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Regional Impact Analyses and the Appropriate Treatment of public budget constraints under devolution: An application to Scottish Higher Education Institutions (HEIs)

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Regional impact analyses and the appropriate treatment of public budget constraints under Devolution: An application to Scottish Higher Education Institutions (HEIs)

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Abstract

"Policy scepticism" has developed about regional impact studies of HEIs, based on notions of either resource- or budget constraints. This paper provides a systematic critique of this policy scepticism. While the extreme form is rejected the importance of a binding public-sector budget constraints under devolution is recognised. The HEIs sector's impact is estimated net of public funding by breaking impacts down by funding source. Results suggest that conventional impact studies overestimate the expenditure impacts, but they also demonstrate that the policy scepticism that treats these as irrelevant neglects some important aspects of HEIs, in particular their export intensity.

Keywords: Higher education, Input-Output, Scotland, Impact study, Multipliers, Devolution.
JEL classifications:
R51 (public) Finance in Urban and Rural Economies
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1. Introduction

There have been numerous studies of the impact of HEIs on their host regions, which focus solely on their effect on the local demand for goods and services[1]. The best of these studies employ regional input-output analyses. However, there has developed a "policy scepticism" about the value of such analysis based on notions of either demand-side (binding budget constraints) or supply-side (binding resource constraints) "crowding out", to the point where the demand side impact of HEIs has come to be regarded as negligible. This paper provides a systematic critique of this policy scepticism. While the extreme form of policy scepticism is rejected the importance of binding public sector budget constraints under devolution is acknowledged and the argument made that such constraints should be accommodated in future studies. The analysis focuses on the HEI sector's impact net of its public income. This is accomplished by disaggregating the impact attributable to HEIs by its source, using a modified HEI-disaggregated input-output model of Scotland. The results suggest that conventional impact studies do overestimate the impact of HEIs. But importantly, the results also demonstrate that the policy scepticism that treats the expenditure effects of HEIs as irrelevant neglects some important impacts of these institutions, in particular their export intensity.

This case is illustrated through an application to Scotland, which is a UK-region with a large higher education sector and partially devolved fiscal responsibilities. The study of HEIs in Scotland is particularly well suited to demonstrate qualifications to common practice in regional multiplier studies for three reasons: Scotland's devolved status imposes a binding public sector expenditure constraint at the regional level; the variety of spatial origins of HEIs' income motivates a fresh look at the composition of their impact, and the availability of relevant data for the Scottish economy and Scottish HEIs allows a degree of confidence in the results that is more difficult to replicate for other regions in the UK. However, it should be emphasised that the analysis is generally applicable to all impact studies of regions with a devolved budget.

The analysis of HEI impacts is based upon an augmented Input-Output (IO) analysis for Scotland in which the higher education sector is separately identified[2]. Impact results are derived based on standard IO assumptions. However, it is also considered how the standard IO assumptions,

[1] However, perhaps the most important economic impacts of HEIs are those affecting the supply side through for example skills in the labour market, knowledge effects and wider external benefits, which have hitherto not been qunatified to the same extent as demand-side impacts. We turn our attention to these in Hermannsson et al (2010b).

[2] For details of the construction of the Input-Output table, the derivation of the income and expenditure structure of the HEIs sector and the data sources used see Hermannsson et al (2010c).

and current practice, have to be modified to accommodate the binding budget constraint of the Scottish Parliament.

The remainder of the paper is structured as follows. In Section 2 the conventional assumptions of regional HEI impact studies are outlined the results that the implementation of this approach yields discussed using a new HEI-disaggregated IO database. Section 3 explores the "policy scepticism" that has arisen. It is attributed to two broad sources: an acknowledgement of a resource constraint on the supply-side and a public budget constraint on the demand-side. It is argued that the traditional "Green Book perspective" of complete supply-side crowding out of regional expenditure is not applicable to the context of a single devolved region. Indeed, at the regional level the passive supply-side assumptions required to motivate the use of Input-Output analysis may apply in the longer term. Section 4 shows how an Input-Output framework can be applied to take account of the regional budget constraint. Brief conclusions are presented in Section 5.

2. Conventional regional impact analyses

Regional impact analyses are frequently employed to capture the total spending effects of institutions, projects or events. In addition to simply identifying the direct spending injection of the studied phenomenon, multiplier, or "knock-on", impacts are estimated by summing up subsequent internal feedbacks within the economy[3]. Impact analyses are in frequent use worldwide and are far too numerous to document (though see Loveridge (2004) for a review). This section briefly outlines the methods adopted by impact studies. Based on the typical assumptions made in the literature the regional demand-side impacts of the HE sector on the Scottish economy is derived for 2006.

Most regional demand-driven models (e.g. Export base, Keynesian multiplier, Input-Output) view the economy in terms of two parts, exogenous and endogenous. Exogenous variables in these models are taken to be independent of the level of activity of the relevant economy. Specifically intermediate demand and usually consumption demand is taken to be endogenous. Other elements of final demand (exports, government expenditure, investment) is taken to be exogenous[4]. There is then a clear causal pathway from exogenous to endogenous expenditure.

[3] For an overview of the methodology of impact studies and regional multipliers see e.g.: Miller & Blair (2009), Armstrong & Taylor (2000).

[4] The distinction between endogenous and exogenous activity depends on the model and the application. In particular, what is exogenous and what is endogenous to the model does not have to correspond with what is 'inside' and what is 'outside' the region in spatial terms.

In addition to assumptions about the demand-side, interpreting the results of these demand driven models rests on certain assumptions about the operation of the supply-side of the economy[5]. At the regional level, conventional multiplier analyses can be validated by either of two sets of conditions. In the short and medium runs this would be where there is general excess capacity and regional unemployment. In the long-run it could prevail where factor supplies effectively become infinitely elastic, as migration and capital accumulation ultimately eliminate short-run capacity constraints (McGregor *et al,* 1996)[6]. A more detailed discussion of these assumptions can be found in Appendix II.

The derivation of the multipliers draws on the notion of exogenous income driving endogenous activity (Appendix II). In the standard Leontieff Input-Output approach total activity within the economy can be described in terms of an identity where total output equals final demand, (exogenous) times multipliers as represented by the Leontieff inverse, which determines the level of endogenous activity. This can be summarised as:

$$\boldsymbol{q_i = (1 - A)^{-1} f_i} \qquad \textbf{Equation 1}$$

where $\boldsymbol{q}_i$ is a vector of gross outputs, $\boldsymbol{f}_i$ is a vector of final demands and $\mathbf{(1\text{-}A)^{-1}}$ is the Leontieff inverse. The output multiplier for each sector can be found as the sum of columns of the Leontieff inverse. This allows a convenient expression for the gross output q_i attributable to each sector i and how it is composed of exogenous final demand f_i and knock-on impacts as described by the relevant output multiplier l_i,:

$$\boldsymbol{q_i = l_i f_i} \qquad \textbf{Equation 2}$$

Multipliers can be derived to relate a variety of activity outcomes, such as employment, income, output or GDP, to exogenous changes in demand. Although a number of variants can be applied the, Type-I and Type-II demand driven multipliers used here are typical for Input-Output based impact studies. Type-I multipliers incorporate the increase in demand from intermediate inputs.

[5] Essentially, the supply-side needs to be passive and respond linearly to any exogenous demand increase.

[6] The nature of the regional economy affects the feasibility of such an assumption. One can think of limiting cases such as for the island economy of Jersey where the institutional framework restricts migration so that crowding out can be expected even in the long run. See Learmonth et al (2007).

Type-II multipliers also include induced consumption effects (Miller & Blair, 2009, Ch. 6). For further details see Appendix 2.

This study draws on an augmented Scottish Input Output table by Hermannsson et al (2010c). Income and expenditure data for Scottish HEIs is used to identify a separate HEIs sector. That is the existing education sector is split into two elements, HEI and non-HEI education. The disaggregation of the education sector reveals the income and expenditure structure of Scottish HEIs and makes it possible to derive appropriate multipliers in an analogous manner to any other Input-Output sector. The table, and associated model, treat the HE sector on the same basis as any other sector: as a demander of goods and services and factor inputs, and as a supplier of services to meet intermediate and final demand.

Applying these principles to derive the demand-side impacts of HEIs entails estimating the economic activity contingent upon the economy's final demand for the HEIs services and the implicitly linked exogenous expenditure of their students.

An extensive literature estimates the impact of HEI spending on the host economy solely through these demand side (expenditure-related) effects. For example 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. Major Scottish studies are summarised below. Almost all of these have been conducted using models based on assumptions of an entirely demand-driven economy with a passive supply side (see Appendix II for details).

Table 1 below presentd a summary of multiplier values found in major Scottish HEI impacts studies. Most, especially the earlier analyses, are based on Keynesian income-expenditure models e.g. Brownrigg (1973), Bleaney *et al* (1992), Armstrong (1993) and Battu *et al* (1998), whilst a smaller number use some variant of IO modelling e.g. Blake & McDowell (1967), Harris (1997), Kelly *et al* (2004) and most recently Hermannsson *et al* (2010a)[7]. These studies differ in the type of multiplier they report, the approach used to derive the multiplier values and the

[7] 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 indicative results are considered sufficient or IO accounts are not available and cannot be constructed with the resources available.

geographical definitions of the studies. Unsurprisingly therefore, the multiplier values generated differ somewhat and are in most cases not directly comparable[8].

Table 1 Overview of main Scottish HEI impact studies[9]

Subject of study	Multiplier value	Geographic boundary	Source of multiplier value
St. Andrews University (Blake & McDowall, 1967)	1.45 (Household income)	St. Andrews (pop. 10,000)	Input Output table
Stirling University (Brownrigg, 1973)	1.24 - 1.54 (Income)	Parts of Sterling and Perth (pop. 96,000)	Brown et al (1967), Greig (1971)
Strathlcyde, Stirling and St. Andrews Universities (Love & McNicholl, 1988)	1.34, 1.43, 1.36 (student spending)	Scotland	Brownrigg & Greig (1975), McNicholl (1981)
Aberdeen, Dundee and Stirling Universities (Love & McNicoll, 1990)	2.18 (output), 1.75 (GDP), 1.95 (employment)	Scotland	Scottish Input Output Tables (1979)
Aberdeen University (Battu et al, 1998)	1.46 (spending), 1.61 (employment)	North East of Scotland	Greig (1971), Brownrigg (1971), McGuire (1983), Harris et al (1987)
Strathclyde University (Kelly et al, 2004)	1.63 (output), 1.38 (employment)	Scotland	Input Output table
Strathclyde University (McNicholl, 1993)	2.15 (output), 1.66 (Income)	Scotland	Scottish Input Output Tables (1989), Survey
Scottish HEIs (1) 1995	1.76 (output), 1.7 (employment)	Scotland	Scottish Input Output Tables (Hybrid, 1994-5)
Scottish HEIs (2) 1999	1.73 (output), 1.42 (employment)	Scotland	Scottish Input Output Tables (SLMI, 1997)
Scottish HEIs (3) 2004	1.6 (output), 1.4 (employment)	Scotland	Scottish Input Output Tables (2000)
HEI impacts projects 2009	1.3 (output type I), 2.1 (output type II)	Scotland	Scottish Input Output Table (2004)

A variety of multipliers can be derived to link a particular exogenous change to changes in a number of economic outcome metrics. The Output multipliers relate changes in final demand to the change in gross output. Therefore, an output multiplier of 2.15 as found in McNicoll (1993) implies that a unit increase in the final demand for the outputs of Strathclyde University leads to a Scotland-wide change in output of 2.15. The stated employment multipliers show the economy-wide change in employment caused by a unit increase in direct employment. The household income multiplier used by Blake & McDowell (1967) is slightly unusual, but appropriate for their small borough application, where they relate changes in the total output of the University of St. Andrews to changes in local household income. The income multipliers used by Brownrigg (1973) relate exogenous changes in regional income to the overall change in regional income[10]. Drawing on the HEI-disaggregated Input-Output table for Scotland, we find that in 2006 the Type-I output multiplier for the HEIs sector is 1.3 and the Type-II multiplier is 2.1.

The treatment of students' consumption expenditures

In addition to the impact of the institutions' own expenditures a further impact that has to be accounted for is the implicitly linked (exogenous) students' consumption expenditure that occurs within the local economy. In practice this involves determining the level of student

[8] Except perhaps in the most recent studies based on the Scottish Input-Output tables.
[9] The multipliers presented are in most cases not directly comparable among studies as their exact definition varies. Furthermore, they differ in terms of what spending is treated as exogenous.
[10] Where regional income is equivalent to GDP as derived by the expenditure method. For further details on Keynesian multiplier models see Chapter 1 in Armstrong & Taylor (2000).

spending, to what extent it is additional to the Scottish economy and how it is distributed among sectors. Perhaps the most difficult part of this process is in deciding the attribution of students' consumption expenditures between exogenous and endogenous activity.

In the case of external students this is straightforward. Their expenditure is unambiguously exogenous as their incomes are derived from an external location. The treatment of their expenditure is similar to that of tourists. For local students, the distinction between their endogenous and exogenous consumption is less clear cut. To a large extent their income, and hence consumption, is endogenous to the local economy in that it comes from wages earned from local industries and transfers from within local households. For local students simplifying assumptions are adopted in line with a typical IO-notion of exogeneity. The exogenous components of local students' consumption expenditures are assumed to be expenditures financed from commercial credit taken out during their years of study, student loans and education related grants and bursaries.

For details of Scottish students' income and expenditures this study draws on a comprehensive survey by Warhurst *et al* (2009). The full details of how student expenditures are determined are reported in Appendix III. Concluding that process reveals that per student the net contribution to final demand is greater for incoming students than local ones as there are less deductions of endogenous incomes.

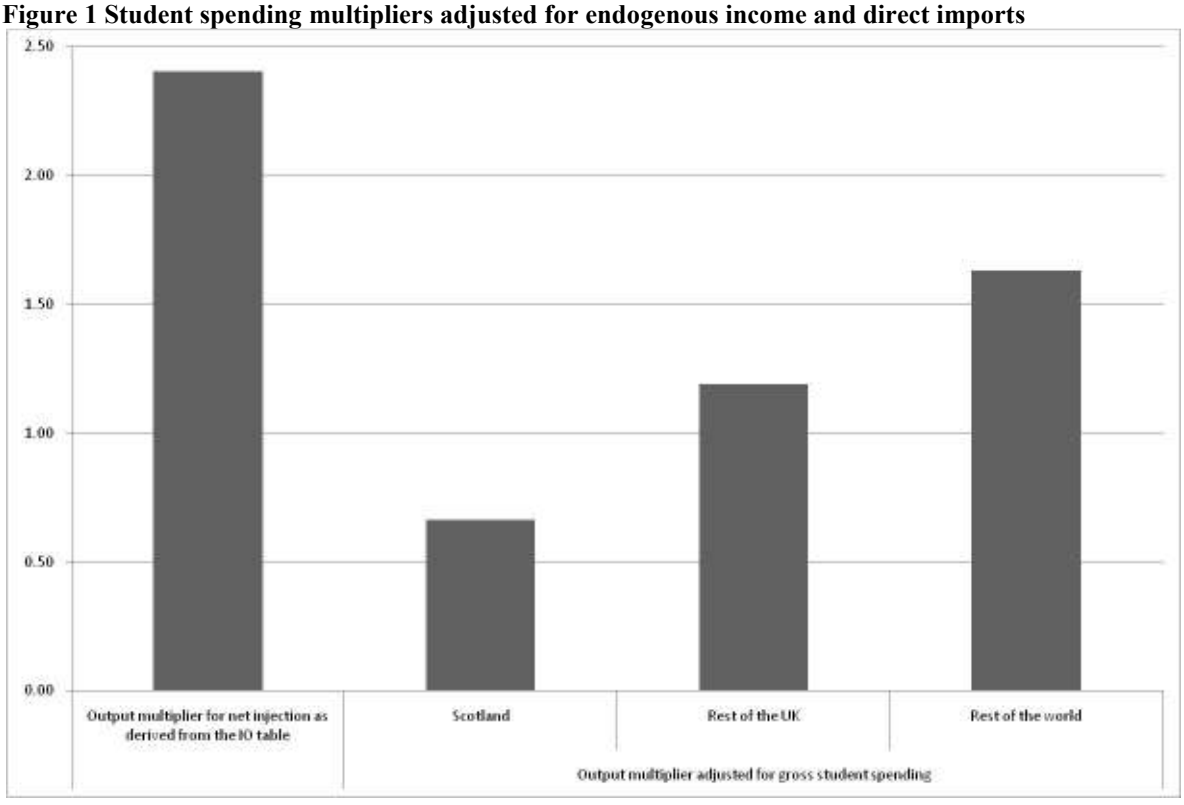
Table 2 Derivation of per student spending broken down by place of domicile

Location of domicile		Scotland	Rest of the UK	Rest of the World
Gross average student spending £	+	6,230	7187[11]	7,187
Income from employment £	-	1,945	1,945[12]	
Within household transfers £	-	453		
Other income £	-	570		
Dissaving £	-	1,073		
Spending attributable to new commercial credit £	+	346		
Exogenous average per student spending	=	**2,535**	**5,242**	**7,187**
Direct imports £ (32%)	-	814	1,683	2,307
Net change in final demand per student £	=	**1,721**	**3,559**	**4,880**
Number of students FTE's	x	108,398	19,236	33,273
Estimated net contribution to final demand by student population £ m	=	**186.6**	**68.5**	**162.4**

[11] Incoming students generally spend more than locals. In the absence of survey information this is proxied by using reported expenditure figures for Scottish students living independently.
[12] Incoming students from the UK are assumed to participate in the Scottish labour market whereas students from the rest of the World are assumed not to.

Once students' net contribution to final demand has been determined the next step is to estimate the knock on impacts of their consumption spending. A student expenditure vector estimated by Kelly *et al* (2004) is used to derive the spending impact of the different student groups in Scotland. In total they support approximately £m 1,000 of output in the Scottish economy as is summarised in Figure 4 below. Figure 3 presents output multipliers for student's consumption spending. The output multiplier for student spending derived from the IO tables is 2.4. However, as the preceding discussion has made clear these cannot be applied directly to students' gross term time spending as found in income and expenditure surveys. Gross expenditures have to be adjusted for spending financed by income sources endogenous to the Scottish economy. When these adjustments are applied to multipliers it is revealed that for each pounds of local students' gross term time expenditures the Scotland wide economic impact is only 66 pence. This is because to a significant extent these expenditures represent a redistribution of spending within the Scottish economy and only partially an additional injection. The impact of per unit gross spending of incoming students is stronger as more of it represents an additional injection into the regional economy.

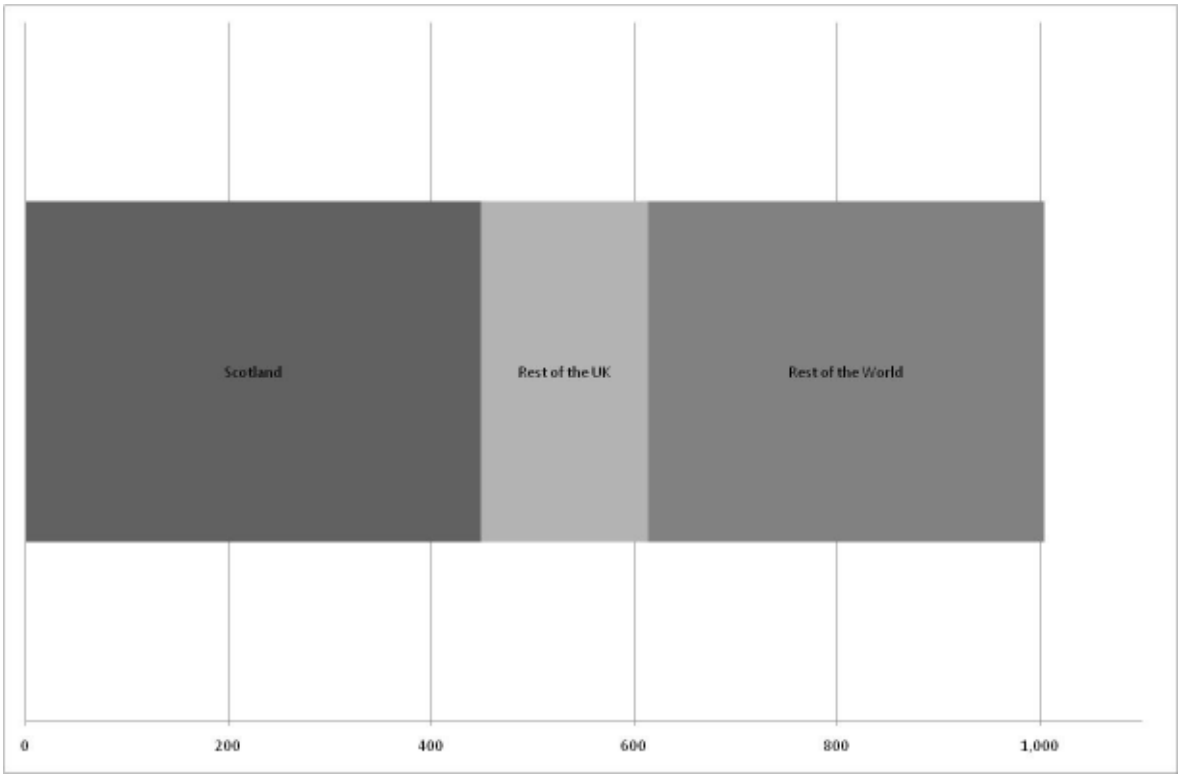
Figure 1 Student spending multipliers adjusted for endogenous income and direct imports



Despite the relatively modest per student impact, Scottish students make up approximately two thirds of the student population and therefore drive approximately 45% of the total student consumption impact. The significance of consumption spending of students from the rest of the

world is little less at approximately 39% of the total impact, whereas the remaining 16% are made up by students from the rest of the UK.

Figure 2 Output impact of student spending in Scotland broken down by student origin, £m



This section has summarised typical practice for studying the regional expenditure impact of HEIs. Drawing on an Input-Output table for Scotland, modified to incorporate a separate HEIs sector, the impact of HEIs in Scotland has been estimated using typical Input-Output assumptions as found in the literature. From this perspective HEIs are a significant driver of economic activity in Scotland as measured in terms of Output, GDP and employment. The next section examines criticisms of this view and discusses how and to what extent it should be accommodated in impact studies.

3. Policy scepticism and the impact of HEIs

3.1 Resource Constraint

One potentially important source of scepticism within the UK about regional demand-driven impact multipliers is the 100% crowding-out argument that characterised the HM Treasury Green Book's analysis of regional impacts (at least until recently- see below). Here a pure demand disturbance that stimulates employment in one region has to have an equal and offsetting impact on employment in other regions of the UK, given that the UK economy is taken

typically to operate at full employment. Even if there were a 100% crowding out at the level of the UK as a whole, there would never be any suggestion that this would apply at the level of the host regional economy[13]. It is quite legitimate for Scottish and Welsh governments, for example, to be concerned about the impact of particular institutions/expenditures for their own economies. In this context aggregate host-region employment multipliers are clearly not constrained to be zero.

Of course, none of this implies that the supply side is unimportant, rather it simply emphasises that the demand side cannot be dismissed as irrelevant at the level of the individual devolved region. The government of such a region would be foolish to neglect the likely impact of its expenditures on real economic activity which may prove to be long-lasting. There undoubtedly is, and certainly ought to be, policy interest in the demand side impact of regional government (and national government) expenditure policies in a regional context. Furthermore, the issue of supply side crowding out must depend on supply side conditions in national and regional economies and on institutional arrangements: there certainly is no "law" of 100% supply-side crowding out of regional demand changes.

Although it can be concluded that IO-modelling is inappropriate at the national level due to resource constraints (binding supply side), these constraints do not bind (at least not to the same degree) at the regional level. Therefore Input-Output models are a relevant tool for estimating impacts at the regional level (given the assumptions underlying the Input-Output model as summarised in Appendix II). However, even at the regional level there is another potential source of crowding out, which challenges the appropriateness of the approach. This occurs directly through offsetting changes in demand that arise through the operation of a binding regional public sector expenditure constraint. In a Scottish context this operates through the Barnett formula, which governs the allocation of Scottish Government funding from the central government in Westminster[14]. The conventional regional multiplier analysis, which we presented in Section 2 above implicitly assumes that the financing of the HEI expenditures in Scotland comes from outwith the country – from the Westminster Government – with no ramifications for other elements of government expenditure.

[13] Though it could under limiting conditions of a completely inelastic labour supply curve or infinitely elastic labour demand curve, but these seem wholly inappropriate for an open regional economy like Scotland (McGregor and Swales, 2005).
[14] For further details see e.g. Ferguson *et al* (2003, 2007).

3.2 Expenditure impacts under a budget constraint

Does taking account of the Scottish budget constraint imply that host-region employment multipliers are zero? To address this question it is helpful to begin by focussing simply on changes in the public funding of HEIs in Scotland, and ask whether more public spending on HEIs is offset by contractions in other government expenditures. Then this section considers exogenous changes in the non- publicly funded dimensions of HEIs. For even if the regional public sector budget constraint implies complete crowding out within the region, only part of HEIs activities are publicly funded. In fact, they are characterised by considerable exports (to the rest of the UK and the rest of the world), and changes in exports are not subject to any automatically offsetting expenditures on the demand side.

Although the Scottish Government has devolved powers in making spending decisions, its income is constrained each year by the block grant it receives from Her Majesty's Treasury[15]. If the Scottish Government allocates additional funds to HEIs this implies that less funds are allocated to other public expenditures. Given this context it can be misleading for an impact study to treat the Scottish Government's funding of HEIs as an exogenous stimulus to the regional economy, although that is standard IO practice.

To illustrate the significance of the difference between the cases two simulations are conducted where a hypothetical additional £100m is spent on HEIs in Scotland. In the first case the traditional impact study assumption are employed that the exogenous increase in expenditure is entirely externally funded (e.g. UK-level funding, foreign students' fees) and does not have any ramifications for other public spending in Scotland. The second case examines the impacts of a £100m increase in HEI spending, which is offset by a corresponding reduction of other public spending in Scotland. In the latter case the £100m reduction of public spending is applied to a sector that is in fact an aggregation of those sectors that receive 93%[16] of central and local government final demand in the Scottish IO tables.

The Type-II multiplier for the HEIs sector is 2.11. Without any offsetting cutbacks in public spending the additional spending on HEIs has an output impact of £211m. Approximately half of that impact is realised as a direct consequence of increased activity in the HEIs themselves,

[15] The Scottish Government does have limited powers to vary its expenditure through adjusting the standard income tax rate up or down by 3 pence in the pound. This is the Scottish Variable Rate. For details see e.g. McGregor and Swales (2005), and Lecca *et al* (2010).

[16] The public sector is aggregated from 5 sectors in the HEI-disaggregated IO table (IO115, IO116, IO117, IO118 and IO119). Approximately 10% of the sector's final demand is from other sources than government.

whereas the other half is generated via "knock on" effects in other sectors, particularly the retail and service sectors.

A more complex picture emerges with expenditure switching. The multiplier for other public expenditure in Scotland is 1.98. If an increase in HEIs funding is met by cutbacks in other public expenditure in Scotland the 'multiplier' for switching is equal to 2.11-1.98=0.13[17]. That is to say, for every £100 m directed from the public sector to HEIs the output impact of switching is £13 m. This positive outcome is primarily driven by the fact that the spending substitution has a stronger direct impact on HEIs than the sectors which experience the cut in public expenditure. In particular the estimated import propensity of HEIs (11%) is lower than the public sectors' import propensity (17%). Therefore for every pound spent on HEIs more is retained within the regional economy than for government spending in general. A qualitatively similar result emerges in results for employment impacts.

The recognition of the regional budget constraint implies that multiplier effects on individual sectors are no longer universally positive, as in the conventional case. In particular, there is a significant contraction in the public sector and a net contraction in other sectors that are more sensitive to changes in general public expenditure rather than the expenditure on output in the HEI sector. In a devolved context, changes in public expenditure (financed within the region) typically involve expenditure switching, and the multiplier effects are accordingly more subdued and, indeed, even the direction of their impact cannot be known a priori. This is a crucial result that appears not to be widely appreciated in existing impact studies.

[17] For further discussion of expenditure switching see Allan et al (2007).

Table 3 Impact of £100m increase in final demand for Scottish HEIs

	Without Spending Substitution			With Spending Substitution		
Sector	Change in Final Demand (£m)	Output Impact (£m)	Employment Impact (FTE)	Change in Final Demand (£m)	Output Impact (£m)	Employment Impact (FTE)
Primary and utilities	0	8.34	32	0	1.92	7
Manufacturing	0	15.53	102	0	7.08	47
Construction	0	7.99	74	0	2.27	21
Distribution and retail	0	19.69	344	0	2.67	47
Hotels, catering, pubs, etc.	0	4.89	136	0	0.35	10
Transport, post and communications	0	9.81	90	0	-0.40	-4
Banking and financial services	0	7.62	51	0	-1.58	-10
House letting and real estate services	0	16.25	42	0	3.68	9
Business services	0	7.73	119	0	0.22	3
Public sector	0	3.78	59	-100	-105.42	-1,651
HEIs	100	102.09	1,682	100	101.64	1,675
Other services	0	6.87	84	0	0.14	2
	100	**211**	**2,816**	**0**	**13**	**156**

Figure 3 Output impact of £100m increase in final demand for Scottish HEIs

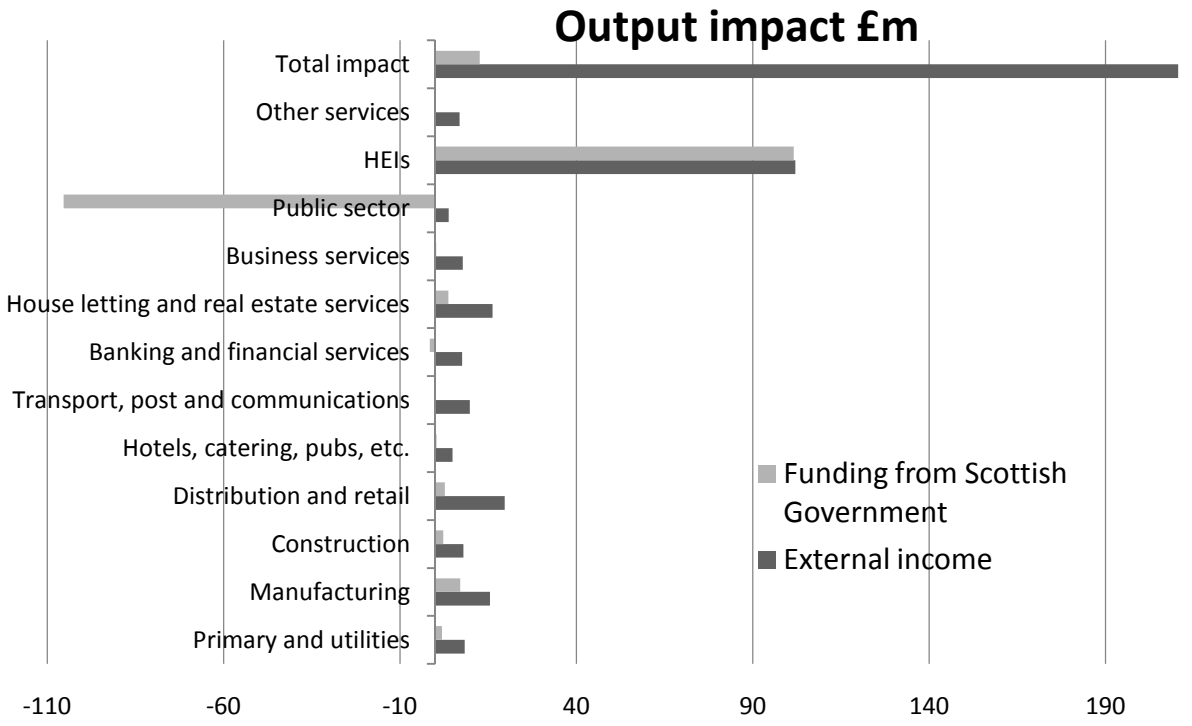
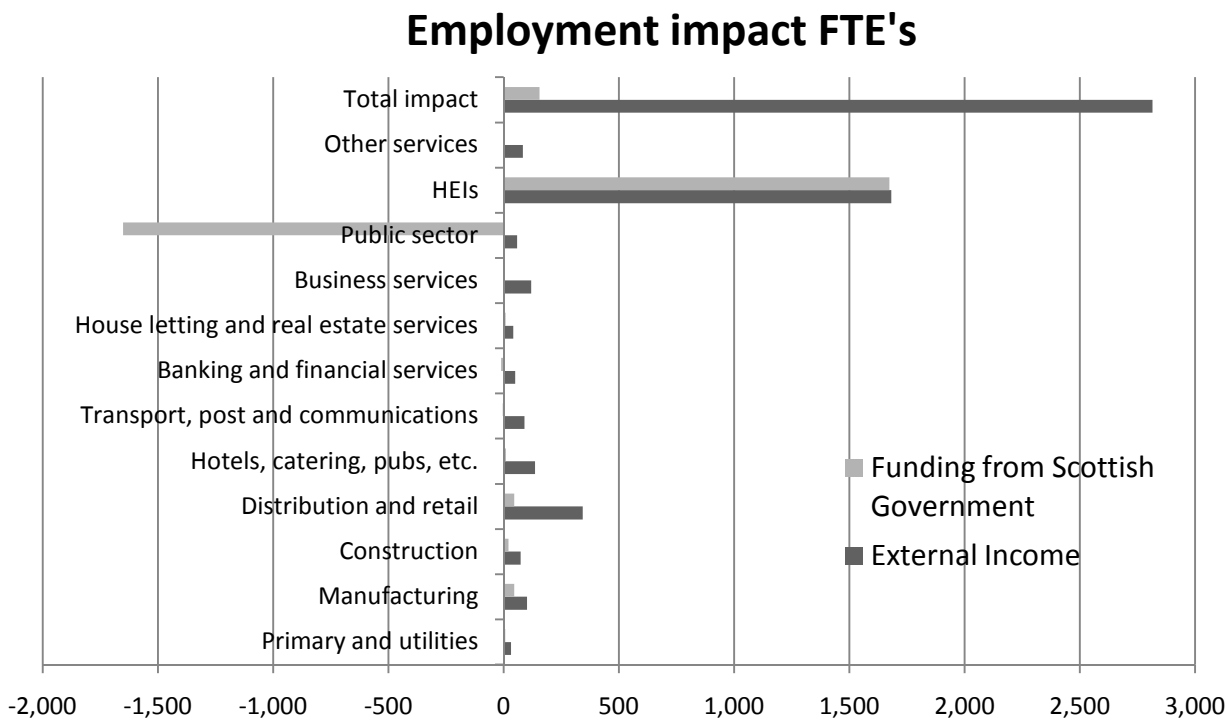


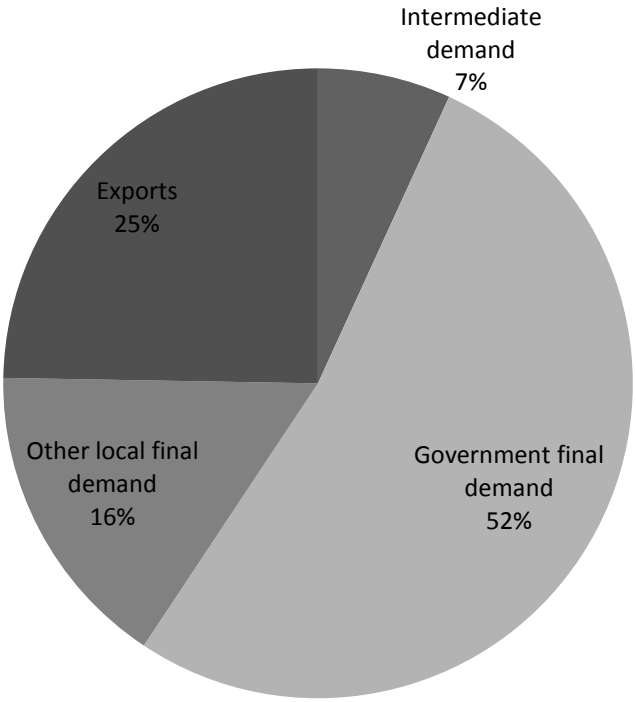
Figure 4 Employment impact of £100m increase in final demand for Scottish HEIs



As can be seen from the analysis above, care must be taken in determining the origin of the income for any impact study applied to a region with a devolved budget. While the example of HEIs is used here, the principle is, of course, quite general. Devolution matters a great deal for the appropriate conduct of regional impact analyses. These results might be interpreted as suggesting that the impact of HEIs' spending is very limited at the Scottish level, because of expenditure switching within Scotland, since in the absence of HEIs the funding would simply be allocated to public services. However, while HEIs are often perceived to be part of the public sector they are not in fact[18], and an analysis of their income based on data from HESA (Hermannsson et al, 2010c) reveals that only approximately 52% of their income can be traced back to the Scottish Government. A quarter stems from sources outside Scotland and approximately 23% originates from households, businesses, charities and other institutions whose funding is independent of the block grant. The external income is unambiguously additional to the Scottish economy and it is reasonable to assume the latter part is as well.

[18] In the Scottish Input-Output tables HEIs are classified as part of the NPISH category, i.e. Non-Profit Institutions Serving Households.

Figure 5 Income structure of the HEIs sector in the HEI-disaggregated Input-Output tables



4. Accounting for the regional budget constraint within the Input-Output framework

The Input-Output tables provide a useful accounting framework. Based on the dichotomy of exogenous (final demand) and endogenous ('knock-on' effects) activity, each sector can be attributed with the total activity its final demand drives within the regional economy. Again, this activity can be measured in terms of output, employment or GDP. Using the example of output, this impact is composed of both the final demand for the output of that sector and also the knock-on impacts on other sectors. The advantage of Input-Output as an accounting framework is that it is consistent. When such an attribution exercise is carried out on a sector by sector basis, the sum of the impacts attributable to each sector equals the economy-wide total[19].

As discussed in the previous section, one of the criticisms levelled against deriving the economy-wide expenditure impact of HEIs in such a way is that, given their funding arrangements in Scotland, attributing HEIs with impact of spending public funds is disingenuous. Such an impact is not so much caused by the HEIs as it is by the availability of

[19] Moreover, the validity of this attribution method does not rest on the same strict assumptions as identified for IO modelling in Sections 2 and 3. For example, CO_2 attribution analyses of the type associated with the carbon footprint is most rigorously calculated using IO tables.

public funds and potentially similar results could be obtained if the funds were spent on other public services.

The Input-Output framework, combined with detailed information about the income sources of HEIs, enables a disaggregation of the sector's impacts in terms of the origin of the exogenous final demands. This allows an analysis of to what extent the impacts attributed to the HEIs sector under a traditional IO approach should in fact be attributed to the expenditure of the Scottish Government.

It transpires that based on traditional assumptions HEIs account for 1.51% of Gross Output, 2.28% of GDP and 2.46% of employment in Scotland. Adding the impact of student's consumption spending as derived in section 2 Scottish HEIs support 1.91% of Gross Output, 2.73% of GDP and 2.83% of employment in the region. Taken at face value it is clear that the sector is important as an employer and demander of goods within the regional economy. The controversy concerns whether the traditional impact-study approach may be providing illusions of grandeur rather than a robust estimate of the sectors contribution to the economy.

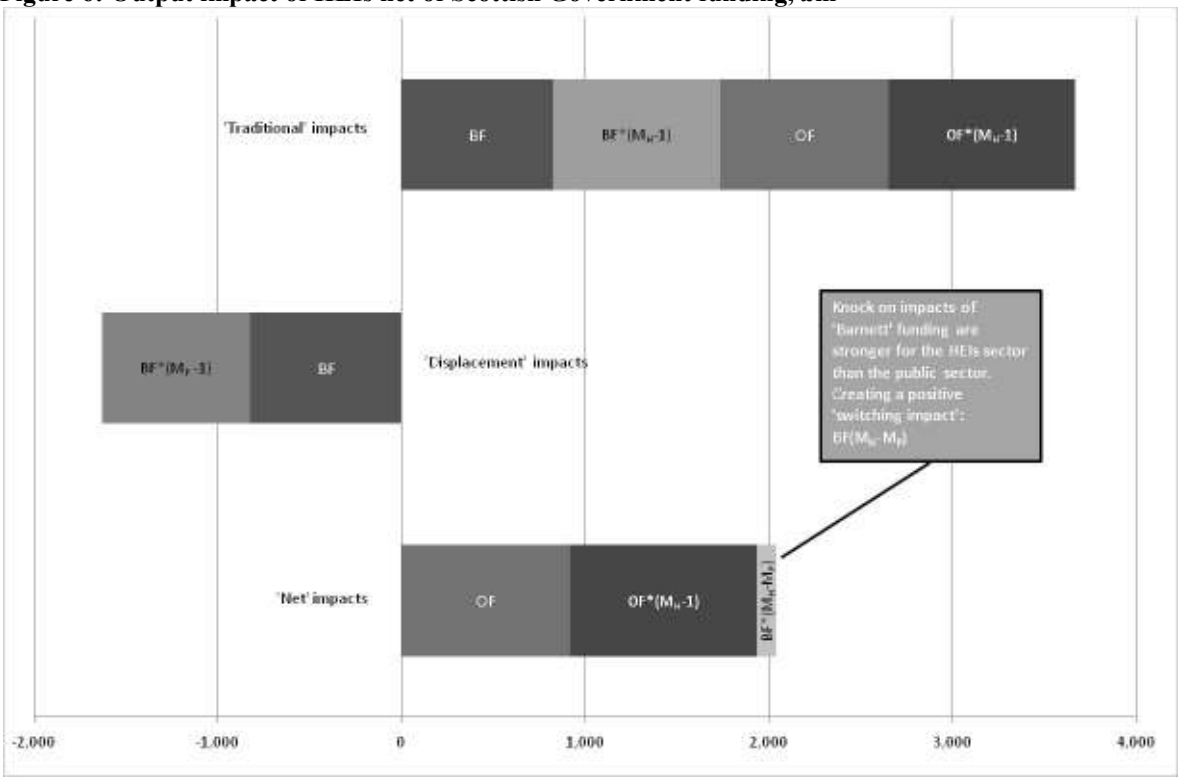
As the upper bar in Figure 4 reveals, even if a large proportion of the impacts of HEIs institutional expenditures can be attributed to the expenditures of the Scottish Government (approximately 40%) a greater share is additional to the Scottish economy.

To explicitly take account of the public expenditure switching effects (discussed in Section 3) as funds are moved between the public sector at large and the HEIs sector, the impacts of the Scottish Government ('Barnett') funding are deducted from the overall expenditure impact presented in Figure 3, as illustrated by Figure 4 and the equation below:

$$(BF + OF)M_H - BF * M_P = OF * M_H + BF(M_H - M_P)$$

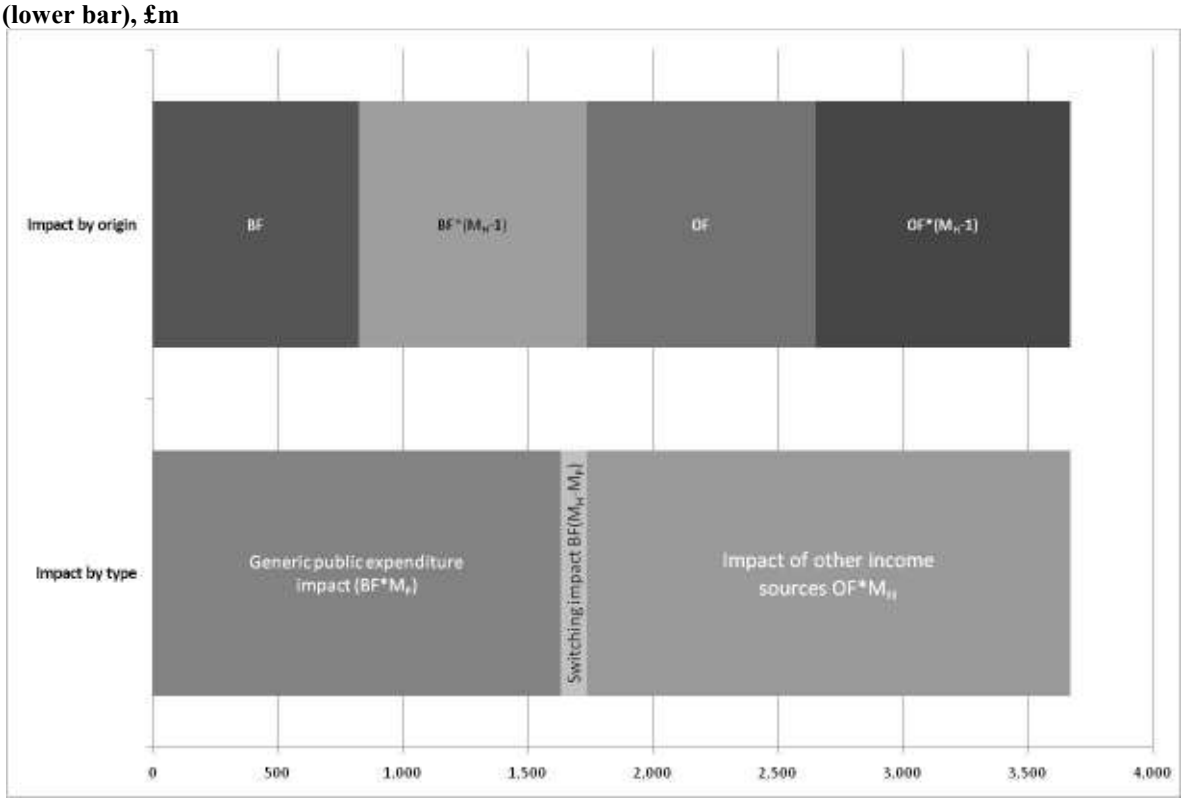
Where, BF is the final demand for HEIs outputs attributable to Scottish Government funding, OF is HEIs final demand from other sources, M_H is the output multiplier for the HEIs sector and M_P is the output multiplier for the public sector. To summarise, the output impact of HEIs net of Scottish Government funding equals the output impact attributable to other funding sources in addition to the switching impact.

Figure 6: Output impact of HEIs net of Scottish Government funding, £m



As Figure 3 illustrates, when the effects of Scottish Government funding have been deducted from the output impacts of HEIs institutional expenditures a small but positive switching impact remains, in addition to impacts of income from other sources. As discussed in section 3 this is due to the fact that the multiplier for HEIs expenditures is higher than that for the public sector. To clarify, the impact of Scottish Government funding upon HEIs can be re-arranged into a 'generic' public expenditure impact and a 'switching' impact. The output impacts of the HEIs sector is illustrated in these term in the lower bar of Figure 4 below.

Figure 7: Output impact of HEIs disaggregated by origin (upper bar) and disaggregated by impact type (lower bar), £m



In addition to the expenditure impacts of the HEIs themselves, the same approach can be applied to student's consumption expenditures. In this case:

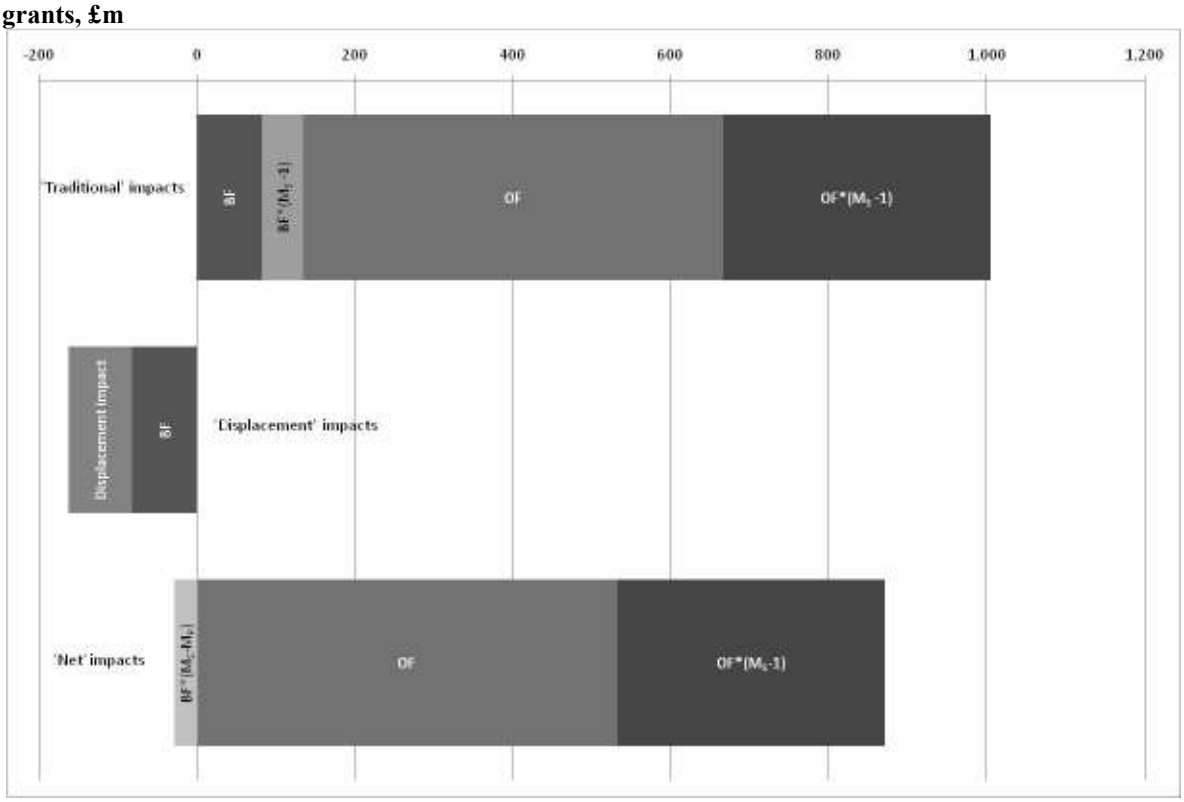
$$(BF_S + OF_S)M_S - BF_S * M_P = OF_S * M_S + BF_S(M_S - M_P)$$

Where, BF_S is student's consumption final demand attributable to Scottish Government student support[20], OF_S is student's final demand for consumption from other sources, M_S is the output multiplier for students' consumption expenditures and M_P is the output multiplier for the public sector.

When students' consumptions expenditures are analysed in this way the results are qualitatively different from those for the HEIs institutional expenditures. Primarily due to the strong direct import component of students' consumption expenditures the output multiplier is smaller than for the public sector on average. Hence there Scottish Government gets less 'bang for buck' from expenditures on student support than on its expenditures on average. The switching impact is negative, whereas it was positive for HEIs institutional expenditures.

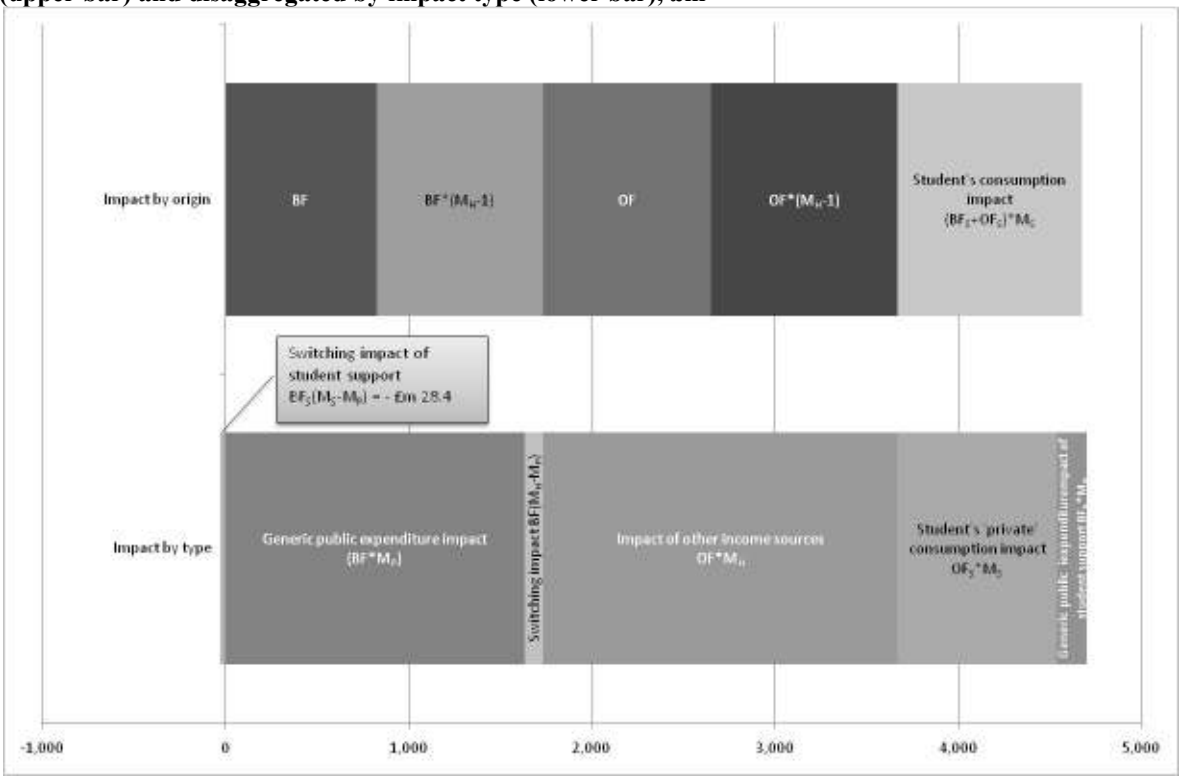
[20] A part of Scottish students' expenditures is funded by student support grants provided by the Scottish Government.

Figure 8: Output impact of student's consumptions expenditure net of Scottish Government support grants, £m



The impact of students' consumptions expenditures has been combined with the impacts of HEIs institutional expenditures in Figure 7 below. As can be seen from the upper bar of Figure 7, the impacts of students' consumption expenditures $(BF_S+OF_S)*M_S$ constitute approximately a fifth of the overall impact of HEI activity. When the impacts are broken down by type (lower bar) it is evident that the lion's share of students' consumption expenditures is provided by income sources that are not subject to the budget constraint of the Scottish Government However about 13.4% of the student consumption impact are attributed to student support from the Scottish Government. In Figure 7 (lower bar) this is represented as a generic public expenditure impact (16.2%) offset by a negative switching impact (-2.8%).

Figure 9: Output impact of HEIs and student's consumption expenditures disaggregated by origin (upper bar) and disaggregated by impact type (lower bar), £m



This section has examined the impact attributable to the HEIs sector in Scotland in more detail than impact studies traditionally do. In addition to the traditional approach of attributing the sector its impact (as the final demand for institutional expenditures times its multiplier plus the impact of student's consumption expenditure) the origin of the final demands have been examined and how knock-on impacts can be attributed to each of these. In an accounting sense the total impact of the HEIs sector is the same in each of these exercises. However, instead of simply revealing an aggregate impact, that impact has been broken down into sub-components depending on origin. Although notionally the impact of HEIs is unchanged by this, the analysis reveals that there is some justification for policy scepticism based on the binding regional public budget constraint. Just over a third of the impact of the HEIs sector in Scotland is a 'generic' public spending impact as would have materialised anyway had the money been spent elsewhere in the local public sector. A small qualification to this point of view is revealed by the 'switching impact'. As the HEIs have stronger backwards linkages than the public sector in Scotland on average, more 'bang for buck' is realised from spending on HEIs than would be from spending on public services on average. However, for students' consumption expenditures the switching impact is negative as the knock-on impacts are less than for public expenditure on average.

Conversely, the analysis reveals that the extreme form of policy scepticism, which argues that once the public budget constraint has been accounted for the Impact of the HEIs sector is negligible, is not backed up by the evidence. Indeed, approximately two thirds of the sector's impacts are in-addition to the public expenditure impact. These are attributable to funding from sources independent of the Scottish block grant and the consumption expenditures of students that are not supported by the Scottish Government.

In this paper Input-Output analysis has been applied as an accounting framework to determine the economic activity within Scotland attributable to the activities of the HEIs sector. Furthermore, this impact has been disaggregated in terms of its origins. If an Input-Output modelling stance were to be adopted and simulations made of the impact of changes in the income stream of the sector a significant practical problem would arise. Are the different income sources of HEIs independent of each other or might they be complementary? Say for example that the Scottish Government were to cut back funding of HEIs in Scotland, would this affect the sector's ability to seek income from other sources, such as the science councils at the UK-level or the tuition fees of incoming students? As far as the authors of this paper know this question has not been systematically addressed. Although it is sometimes the case that such a complementary nature of funding is assumed in impact studies, giving rise to 'internal multipliers'[21]. Undoubtedly various points of view can be argued for in this case but gaining a better understanding of such institutional mechanisms of HEIs should be of great applied relevance.

4. Conclusion

"Policy scepticism" appears to have developed in respect of regional impact studies of HEIs. This is based on the notion of either a demand-side (public budget constraint) or supply-side (real resource) "crowding out". In the limit this policy scepticism suggests that the expenditure impacts of HEIs are negligible, and can therefore be ignored. We reject this variant of policy scepticism. However, we do recognise that the regional public sector budget constraint is binding under devolution and argue that future regional impact studies focussed on regions with devolved public spending should take account of this perspective. The analysis in this

[21] Some studies, at least implicitly, assume a causal link between recurring public grants (e.g. funding council income) and the other income of HEIs. An off-line calculation is made where a unit of public funding is assumed to attract complementary funding from other sources. This leads to an effective multiplier for public HEIs funding that is greater than that derived directly from standard impact models. Although the authors have not come across examples of such approaches being applied in peer-reviewed work, its influence is apparent in some policy documents (e.g. National Assembly for Wales (2009)).

paper has shown how the regional public budget constraint can be identified and accounted for within an Input-Output framework. The appropriately modified analysis reveals that Scottish HEIs have a positive net impact upon Scotland through their expenditure effects, even when other displaced public sector expenditure is taken into account. This is primarily due to the fact that a significant part of their income, notably export earnings, is independent of the regional public sector budget constraint.

Furthermore, this paper has examined the role of students' spending in the demand-side impacts associated with HEI activity. Findings from a recent survey of Scottish students incomes and expenditures are used to identify the parts of student spending that are additional to the regional economy. This gives more weight to the consumption expenditures of incoming students as a significant part of local students' incomes are endogenous to the Scottish economy. This is a rather conservative approach as no allowance is made for the potential role that HEIs may play in retaining some students within Scotland. These students might have migrated out of Scotland, hence 'taking' their study related expenditures elsewhere, had the local supply of higher education not met their needs. Nonetheless, students' consumption expenditures represent about 14% of the overall impact attributable to Scottish HEIs and support about 0.2% of GDP in Scotland.

The analysis of this paper applies to impact studies conducted in regions with devolved spending powers. In these circumstances, researchers seeking to identify the economic activity attributable to a particular sector should acknowledge the devolved budget constraint explicitly and identify the fraction of activity attributable to the public funds. In general this will reveal that a significant part of HEIs impact is in fact a 'generic' public expenditure impact and in the limit this may reveal the demand side impact of particular regional institutions to be effectively zero once the regional public budget constraint has been taken into account. However, in the case of Scottish HEIs considered in this paper, substantial impacts can be attributed to HEIs activity, in addition to those driven entirely by local public expenditures.

Finally, it should be noted that regional impact analyses can at best identify the likely demand-side effects of any regional institutions' expenditures. In the case of HEIs, at least, many of their impacts on regional economies can be expected to come through the direct stimulation of the supply side, for example, through their impact on the skills of the host region's labour force and through knowledge exchange activities. These impacts can only be explored in a framework that explicitly accommodates these supply side effects (see e.g. Hermannsson *et al*, 2010b).

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Appendix I: Construction of an HEI disaggregated IO table

The preceding analysis is based upon the officially produced I-O tables for the Scottish Economy for the year 2004. However, extensive work is required in order to generate a useable Scottish analytical table that identifies each individual HEI in Scotland as a separate sector. For this we have drawn on data from the Higher Education Statistics Agency (HESA). The chosen year of reference is 2005/2006 as this is the latest year for which the necessary data were available. The procedure used to derive the HEI disaggregated IO-table can be broadly divided into two steps. First we "rolled forward" the 2004 Scottish IO table to reflect changes in Gross Value Added (GVA) from 2004 to 2006. Then we proceeded to separately identify each HEI by creating a row and column for each institution.

Rolling forward the 2004 IO table

Since the academic year 2005/2006 has been chosen as the reference year of the study, the official Scottish analytical I-O Table for 2004 (2007) had to be "rolled forward" to reflect the output level and prices in the year 2006. This is done using Gross Value Added (GVA) as a benchmark. Between 2004 and 2006 GVA increased 10.28% from £82,538m to £91,024m – therefore all figures in the official 2004 table are uniformly adjusted upwards by a factor of 1.1028. Comparisons of surveyed IO tables have shown that changes in technical structure of an economy occur slowly so that limited change can be expected over the short run(Miller & Blair, 2009). Therefore extrapolating a table to reflect price and volume changes over a two-year period is expected to provide a reliable account of the Scottish economy in 2006.

Disaggregation of HEIs

The next step is to separate HEIs from the rest of the education sector, which is under IO sector ode 116. The additional data required is sourced from HESA (2007), which gives information on output totals and wage expenditure. In addition data on income by source can be used to estimate exports for each institution. Combining income and expenditure totals from HESA with accounting and survey data on HEIs expenditures we are able to construct a separate row and column for each institution. Finally each individual HEI row and column is then deducted from the education sector in the IO table to form an Education sector not including HEIs.

Creating separate columns for each HEI

A column in an IO table reveals the total expenditures of a sector and how they are divided between intermediate inputs, imports and valued added. Following is a description of the steps taken in creating a separate column for each HEI

Table 4 Summary of HEI columns

Column Component	Level of detail	Data source
Total expenditure	Individually determined for each HEI	HESA accounting data
Imports	Determined in a uniform manner for all HEIs	JCAPC data on aggregate purchases of Scottish and N-Irish HEIs
Compensation of employees	Individually determined for each HEI	HESA accounting data
Taxes on expenditure,	Proxied by assuming ratios for the education sector as whole hold for HEIs	Scottish Input-Output tables
Other Value added	Proxied by assuming ratios for the education sector as whole hold for HEIs	Scottish Input-Output tables
Intermediate expenditures	Total intermediate expenditure determined as residual item. Distributed uniformly across all HEIs based on an expenditure survey	Expenditure survey obtained from previous work done by Kelly et al (1997).

The first issue is the estimation of imports for each institution. We have data on the amount of interregional and international imports from JCAPC, the purchasing consortium for Scottish and Northern Irish HEIs. These data reveal aggregate expenditures by Scottish HEIs broken down by category and geographic location of suppliers (Scottish, rest of UK, overseas). Imports were 12.9% of total output in 2005/2006. Imports are further recorded to consist of 98% RUK imports and of only 2% international imports indicating strong interregional links. The data do not reveal purchases of individual HEIs so the proportions are applied uniformly to all of them. This import propensity differs from ones assumed in previous impact studies. For example (Kelly 2004) assume 25% while (Harris 1997) calculates imports to be 22% based on the narrow geographic definition of Portsmouth. Input-Output tables for Scotland record imports to the education sector at 11% of the value of total output.

From HESA publications we have data on wage expenditure (compensation of employees) and total output (income) by source. The remaining elements of each IO column we need to derive are: the intermediate purchases, net taxes and gross operating surplus. Net taxes and gross operating surplus were determined for each HEI as the same proportion of overall expenditure

as in the overall education sector (IO116) in the 2004 tables. These represent a small fraction of overall expenditure 2.8% for net taxes and 3.1% for gross operating surplus.

Having identified all the other cost elements we are left with the amount of intermediate purchases from Scottish industries. This residual was split down the column according to coefficients used by Kelly et al (2004). These coefficients of intermediate expenditures are based on a survey of UK HEIs described in Kelly et al (1997). Production technology in IO tables has been found to change only very gradually Miller & Blair, 2009). It is likely therefore that surveying for new coefficients would only have a marginal effect upon the table. This is primarily because it would only alter the composition of intermediate inputs and secondly because the amount of intermediate inputs is less then a quarter of total output of HEIs (23% on average).

Creating separate rows for each HEI

A row in an IO table reveals the total income of a sector and how it is broken down into supply of intermediate inputs to other production sectors or sales to final demand sectors such as households, government and exports.

Table 5 Summary of HEI rows

Row Component	Level of detail	Data source
Income from exports	Individually determined for each HEI	Accounting data from HESA
Income from other final demand categories and intermediate demand	Income apart from exports is uniformly distributed along the row based on proportions of the overall education sector	Scottish Input Output table

Drawing on HESA data allows us to contruct rows that reflect the individual structure of each HEIs income. Export- and government income are key sources amounting to 25% and 53% respectively of HEIs income on average. These two categories represent 78% of the HEI sector's income and are individually determined for each HEIs based on HESA accounting data. Doing so is a key feature of the HEI-disaggregated IO table, which enables an accurate report of the heterogeneity of HEIs income structures. HESA data allows us to calculate the amount of exports for each institution. The residual from deducting export and government income from total income is then distributed along the row (other final demand categories and intermediate

demand) in the same proportions as in the education sector (IO 116) of the Scottish Input-Output tables.

HESA classifies HEIs income into broad categories and then subcategories. From the definitions of these sub-categories, 77% of HEIs income can be attributed directly either to local demand or export demand. The remaining 23% of HEIs income categories constitute income originating at a UK level. In those cases attribution was made to local demand and export demand based on the proportions of local demand and exports determined by the 77% of income that has an unambiguous spatial origin.

Table 6 Attribution of HESA income sources in IO table to SCO, RUK and ROW origin

Income category	Attribution	% of income
Funding Council grants		
Recurrent grants (Teaching)	SCO	28%
Recurrent grants (Research)		9%
Recurrent grants (other)		3%
Release of deferred capital grants		1%
Research grants & contracts		
OSI Research Councils	RUK	7%
UK based charities	Attributed to SCO, RUK/ROW in same proportions as the export intensity of income with known spatial origin	4%
UK central government/local authorities, health & hospital authorities		3%
UK industry, commerce & public corporations		2%
Other sources		0%
EU sources	ROW	2%
Other overseas sources		1%
Other income - other services rendered		
UK central government/local authorities, health and hospital authorities, EU government bodies	Attributed to SCO, RUK/ROW in same proportions as the export intensity of income with known spatial origin	2%
Other		3%
Tuition fees & education grants & contracts		
Home & EU, full time HE standard rates	Attributed to RUK proportionately to RUK students, remainder SCO	8%
Home & EU, full time HE Non-standard rates		2%
Home & EU part-time HE fees		1%
Non-EU domicile	ROW	7%
Non-credit bearing course fees	SCO	1%
Other fees & support grants		1%
Other income - other		
Grants from local authorities	SCO	0%
Release of deferred capital grants		1%
Endowment & investment income	Attributed to SCO, RUK/ROW in same proportions as the export intensity of income with known spatial origin	2%
Income from intellectual property rights		0%
Income from health & hospital authorities (excluding teaching contracts for teaching provision)		1%
Residences & catering operations (including conferences)		6%
Other operating income	ROW	5%

Income from funding councils is income that comes from within the region for all institutions, and so no portion of this is attributable to exports.

Research income from the OSI research councils is treated as RUK exports as these are funded by the central government. On other UK level research grants & contracts we have no information on geographic origin within the UK. Therefore we attribute these to local demand and exports in proportion to income sources with a known spatial origin.

Two subcategories are found under the heading 'Other income – other services rendered'. These income streams are for various services rendered, including consultancy. About a third of the services are rendered to public bodies. These are attributed to local demand and exports in the same proportions as observed from income sources with a known spatial origin.

In the HESA dataset tuition fees are pooled for Scottish, RUK and REU students. Student numbers by origin are used to disaggregate these into Scottish, RUK and REU tuition fees. The Scottish funding council pays for Scottish students. We treat the tuition fees of REU students as domestic demand under the assumption they are all Erasmus exchange students, whom the Scottish funding council pays for as well. RUK tuition income is treated as RUK exports. Tuition fees of students from outwith the EU are treated as ROW exports.

The category 'Other income – other' is treated in three different ways depending on sub-category. 'Grants from local authorities' and 'Release of deferred capital grants' are treated as local demand while 'Other operating income' is treated as ROW exports since according to HESA definitions this mostly comprises European funding sources. The remaining sub-categories are attributed to local demand and exports proportionately to attribution of categories with a know spatial origin.

Within aggregate local demand we need to determine the amount of income HEIs receive from the Scottish Government. This is relatively straightforward using HESA accounting data. The accounting category 'Funding Council Grants' reports funding provided by the Scottish Funding Council (SFC). This is ultimately drawn from the Scottish block grant and hence attributed to the Scottish Government. The second major source of funding provided by the Scottish Government is tutition fees paid for by the Student Awards Agency for Scotland (SAAS) for Scottish students and incoming EU students. Data for each individual HEIs on the composition of the studend body by origin is used to disaggregate the standard fee categories (Standard rates, Non-standard rates, Part-time HE fees) in the HESA accounts, where an amount proportionate to the number of EU and Scottish students is attributed to the Scottish Government. Furthermore the

income category 'Release of deferred capital grants' is fully attributed to the Scottish Government.

After calculating exports and Scottish Government income, we use row coefficients of the Education sector from the existing IO table to distribute the remaining income between other categories of final demand and intermediate income from other sectors for each institution. This concludes the procedure of estimating the IO rows for each institution.

Having columns and rows for each institution we incorporate them into the existing (rolled forward) Input-Output table. The estimated rows and columns are subtracted from the existing "Education" sector.

The IO table that we have generated consists of 148 sectors out of which 20 correspond to the higher education institutions.

Sectoral employment

Sectoral FTE employment figures were based on those published in the 2004 Scottish IO tables. Since the base year is 2006 these had to be adjusted to reflect 2006 levels. For this we used head count numbers from the Annual Business Inquiry, which report full time and part time employment by regions. Following convention, part time employment was divided by 3 to approximate full time equivalence. Comparing headcount figures for 2004 and 2006 revealed an employment growth of 1.4%, which was used to update FTE figure from 2004 to a 2006 level. Employment in the HEIs sectors was taken from Table 25 of HESA (2007), which reveals FTE employment of all staff of each HEI for the academic year 2005/2006.

Appendix II: Input-Output tables, multipliers and modelling

Input-Output tables provide a snapsot of production in an economy for a given year. They reveal the activities of a industries that both produce goods (outputs) and consume good from other industries (inputs). The Input-Output tables are put to a wide range of uses[22] but perhaps their most prolific application is in various forms of multiplier analyses. In a nutshell multipliers are derived based on the tables so that output is equal to the multiplier times the exogenous components of demand, i.e. an explicit distinction is made between exogenous and enodgenous economic activity as is formally illustrated in section A2.2. In this appendix we will briefly describe the layout of Input Output tables and how they are split into exogenous and endogenous components to derive the multiplier. We will also illustrate how different types of multipliers are defined and how they can be interpreted[23].

Figure 10 Input-Output Transactions table. Source: Miller & Blair (2009), p. 3

		PRODUCERS AS CONSUMERS								FINAL DEMAND			
		Agric.	Mining	Const.	Manuf.	Trade	Transp.	Services	Other	Personal Consumption Expenditures	Gross Private Domestic Investment	Govt. Purchases of Goods & Services	Net Exports of Goods & Services
PRODUCERS	Agriculture												
	Mining												
	Construction												
	Manufacturing												
	Trade												
	Transportation												
	Services												
	Other Industry												
VALUE ADDED	Employees	Employee compensation								GROSS DOMESTIC PRODUCT			
	Business Owners and Capital	Profit-type income and capital consumption allowances											
	Government	Indirect business taxes											

The Input-Output tables can be seen as a description of the flows of inputs and outputs to and from prodution sectors. A column in the Input-Output table reveals the consumption (expenditures) of production sectors. The interindustry transactions table (shaded area) shows how each industry (reading down its column) spends on inputs from within the same industry and other industries. The bottom part of the column shows the industry's expenditures on value added such as employees, capital and government taxes. Reading the rows in the table revelas the value of outputs sold from a particular industry, within that industry, to other industries within the region and to final demand. The Input Output table is consistent with national accounts. Adding up the final demand columns gives us GDP by the expenditure method (C+I+G+(E-M)) and summing the value added rows gives GDP by the factor income method.

[22] For details of Input-Output applications and methodology see Miller & Blair (2009).
[23] The following illustration draws heavily on Miller & Blair (2009) and Seafish (2007).

A2.1 Assumptions of Input-Output modelling

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.

Demand-driven multipliers[24] identify the impact of a sector as a purchaser of inputs. These are the conventional multipliers that have been discussed in the report up to now. When a sector expands, it requires more inputs of intermediate goods and services and increases its employment and wage payments. This generates positive knock-on effects in sectors supplying the increased demand for intermediate and consumption goods. The expansion in these sectors will produce further increases in intermediate and consumption demands, the process continuing down successive rounds of the multiplier process, with the additional impact in each successive round becoming smaller and smaller. I-O analysis has a technique for capturing all these effects, as long as a number of assumptions hold.

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, we can classify consumption expenditure 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. This multiplier is called a Type I multiplier. It consists 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

[24] Two broad generic types of multiplier are identified in the I-O literature. These are known variously as; backward, demand-driven, Leontief, or upstream multipliers; and forward, supply-driven, Ghoshian, or downstream multipliers. In this paper we only utilise demand driven multipliers, but for wider discussions of different multiplier effects see Miller & Blair (2009).

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 using I-O analysis to calculate demand 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

Constant-returns to scale, fixed coefficient production technology: In calculating the Leontieff multipliers, we assume 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).

Constant coefficients in consumption: 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.

No supply constraints: In our view, this is the key assumption to the use of I-O demand multipliers. 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 that are 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. A corollary of this position is that exogenous demand falls, I-O analysis assumes that there is no supply mechanism to redeploy the released resources.

Essentially a Type II demand-driven I-O multiplier is a sophisticated Keynesian multiplier. It operates in a conceptually similar way but provides greater sectoral disaggregation and models

imports and intermediate demands in a more accurate manner. It shares with the Keynesian multiplier the requirement that the supply-side of the economy plays a completely 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 in either the short or long run is less easy to maintain (McGregor et al, 1999).

A2.2 The demand driven multiplier

To derive the multipliers (and to define them precisely) it is convenient to use matrix algebra. In matrix notation, a simplified standard I-O transaction matrix for an economy with n production sectors, and a vector of value added values and a final demand vector has the following form:

$$\begin{bmatrix} X & f & q \\ y^T & 0 & 0 \\ q^T & 0 & 0 \end{bmatrix}$$

where: X is the n × n matrix of intermediate sales and purchases where $x_{i,j}$ is the sales of sector i to sector j, f is the n × 1 final demand vector, q is the n × 1 gross output vector, and y^T is the 1 × n vector of value added inputs.

All of these are conventionally expressed in value terms, and the following accounting identities hold.

$$Xi + f = q \qquad \text{(A2.1)}$$

$$i^T X + y^T = q^T \qquad \text{(A2.2)}$$

where i is an n × 1 vector of ones.

If the elements x_{ij} of equation (A2.1) are replaced by $a_{ij}q_j$, where q_j is the output of industry j and the technical coefficient a_{ij} is defined as $a_{ij} = \frac{x_{ij}}{q_j}$, the accounting identity (A2.1) can be replaced by:

$$Aq + f = q \qquad \text{(A2.3)}$$

where A is an n × n matrix whose elements are the technical coefficients a_{ij}.

If Aq is subtracted from both sides of equation (A2.3), this produces:

$$f = q - Aq = (I - A)q \qquad \text{(A2.4)}$$

where I is the n × n identity matrix.

Post-multiplying both sides of equation (A2.4) by the inverse of the (I-A) matrix gives:

$$(I - A)^{-1} f = q \qquad \text{(A2.5)}$$

The $(I\text{-}A)^{-1}$ is the Leontief inverse. This is used to calculate the vector of gross outputs, q, from the vector of final demands, f. Each element of the Leontief inverse, α_{ij}, measures the direct, indirect (and where appropriate induced) impact on sector i of a unit increase in the final demand for sector j. The sum of the elements of the jth column of the Leontief inverse is the output multiplier value for sector j.

The multiplier value for any industry is, in principle, determined by all the interactions between firms and, where appropriate, consumers within the economy. However, it is possible to make some generalisations concerning the relative size of multiplier values, usually based upon the cost characteristics of the industry receiving the initial injection.

For any industry, the multiplier values will differ between different measures of activity. That is to say, the output multiplier value will, in general, differ from the employment, income and value-added multiplier values. Further, not only are the absolute values different, but even the rankings of industries by their multiplier values can differ using different activity measures. The reasons for such differences are outlined below, but in general they revolve around the cost structure of the industry receiving the initial injection.

For any one activity measure, an industry's Type II multiplier will always be at least as large as the Type I multiplier. This is because more of the possible knock-on effects are captured by the Type II than by the Type I multiplier. Specifically, the Type I multiplier includes the indirect effects generated by the intermediate purchases made by the sector receiving the initial demand stimulus. However, the Type II multiplier also incorporates induced consumption effects generated by the change in wage income accompanying a change in a sector's activity.

The Type I output multiplier for a particular sector is strongly dependent on the proportion of its gross output that is spent on domestically-produced intermediate inputs. Where this proportion is high, we expect the Type I output multiplier to be large. High proportionate

intermediate purchases by a sector will be linked to low purchases of intermediate imports and a low ratio of value-added to gross output.

For Type I calculations, the additional employment, income and value added produced by £1 million additional final demand to one sector is influenced by two effects. One is the direct effect: the employment, income or value-added intensity of the initial sector itself. The second will be the indirect impact, which should be correlated with the output multiplier value. However how will the corresponding multiplier values be calculated? The employment multiplier can be taken as an example, but the same logic holds for income and value added.

The ratio of direct employment to gross output of £1 million in the initial industry is here identified as e_i. The additional employment generated, primarily in other industries, as a result of the Type I multiplier process is similarly identified as Δe^I_i. This value is positively related to the value of the Type I output multiplier. The total employment-output multiplier, $M^I_{Q,E}$ is given by

$$M^I_{Q,E} = e_i + \Delta e^I_i \qquad \text{(A2.6)}$$

The Type I employment-output multiplier is high therefore where both the output multiplier, determining Δe^I_i) and the direct employment-output ratio, e_i are high.

However, the conventional Type I employment multiplier, $M^I_{E,E}$ is defined as the total change in employment divided by the initial change in exogenous employment. If the initial increase in exogenous demand were £1 million, the corresponding increase in employment would be e_i. Therefore the employment multiplier is given as:

$$M^I_{E,E} = \frac{e_i + \Delta e^I_i}{e_i} = 1 + \frac{\Delta e^I_i}{e_i} \qquad \text{(A2.7)}$$

Equation (A2.7) identifies a seeming paradox. Because the direct employment-output ratio, e_i, appears in the denominator of the second term on the right hand side of equation (A2.7), ceteris paribus, the larger its value, the lower the value of $M^I_{E,E}$, That is to say, labour intensive industries tend to have a high value for the total employment generated by an additional expenditure injection. However, they have a relatively low employment multiplier.

Another factor that reinforces the low Type I employment multiplier for labour intensive industries is that the value of Δe^{I}_{i} is, in general, negatively related to the ratio of value-added to total output. However, the ratio of value-added to total output also tends to be positively related to the labour intensity e_i which again suggests a low value for $M^{I}_{E,E}$.

Exactly the same form of argument applies to the Type I income and value-added multipliers. A sector which has a high share of wage income or value added in total output will generally have high values for the additional income and value added generated by a given change in expenditure. However, their corresponding multiplier values tend to be low.

There are, in general, be differences in the Type I employment, income and value added multiplier values for the same sector. In short, a high ratio of other value added to output depresses the value-added multiplier against the income and employment multipliers. A relatively high wage depresses the wage income multiplier against the employment multiplier.

Type II multipliers are slightly different. These multipliers incorporate the impact of not only the additional intermediate demands but also the induced additional consumption expenditure. Here the value of a sector's output multiplier depends positively upon the ratio of the wages plus domestically supplied intermediate demand to gross output. Industries with low Type II output multipliers will have high imports and other value added (rents and profits payments) in proportion to their gross outputs.

For the standard Type II employment, wage income and value-added multipliers a similar relationship applies as expressed in equation (A2.7) for Type I multipliers. However, one consideration is important. In this case the value of the output multiplier should be positively, not negatively, related to the ratio of the sector's employment, income and value added intensity. However, it is still the case that a sector with a low employment-output ratio but a high wage has, ceteris paribus, a high Type II employment multiplier. On the other hand, a labour intensive sector with a relatively low wage is likely to have a low Type II employment ratio. What really matters in determining the Type II employment multipliers is the absolute size of the average wage payment and domestically-supplied intermediate expenditures per worker.

Appendix III: Derivation of student's consumption expenditure

This appendix presents the details of how the impact of students' consumption expenditures were derived. For this we draw on a comprehensive survey by Warhurst *et al* (2009)[25], who conducted a large scale survey complemented with face to face interviews. They interviewed 1,000 Scottish domiciled undergraduate students at Scottish institutions and estimated their average term time expenditure at £6,404 in the academic year 2007/2008. However, these results only refer to a part of students at Scottish HEIs as a third come from outwith Scotland[26] and 19%[27] are postgraduate. Surveys have not been carried out relating to the expenditure of students of RUK and ROW origin nor for Scottish domiciled postgraduate students. These students' expenditures are expected to be greater as expenditures generally increase with age and the year of study, and these students are staying away from home and so must pay for accommodation in full.

According to Warhurst *et al* (2009) Scottish domiciled undergraduates living independently spent on average £7,187 in 2007/2008 while those living with parents spent £5,317. The expenditure level of independently living Scottish students is used as a proxy for expenditures of incoming students. However it is reasonable to expect incoming students to have to incur more costs than locals if only due to unfamiliarity with local conditions and an inability to draw on a social network as would be the case for local students. A higher estimate for living costs is, for example, suggested by the Icelandic Student Loan fund, which estimates student expenditures (apart from tuition fees) for an academic year in Scotland at £8,520[28]. Here the rather conservative approach is adopted that the average for Scottish domiciled undergraduates is applied to all Scottish domiciled HE students and the average expenditures of Scottish domiciled undergraduates living independently is applied to all incoming students.

A number of adjustments have to be applied to the 'gross' student spending as reported by Warhurst *et al* (2009) to conform with IO assumption (their main findings on student spending in Scotland are outlined in Table 2 below). In particular care must be taken to deduct non-additional ('endogenous') spending components to avoid double counting. For Scottish domiciled students this means that the components of consumption that are treated as

[25] Warhurst *et al* (2009) build on and expand work by Callander *et al* (2005).
[26] See HESA (2007) Students in Higher Education, Table 0a
[27] See HESA (2007) Students in Higher Education, Table 0b
[28] For the academic year 2008/2009 the Icleandic Student Loan Fund (LÍN) estimates the cost of subsistance for obtaining a single ECTS credit in Scotland is £142, where a full academic year will consist of 60 credits, amounting to anticipated costs of £8,520. See: http://www.lin.is/Namslan/utlan/framfaerslutafla.html

additional (exogenous) are those that attributable to student loans, commercial credit students take out to support themselves and student support & grants as reported by Warhurst *et al* (2009). This changes slightly when the budget constraint of public expenditures in Scotland is acknowledged as student support and grants are to a significant extent[29] funded by the Scottish block grant and therefore represent a re-allocation of Scottish Government spending within Scotland (see general discussion in section 3)[30]. The student loans received by Scottish students are however treated as additional as they are provided by the Student Loans Company, a UK-level non-departmental public body. Informal transfers within the family do not constitute additional spending in Scotland as they are a re-allocation of total household spending[31]. Term-time labour market earnings are equally not-additional to the Scottish economy as under IO assumptions, of a passive supply-side, if the student was not earning that wage income some other Scotland resident would be. That leaves other income, which is assumed to be endogenous to the Scottish economy[32] and the student's income shortfall (expenditure in excess of income). Precise information is not available on the composition of this income shortfall, but it can be expected to constitute some combination of informal income/credit not previously accounted for and commercial credit. New commercial credit taken out by Scottish domiciled students represents an exogenous impact on the local economy, while informal credits are assumed to be obtained locally and therefore represent a transfer within the economy rather than an additional impact.

Warhurst et al (2009) provide information on the amount of commercial credit taken out by Scottish students during their time of study, which is used to estimate the magnitude of this impact. Care must be taken to count only the net commercial credits obtained as students run up commercial debts during term time but typically repay these to some extent between years. Table 4.15 in Warhurst et al (2009, p. 100) reports the amount of commercial credit owed by students at the end of each of their year of study. They find a wide range of commercial debt incurred by year of study. Of course it must be born in mind that their survey is a cross section but interpreted literally it suggests that students rely less on commercial credit as they progress through their studies (and a net repayment occurs between years 3 and 4). This is in line with

[29] The category also includes support from private charities. Here the conservative stance is adopted that the charities are funded from Scottish contritutions and therefore represent a re-distribution within the Scottish economy rather then an additional injection.
[30] For strict consistency this element of Scottish Government funding should be treated exactly like Scottish Government funding for HEIs in section 3. However, as this will have an insignificant impact on overall findings we take a short-cut in adopting this assumption for simplicity.
[31] In principle parents could be funding these transfers by drawing on savings or taking out new credit, but we assume they are met with consumption switching from parents to student.
[32] Information on the composition of other income is not available in Warhurst (2009). Therefore we adopt the conservative stance that it is non-additional to the Scottish economy.

their findings that students' earning power increases with year of study. Here the assumption is adopted that commercial debt levels at the end of year 4 are representative for their overall net-incurrence for the entire duration of undergraduate study.

Figure 11: Commercial credit at the end of term by year, £. Source: Warhurst et al (2009, Table 4.15, p. 100).

	Year 1	Year 2	Year 3	Year 4
Total commercial credit owed at the end of term time	968	1,240	1,699	1,384
Marginal debt incurred each year	968	272	459	-315
Implied average per year of study	968	620	566	346

Based on these assumptions the average additional ('exogenous') component of Scottish students' term time spending is £346 (1,384/4). The assumption suffers from a potential downward bias in that 4th year students are fewer than one quarter of the student population. However, it could be counter-argued that students' will use income earned in the following summer to further pay back their commercial debt so in that sense the estimate is biased upwards. Available evidence does unfortunately not allow a precise estimate but on balance the assumption adopted here should be seen as rather conservative. Available evidence (see Table 2 below) suggests that the average income shortfall of Scottish undergraduates is significantly larger each year, amounting to £ 1,073. Unfortunately Warhurst et al (2009) do not elaborate on how the income shortfall might be explained but we expect it to be met by some combination of underreported informal contributions (within household transfers), earnings outwith term-time (drawing on savings) and commercial credit.

Figure 12 Average term time income and expenditures of Scottish undergraduates, £. Source: Warhurst et al (2009, Table 2.4 & 3.4, pp. 24, 56).

	£	% of income	% of expenditure
Average total income	**5,157**	**100%**	**83%**
Student loan	1,430	28%	23%
Informal housing contribution	163	3%	3%
Informal living contribution	290	6%	5%
Term-time earnings	1,945	38%	31%
Education related grants and bursaries	759	15%	12%
Other	570	11%	9%
Average total expenditure	**6,230**	**121%**	**100%**
Housing costs	1,116	22%	18%
Living costs	3,954	77%	63%
Participation costs	957	19%	15%
Child specific costs	203	4%	3%
Other costs	110	2%	2%
Dissaving	**1,073**	**21%**	**17%**

Warhurst *et al* (2009) estimate the average term time employment income of Scottish undergraduates at £ 1,945. We assume this average holds for incoming students from other parts of the UK, while foreign students are assumed not to participate in the labour market. Finally we deduct the direct import content of student's expenditure, which we assume to equal that of Scottish households in general (32%) as reported in the Scottish Input-Output tables.

Figure 13 Derivation of per student spending

Location of domicile		Scotland	Rest of the UK	Rest of the World
Gross average student spending £	+	6,230	7187	7,187
Income from employment £	-	1,945	1,945	
Within household transfers £	-	453		
Other income £	-	570		
Dissaving £	-	1,073		
Spending attributable to new commercial credit £	+	346		
Exogenous average per student spending	=	**2,535**	**5,242**	**7,187**
Direct imports £ (32%)	-	814	1,683	2,307
Net change in final demand per student £	=	**1,721**	**3,559**	**4,880**
Number of students FTE's	x	108,398	19,236	33,273
Estimated net contribution to final demand by student population £ m	=	**186.6**	**68.5**	**162.4**

Having estimated the students' net contribution to final demand we can estimate the knock on impacts of their consumption spending. Using a student expenditure vector estimated by Kelly *et al* (2004) we derive the spending impact of the different student groups in Scotland. In total they support approximately 0.3% of GDP and this impact is primarily driven by incoming students as only a small fraction of Scottish student's expenditures is truly additional to the economy.

Figure 14 Impact of student spending in Scotland

	Student origin			
	SCO	**RUK**	**ROW**	**Total**
Output impact of student spending £m	449	165	390	1,004
% of Gross Output	*0.2%*	*0.1%*	*0.2%*	*0.4%*
GDP impact of student spending £m	185	68	161	414
% of SCO GDP	*0.2%*	*0.1%*	*0.2%*	*0.5%*
Employment impact of student spending FTE's	3,282	1,205	2,857	7,344
% of total employment	*0.2%*	*0.1%*	*0.1%*	*0.4%*

Different perspectives on students' consumption impacts

We acknowledge that the approach taken may understate the spending impact attributed to Scottish students. Adopting a modelling stance, it can be argued that the presence of the HEIs in Scotland acts to retain students in the sense that they choose to study locally rather than

elsewhere. If Scottish student's were to go elsewhere for their studies, the element of spending supported by their families and various student funding systems in Scotland that we currently treat as non-additional would be lost to the regional economy and spent elsewhere. This view is typically taken when estimating the impact of HEIs at a sub-regional level. For example Harris (1997), studying the impacts of the University of Portsmouth on surrounding boroughs, argues that if the students were not studying in the host region they would be seeking education elsewhere and therefore their spending within the region ought to be attributed to the presence of HEIs in that region. Under such an assumption we count the spending of Scottish students as part of the HEIs' impact. This assumption seems most appropriate at the sub-regional level, since at smaller spatial scales there are more options for studying outwith the host region. At the regional level a more common view, adopted for example by Kelly *et al* (2004), who estimated the impact of Scottish HEIs, is that if the students were not studying in Scotland they would still be living in the country and maintaining a similar level of spending. In this case it would clearly be inappropriate to attribute local students' expenditures to HEIs, and to do so would overestimate the impact of HEIs on general economic activity in the region.

Both views represent limiting cases. No doubt Scottish HEIs act to retain a number of local students who would otherwise have moved away to study and taken their spending with them. Similarly there are no doubt other students who would have stayed in Scotland regardless of the presence of HEIs. To some extent institutional features act as natural barrier to students taking up studies elsewhere, for example as Scottish students leave School a year earlier than in England (and many European countries) but make up for it by an extra year of undergraduate study within the four year 'Honours' degrees offered by Scottish universities. Furthermore, Warhurst et al (2009) find evidence that financial limitations cause many students to opt for the local option when it comes to higher education. Arguably, therefore, there are forces outwith the HEIs themselves that motivate Scottish students to seek higher education within Scotland.

When carrying out an accounting exercise such as this one, where we seek to identify the regional economic activity attributable to the HEIs care must be taken to maintain the consistency of Input-Output as an accounting framework. That is if the attribution approach were to be carried out for the entire economy as represented by the Input-Output table, the sum of all identified exogenous and endogenous components should equal the gross output of all sectors. However, we acknowledge there are circumstances which would motivate an analysis of the potential student retention effects of HEIs as part of a modelling exercise. An example would be when adopting shut-down assumptions (hypothetical extraction). In such cases it

would, in principle, be possible to survey students on their views to determine the extent to which Scottish domiciled students should be counted as part of the overall impact. However, such stated preferences could still be disputed and it is unlikely that we will be offered the opportunity to observe a natural experiment such as the closure of an HEI, as these are rare occurrences. At the margin it is well conceivable that Scottish students' degree of preference for home institutions could change. In the absence of further evidence the most appropriate venue for exploring the impacts of such hypothetical changes would be in simulations adopting degrees of sensitivity to the observed state.