveyed on their employment status six months after leaving their institutions of study. Result for the Glasgow HEIs, for the year 2005-2006 give an indication of where the graduates head upon completing their degrees. Although we

cannot see what happens subsequently in their carriers, 92% of new graduates are retained within Scotland and 70% within the Strathclyde area in the months immediately following graduation.

Table 15: Destination of leavers 6 months after graduation

	Caledonian	Glasgow	GSA	Strathclyde	RSAMD	Total
Glasgow City	49.8%	42.3%	49.6%	36.1%	44.8%	41.7%
Rest of Scotland	44.7%	50.1%	39.3%	55.2%	47.1%	50.7%
Borders	0.0%	0.1%	0.0%	0.1%	0.0%	0.1%
Central	3.2%	3.2%	0.0%	3.7%	0.0%	3.3%
Dumfries and Galloway	0.9%	2.8%	3.0%	1.7%	4.6%	1.9%
Fife	1.9%	1.9%	3.0%	1.3%	1.1%	1.7%
Grampian	2.8%	5.1%	0.0%	4.0%	1.1%	3.9%
Highland	1.0%	1.5%	0.0%	0.9%	0.0%	1.1%
Lothian	5.3%	6.4%	4.4%	7.2%	3.4%	6.4%
Orkney	0.0%	0.1%	0.0%	0.1%	0.0%	0.1%
Strathclyde (Rest of)	27.2%	28.3%	15.6%	30.4%	16.1%	28.6%
Tayside	0.5%	0.6%	0.7%	1.3%	2.3%	0.9%
Western Isles	0.2%	0.2%	0.0%	0.4%	0.0%	0.3%
Scotland, undisclosed	1.5%	0.0%	12.6%	4.0%	18.4%	2.5%
RUK	3.8%	3.8%	6.7%	5.3%	3.4%	4.5%
Channel Islands (The)	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
England	3.6%	3.5%	5.2%	5.1%	3.4%	4.2%
Northern Ireland	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Wales	0.0%	0.3%	1.5%	0.1%	0.0%	0.2%
ROW	1.7%	3.8%	4.4%	3.4%	4.6%	3.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Spatial disaggregation of HEI spending

Only a part of the direct spending of the HEIs will occur within Glasgow City limits. No published data is available that details this. However the University of Strathclyde purchasing department has provided data on non-staff purchasing expenditure, which reveals commodity type and supplier location. This allows a further degree of accuracy as it's possible to determine the distribution of direct spending within and outwith the geographic boundaries of the impact assessment. Furthermore we were provided with data on staff domicile so we were able to spatially disaggregate the Universities staff expenditure.

Table 16: Salaries payments by the University of Strathclyde

Domicile of recipient	Salaries paid	% of total
Glasgow City	41,888,009	40.1%
Rest of Scotland	55,373,458	53.0%
Scottish Borders	119,972	0.1%
Central	4,620,792	4.4%
Dumfries and Galloway	89,819	0.1%
Fife	276,094	0.3%
Grampian	317,650	0.3%
Highland	96,647	0.1%
Lothian	4,036,235	3.9%
Strathclyde (Rest of)	45,406,511	43.5%
Eilean Siar	25	0.0%
Tayside	409,713	0.4%
Rest of UK	3,591,340	3.4%
Unidentified	3,534,200	3.4%
Total	104,387,008	100.0%

As can be seen from the table above 83% of all salaries paid by the University of Strathclyde are received within the Strathclyde area. Significant amounts are paid to staff residing in the Central and Lothian areas, many of which commute into Glasgow on a regular basis. A small fraction resides further afield in Scotland and about 3% in the Rest of the UK. Another 3% could not be identified at a post code level. For the University of Strathclyde 60% of expenditures is on wages (61-65% for other Glasgow HEIs). Based on the salaries data alone it can therefore be seen that at least 50% of direct impact of Strathclyde University is felt within Glasgow City and the surrounding commuter belt within the Strathclyde area. We have no reason to believe this pattern is significantly different for other HEIs in the city.

Table 17: University of Strathclyde purchases in 2007

Location of supplier	Expenditure	% of total
Glasgow City	13,302,602	25.3%
Rest of Scotland	14,880,238	28.3%
Scottish Borders	91,440	0.2%
Central	788,411	1.5%
Dumfries and Galloway	18,936	0.0%
Fife	449,983	0.9%
Grampian	47,126	0.1%
Highland	104,850	0.2%
Lothian	4,486,208	8.5%
Shetland	15,240	0.0%
Strathclyde (Rest of)	8,713,994	16.5%
Tayside	164,050	0.3%
Rest of UK	22,133,969	42.0%
Unidentified	2,353,209	4.5%
Total	52,670,018	100%

Based on purchasing data we can see that the spending of the University of Strathclyde is quite concentrated on suppliers within the Strathclyde area, with 25% of the purchases being from suppliers within Glasgow City and 17% within the rest of Strathclyde. 11% of purchases are made from Scottish suppliers outside Strathclyde, mostly from greater Edinburgh (Lothian area). However this data is not sufficient by itself to proxy the intermediate consumption of Strathclyde University as we do not know the input structure of the suppliers.

Implications for model development

From the above it is evident that a great deal of interactions over space driven by the HEIs occurs between Glasgow City and the rest of the Strathclyde area. This includes students moving into Glasgow from surrounding areas for study, the HEIs employing staff residing outside the city and sourcing inputs from suppliers. To a lesser extent similar dynamics can be observed between the HEIs in Glasgow and areas in the rest of Scotland outside Strathclyde.

This implies that Glasgow City is a too narrow geographical definition for the impact study, as a considerable portion of the imports and exports are in fact between Glasgow and its suburbs. In a two region model of Glasgow City and the rest of Scotland, the cities HEIs would be shown to have a significant impact upon the rest of Scotland, which could be a misleading label as a big part of it is in fact realised just outside the city council limits.

A second option would be to construct a two-region model based on Strathclyde²² and the rest of Scotland. This would have the benefit of showing a more “natural” divide between the impact on Glasgow City and its surrounding area on the one hand and the impact upon the rest of Scotland (further afield) on the other. This definition would relieve the need to model flows between Glasgow and its periphery and thus be less data intensive. However, this would mask the significant interdependencies between Glasgow City and its surrounding communities.

Optimally therefore, we would like to construct a three region model consisting of Glasgow City, the rest of Strathclyde and the rest of Scotland. This would best allow us to capture separately the impacts of HEIs in the area upon the three regions.

In section four we discuss the inherent weakness of using a Location Quotient based IO table, over a surveyed one, in that you risk overstating local impacts. That

²² Possibly of modified boundaries to omit the most outlying councils.

problem is mitigated by moving to a multi-regional IO table. In such a framework the impact on individual sub regions should add up to equal that upon Scotland as a whole and therefore the estimated impact upon Scotland (based on a surveyed IO table) can be used as a benchmark. Any errors caused by the LQ method would then result in a skewed attribution of the impact between the sub-regions rather than an overstatement of the overall estimated demand impact.