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**Consumption Expenditures in Economic Impact Studies:
An Application to University Students**

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Abstract

We raise the issue of how appropriately to attribute economic impact to consumption expenditures. Despite the salience of the topic for applied economics it has not received much explicit attention in recent literature. In Input-Output analysis consumption expenditures are either treated as wholly endogenous or wholly exogenous. For many applications, such as those focusing on the impacts of tourism, benefits systems or student expenditures, these binomial assumptions are not satisfactory. Therefore practical necessity has resulted in conventions ('rules of thumb') for dealing with such cases. We argue that consumption is neither wholly endogenous nor wholly exogenous but that the degree of this distinction is rather an empirical matter. To deal with this issue we set out a general model for the treatment of consumption expenditures. We illustrate its application through the case of university students in Scotland and determine the exogeneity of their expenditures drawing on survey evidence. Students are a particularly useful example as we can analyse the difference in impacts between individual student groups and how the impacts of students at particular institutions are influenced by the composition of the student body. Furthermore we take into account the binding budget constraint of public expenditures (as is the case for devolved regions in the UK) and examine how this affects the impact attributed to students' consumption expenditures.

Keywords: Input-Output, Impact, Higher Education, Students, Expenditures

JEL-Codes: I23, I25, R12, R15

1 Introduction

There is some ambiguity in applied demand-driven economic impact analysis as how to treat consumption expenditures. For Input-Output analysis this is clear-cut in principle. Household consumption is either treated as wholly endogenous (Type-I) or wholly exogenous (Type-II). In many practical applications, however, this either-or distinction is not fit for purpose. This is manifested, for example, when determining the impact of tourism spending where in some cases not all of it is wholly exogenous (see for example Allan et al (2007) for the case of sports tourism in Glasgow) or when analysing the consumption spending of social groups whose consumption is partially supported by state transfers (Dunlop, XX). These problems tend to be solved by researchers on a case by case basis, but have (to our knowledge at least) received limited formal attention.

We seek to address this apparent lacuna by setting out a model, which treats the degree of exogeneity of consumption expenditures essentially as an empirical matter, determining it via a simple accounting approach, drawing on available survey data. We illustrate our case through an application to the case of students at Higher Education Institutions (HEIs) in Scotland. This case has three particular merits for our purpose: Firstly, it has been studied somewhat extensively by applied economists in the past; secondly, different types of students draw on different sources of income, therefore raising interesting challenges as how to treat the impact of these; and the availability of sufficiently good data, in particular recent surveys of students incomes and expenditures (Warhurst et al., 2009).

A number of studies have examined the impact of student's consumption (e.g. Love and McNicoll 1988, Steinacker 2005), often in the context of the host institution's expenditure impacts (e.g. Armstrong 1993, Bleaney et al 1992, Brownrigg 1973, Harris 1997, Hermansson et al 2012ab, Love & McNicoll 1990). There have been two alternative treatments of student expenditures in past impact studies: one incorporates only the expenditures of in-coming students (e.g. Kelly *et al*, 2004), the other includes all student expenditures, irrespective of their origin (e.g. Harris, 1997).

We argue that each of these past treatments represents an approximation to an input-output accounting approach in which the crucial distinction is between the exogenous and endogenous components of student expenditures. External students' expenditures (net of direct imports) can be regarded as exogenous to the host region. However, home students' expenditures cannot legitimately be treated as either wholly endogenous, which would validate the first approach, nor wholly exogenous, which would validate the second. We apply our model based on a recent survey of sources of student incomes in Scotland (Warhurst *et al*, 2009), to allow a more nuanced, and more informed, distinction between the exogenous and endogenous components of student expenditures. We first show the significance of the approach by estimating the impacts of expenditures of the entire student population in Scotland and comparing the results with those generated by the two alternative approaches. We further consider variations in student impacts across HEIs and show how different assumptions affect individual institutions heterogeneously.

A part of student's consumption is funded by public grants. Devolved regions like Scotland are subject to a public expenditure constraint determined by the Barnett formula. This implies that public funds allocated to students cannot be used to finance other types of public expenditure. Similarly, public funding of students at HEIs in Scotland has an opportunity cost for the Scottish government (Hermannsson *et al*, 2010ab). We explore the impact of accommodating this funding constraint in our attribution analysis in order to isolate that part of the overall impact of student expenditures that is attributable to students *per se*, rather than to the public funding that they receive. The *balanced expenditure* multipliers that we derive for student expenditures incorporate an adjustment for the alternative use of public funds (to expand aggregate public expenditure).

In the next section we discuss the conventional treatment of consumption in Input-Output models, focussing on the example of higher education students. Then, we set out a general model for consumption impacts and demonstrate its use based on survey information for the income and expenditures of students. In the fourth section we analyse the expenditure impacts of students' consumption expenditures in Scotland and show how results based on empirically determined exogeneity parameters differ from those derived under conventional 'rule of thumb' assumptions applied in the literature. Furthermore, we show how the model can accommodate the binding budget constraint of devolved public expenditures in Scotland. In the fifth section we apply the model to the expenditure impact of students at individual

institutions to analyse the degree of heterogeneity of impacts, what drives this heterogeneity and whether conventional assumptions lead to heterogeneously biased results for individual institutions. Again, we explore the balanced expenditure impacts of students' consumption expenditures, this time based on students at individual HEIs. Brief conclusions are presented in Section 6.

2 The treatment consumption in IO models and established conventions for student expenditures

In Input-Output analysis household consumption is either treated as wholly exogenous or entirely endogenous. These are referred to as Type-I and Type-II cases (for a general discussion see Leontief 1986, Miller 1998, Miller & Blair 1999). In the first case households' consumption expenditures provide an exogenous injection to the economy under analysis and the multiplier captures the internal feedbacks this drives. In the second case the model is closed with regards to wages and household expenditures. In this setting the remaining exogenous elements (typically government expenditures, investments and exports) drive endogenous feedbacks, i.e. intermediate trade and household consumption, which respond passively to responses in external stimuli.

Elaborations on the type-II principle include Type-III and Type-IV multipliers. Whereas Type-II multipliers assume a linear relationship between total income and total consumption spending for all consumers, Type-III multipliers (Myernik, 1967) adjust these for the spending patterns of different income groups. Type-IV multipliers (Batey & Madden 1983) make a distinction between those households where average consumption coefficients apply (such as in the Type-II case) and those where marginal consumption coefficients are more relevant, such as in-migrants or those that are re-employed out of unemployment. Although these are useful refinements of the Type-II multiplier they relate to the pattern of expenditures generate by household consumption rather than the determination of endogeneity or exogeneity of the income driving those expenditures. Therefore, the basic dichotomy between all in or nothing remains.

This dichotomous distinction can be overly simplistic for applied work. In many cases household consumption is partially endogenous and partially exogenous and capturing that nuance can be important for accurately assessing the economic impact of the subject being

studied. An example of this is the case of football tourists in Glasgow as illustrated by Allan *et al* (2007). Glasgow's football fixtures attract a large number of spectators, from within the city, other parts of Scotland and further afield. Some of the associated consumption expenditures are net injection to the city economy (exogenous), while the expenditures of local spectators displace other consumption expenditures and are therefore endogenous. Other examples include the impact of transfer payments (Dunlop, xx) and students (Hermannsson, 2010ab).

Several studies have analysed the consumption expenditures of students and how they impact their host economy. Often the motivation is to study expenditure impacts of particular HEIs, one component of which are the consumption expenditures of associated students. Two conflicting approaches to measuring this impact have been employed in the literature. The first is typically motivated, in effect, by an assumption that all students would have studied elsewhere in the absence of local HEIs, as in Bhattu *et al* (1998) and Harris (1997). On this assumption the whole of all students' expenditures in the host region are directly attributed to that region's HEI(s). In the remainder of the paper we shall refer to this as the 'All Included' (AI) approach. The alternative treatment takes the expenditures of students who move into the region to study to be the only genuinely additional part of student expenditures, as in Kelly *et al* (2004). For convenience we label this as the 'External Only' (EO) approach. This view is often motivated in terms of the notion that indigenous students are likely to remain in the region even in the absence of HEIs. For small host regions with a single HEI, which is the case Bhattu *et al* (1998) and Harris (1997) were considering, the former (AI) view may appear to be more convincing since many of the students are likely to be in-migrants anyway, and it may be easy for any indigenous students to travel to study at an alternative HEI. However, in the context of a study of the expenditure impacts of students at individual HEIs in a much larger region like Scotland, with 20 HEIs, the second (EO) treatment is often favoured.

In this context, attributing regional economic activity to the whole of students' expenditures is tantamount to assuming that all of these expenditures are exogenous to the region. In contrast, attributing regional economic activity only to in-migrant students effectively assumes that all of the expenditures of home students are endogenous, since no activity is attributed to their spending. Neither of these limiting assumptions is likely to be satisfied in practice, rather some parts of student expenditures are likely to be exogenous and some parts are likely to be endogenous.

In order to clarify this it is helpful to consider the different groups of students that will comprise the typical HEI's student body: overseas students; students from other regions of the UK, and home students. For students who are attracted into the region from outwith the UK, it is reasonable to assume that the whole of their expenditure is exogenous, since it is entirely funded by activity in the rest of the World (whether by students' own saving, family or governmental transfers).

However, for students who come to study from another region of the UK matters are less clear cut. Local employment is much more likely than it is for overseas students, given the shared language, culture and absence of legal barriers to employment. This element of student funding is clearly endogenous to the host region. However, expenditure financed by parents in RUK, from borrowing, by other regional governments, or by the national government, is appropriately treated as exogenous.

Finally, it seems very unlikely that local or home students' expenditures can legitimately be treated as either wholly exogenous or wholly endogenous, though we would expect a greater degree of endogeneity for home students as compared to those who move in to Scotland to study at an HEI there from other regions of the UK. Many students work part-time and many receive support out of parental incomes, and so at least a part of their expenditures are very likely to be endogenous. However, the presence of some Scottish government funding and credit financing suggest that at least a part of Scottish students' expenditures should be regarded as exogenous.

On *a priori* considerations alone only the treatment of overseas student expenditures as exogenous seems entirely appropriate within both approaches. Conversely, both approaches (identical) treatment of the expenditures of students from RUK as entirely exogenous is questionable. Furthermore, both approach's treatment of home students' spending is dubious, but for different reasons. If the AI approach potentially overstates student impacts by treating their consumption expenditures as entirely exogenous, the EO assumption, that they are entirely endogenous amounts to throwing out the baby with the bathwater.

If we were compelled to choose which student group's expenditures are endogenous and which exogenous on the basis of no further information, we would probably opt for the (EO) version that includes only external students' expenditures as exogenous, since we know that

the (AI) alternative certainly overstates the impact of student expenditures. We could also adopt an agnostic stance by calculating both estimates of impact and leaving the choice to readers, knowing that the truth must lie somewhere in-between. However, it is crucial to recognise that there is nothing compelling us to make a choice from among such constrained alternatives: we can instead seek to identify which *elements* of student expenditures are likely to be endogenous and which are most appropriately treated as exogenous. In principle, at least, this should result in an improved treatment of the expenditures of both students from RUK and from the host region.

In contrast, we develop an alternative approach, which is novel in the context of the HEIs impact literature, but entirely consistent with the use of IO as an accounting framework to determine the economic activity attributable to HEIs (Hermannsson *et al*, 2010ab). We label this alternative as the Exogenous-Endogenous Attribution (EEA) approach. In our alternative approach the key focus is on the distinction between those elements of student expenditures that are exogenous to the host economy and those that are endogenous: we then attribute endogenous economic activity to each of the exogenous expenditures using a multiplier model.

3 A model of student's consumption expenditure impact

In practice accounting for the implicitly linked (exogenous) students' expenditure involves: determining the level of student spending; judging the extent to which this is exogenous to the host economy, and identifying how student expenditures are distributed among sectors. Then an Input-Output model can be used to derive the knock-on impacts of these expenditures.

In the Leontief model, gross output in the economy (\mathbf{q}) is determined as the product of the Leontief inverse $(\mathbf{1} - \mathbf{A})^{-1}$ and a vector of final demands (\mathbf{f}):

$$\mathbf{q} = (\mathbf{1} - \mathbf{A})^{-1}\mathbf{f} \quad (1.a)$$

In Input-Output parlance, what we need to do is to estimate the share of final demand attributable to students (\mathbf{f}^s). This is determined as:

$$f_n^s = v_c^s c_n^s x_n (1 - \delta) \quad (2.a)$$

where v_c^s is a vector that reveals the sectoral breakdown of students' consumption expenditures¹, c_n^s is the average gross consumption expenditures of student type n, x_n is the share of gross consumption expenditures of student group n that is exogenous and δ is the direct import share, which is equal across all student groups and fixed at 32.0% (equal to that of households in the Scottish IO-tables).

The columns of the Leontief inverse can be summed to obtain output multipliers. From this point of view a sector's output (q) can be determined as the product of the final demand for the sector's outputs f and the relevant multiplier (m):

$$q = f m \quad (1.b)$$

An output multiplier for students- consumption expenditures (m^c) can be obtained by post multiplying the Leontief inverse with the sectoral breakdown of students' consumption (v_c^s):

$$m^c = (\mathbf{1} - \mathbf{A})^{-1} v_c^s \quad (3)$$

This multiplier is effectively a weighted average of the output multipliers of all the local sectors students purchase from².

Furthermore, using the scalar notation introduced in equations 1.b and 3, equation 2.a can be modified so that the final consumption demand of a student representative of type/group n can be expressed as:

$$f_n^s = c_n^s x_n (1 - \delta) \quad (2.b)$$

where c_n^s is the average gross consumption expenditures of student type n, x_n is the share of gross consumption expenditures of student group n that is exogenous and δ is the direct import share, which is equal across all student groups and fixed at 32.0% (equal to that of

¹ This is obtained from a survey carried out by Kelly et al (2004). We assume this same consumption pattern holds across all student groups.

² That is: $m^c = \sum \alpha_i^s m_i$ where $\alpha_i^s = f_i^s / \sum f_i^s$.

households in the Scottish IO-tables). Furthermore, Inserting equations 2.b and 3 into equation 1.b the output impact of a student's consumption expenditures can be represented as:

$$q^s = m^c c_n^s x_n (1 - \delta) \quad (4)$$

The earlier approaches can be seen, in effect, as special cases of our own, which resolve the difficulty simply by assuming that either all, or only external, students' expenditures can be regarded as exogenous. In general, however, the distinction between exogenous and endogenous components of student expenditures is likely to be rather more complex than either of the traditional treatments recognise.

4 IO-impacts under different assumptions about the exogeneity of students' consumption expenditures

In this section we shall demonstrate how survey evidence can be used to determine to what extent the consumption expenditures of students are exogenous to their host region of study. This attribution is then used to determine the expenditure impact of the HE-student population in Scotland under the EEA approach. In a following sub-section we analyse the composition of this impact more closely and make a comparison with the results that would be obtained under the alternative (AI and EO) approaches. Finally we re-examine the assumption that devolved government's contributions to students is treated as exogenous and determine the "balanced expenditure" impacts of students' consumption expenditures by explicitly acknowledging the binding budget constraint of the Scottish Government.

In the case of *external* students the identification of exogenous expenditures is straightforward. The whole of external students' expenditures are unambiguously exogenous as their incomes are derived from an external location, i.e. $x_n = 1$. The treatment of their expenditure is similar to that of tourists. For *local* students, however, 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. However, under the EEA approach local students' expenditures contain some exogenous elements. We take these

to be expenditures that are 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 the comprehensive survey by Warhurst *et al* (2009). We begin by identifying the scale of Scottish students' expenditures and how they are funded. The full details of how student expenditures are determined are reported in the Appendix of Hermannsson *et al* (2010a) but the results are summarised in Table 1.

Table 1 Derivation of exogenous student spending by place of domicile

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 £ ($c_n^s x_n$)	=	2,535	5,242	7,187
Direct imports £ ($\delta=32\%$)	-	811	1,677	2,300
Final demand for output of local sectors per student £ ($c_n^s x_n(1-\delta)$)	=	1,724	3,565	4,887
Number of students FTE's	x	114,262	22,052	24,555
Net contribution to final demand for output of local sectors £m (f_n^s)	=	197.0	78.6	120.0

To illustrate how we arrive at our results, it is useful to run through each column of the table. If we begin with the case of Scottish students the starting point is the average expenditure of Scottish domiciled undergraduate students as reported in Warhurst *et al* (2009) £6,230. From this we make a number of deductions for income sources that are endogenous to the Scottish economy, that is 'Income from employment', 'Within household transfers', 'Other income', and 'Dissaving'. These are all derived directly or indirectly from results reported by Warhurst *et al* (2009) as is detailed in the Appendix of Hermannsson *et al* (2010a). Furthermore we add back an estimate for expenditures supported by students taking out additional commercial credit during their studies. This results in an estimate of the exogenous element of the expenditures of the average student, which is equivalent to $c_n^s x_n$ in our expenditure model. Then we deduct the direct import component of these expenditures based on the direct import rate of Scottish households ($\delta=32\%$). This results in the exogenous expenditures of the average student of a Scottish domicile on local sectors (£1,724). This is equivalent to $c_n^s x_n(1 - \delta)$ in our student

impact model. Once this per student impact has been determined it is straightforward to scale this up to the impact of the entire student group by drawing on FTE student numbers³.

The same process is applied to incoming students. However, in this case the starting point is different. In the absence of survey evidence of the expenditure levels of incoming students we use the average expenditures of Scottish students living independently (£7,187) as a proxy of the living expenditures of incoming students. For incoming students these expenditures are exogenous to the Scottish economy, except that we assume students from the rest of the UK to participate in the labour market at the same rate as Scottish students⁴. The same procedure is applied as before to deduct the direct import content of the exogenous expenditures.

There are a number of points worth noting from Table 1. First our estimate of exogenous expenditure per local student ($c_n^S x_n$) is £2,535 which is less than half of the estimated £5,242⁵ of exogenous expenditures by the typical student from RUK studying in Scotland, and only 35% of the corresponding estimate for an ROW student⁶. Accordingly, our treatment implies that it would be inappropriate to regard the whole of Scottish students' expenditures as exogenous, since elements are clearly endogenous (including those related to income from employment), as is assumed by one traditional impact measure. Equally, while the endogenous expenditures of local students constitute 41% of their total expenditure, this is well below the 100% effectively assumed by the other traditional approach to estimating student expenditure impacts.

Our approach clearly has an impact on the stimulus to demand that student expenditures represent. Once direct imports are deducted from estimated exogenous student expenditures, we obtain estimates of the *per student* contribution to local final demand. This is much higher for RUK and ROW students than for home students. However, to obtain total impacts on final demand we multiply by the number of students in each category, and the results are reported

³ These are obtained from the Higher Education Statistics Agency (HESA).

⁴ These assumptions are stylised but are used for simplification in the absence of more detailed information. Anecdotal evidence suggests that some foreign students participate in the labour market, most notably postgraduate students who may be employed by their HEIs for work such as tutoring. However, the magnitude of this labour market participation is unlikely to be similar to that of local students.

⁵ 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.

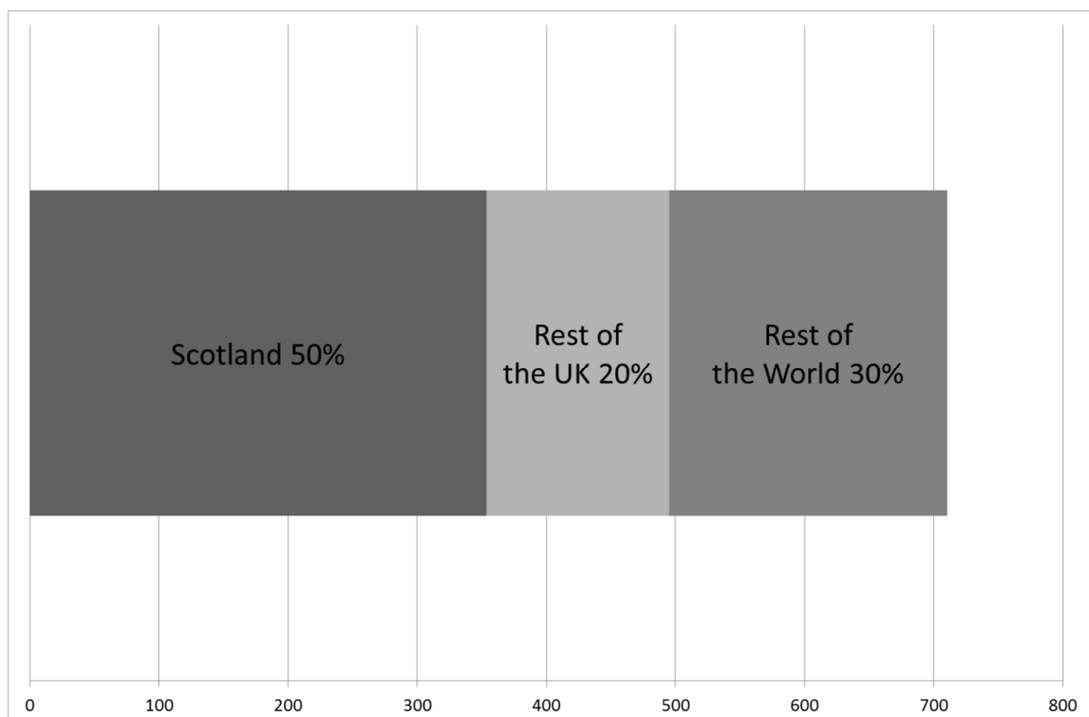
⁶ Incoming students generally spend more than locals. In the absence of survey information this is proxied by using reported expenditure figures for Scottish students living independently.

in the final row of Table 1. Our estimates imply that local student expenditures contribute £197.0 million to local final demand, about one and a half times more than the amount contributed by ROW students and over two and a half times that of RUK students.

Once students' contribution to final demand has been determined the next step is to estimate the knock-on impacts of their consumption spending. The Type-II output multiplier for student consumption spending (m^c) derived from the IO tables is 1.8. Hence, a direct injection of £395.6 million (the sum of the elements in the bottom row of Table 1 generates £710.6 million of output in the Scottish economy, as is summarised in Figure 1 below, or approximately 0.4% of total output.

Despite the relatively modest impact *per student*, Scottish students make up approximately two thirds of the student population and therefore drive a significant portion of total student final demand and account for approximately half of the total student consumption impact. The consumption spending of students from the rest of the world is a little less, accounting for 30% of the total consumption impact, and the remaining 20% is attributable to the expenditure of students from the rest of the UK.

Figure 1 Output impact of student spending in Scotland disaggregated by student origin, £m



As we have seen, our accounts of the exogenous spending of students and the student consumption multiplier derived from the IO-table are sufficient to estimate the output impact of each student group in Scotland. However, in order better to illustrate what drives the student expenditure impact and to facilitate comparison between outcomes under different assumptions/approaches, we shall compare output impacts of students in Scotland as a whole based on alternative assumptions about the exogeneity of the consumption expenditures of different student groups.

4.1 Comparison of students' consumption impacts under different approaches

Table 1 demonstrates how the exogenous expenditures of different student groups add up to reveal differences in final demand expenditures by student groups. Furthermore, equation 4 shows how, the differences in final demand expenditures by student groups can be accommodated in an impact model. For each of these student groups the consumption multiplier is the same but the differences in impacts are driven by their gross expenditures c_n^s and the extent to which these expenditures are exogenous x_n .

Acknowledging the differences in final demand impacts across student groups is a step in the right direction. However, multipliers offer the benefit of a scale-independent metric which is convenient for comparison. Therefore, it is useful to derive an expenditure multiplier for each student group to facilitate comparison of their impacts.

To obtain a multiplier (control for scale) we can divide through with gross consumption c_n^s , so that:

$$m_n^s = \frac{q^s}{c_n^s} = m^c x_n (1 - \delta) \quad (5)$$

This multiplier is not directly comparable with conventional IO output multipliers, as it does not relate final demand to output impact, but has been modified to show the link between gross student expenditures and the output impact of students' consumption expenditures.

The estimates for exogenous and endogenous consumption expenditures of different student types can easily be summarised in terms of the parameters of our student impact model. A summary of these parameters is presented in Table 2 below.

What we want to do next is to show how these individual impacts can be scaled up to reflect the impact of whole student populations, but also to aggregate group impacts to show combinations of different student groups for entire regions, such as Scotland, or individual HEIs there within, as we explore in the next section.

Table 2 Comparison of parameters for the student spending model and estimated per student impacts, by student origin.

		Scotland	Rest of the UK	Rest of the World
Gross consumption	c_n^s	6,230	7,187	7,187
Consumption multiplier	m^c	1.80	1.80	1.80
Exogenous share of expenditures	x_n	41%	73%	100%
Share of direct imports in expenditures	δ	32%	32%	32%
Students' gross-expenditure/output multiplier	m_n^s	0.50	0.89	1.22
Output impact of consumption expenditures	q_n^s	3,097	6,403	8,779
Number of students FTEs	v_n	114,262	22,052	24,555
Impact of student group/type n (£m)	\bar{q}^s	354	141	216

Scaling up is straightforward, we simply multiply the impact of a single student representative of group/type n, with the number of FTE students belonging to that category (s_n). If we use bar to represent a whole group of students of type n, then the output impact of their consumption expenditures can be represented as:

$$\bar{q}_n^s = m_n^s c_n^s s_n = m^c x_n (1 - \delta) c_n^s s_n \quad (5)$$

Furthermore, impact of different student groups n can be aggregated to provide the consumption impact of the entire student population:

$$\bar{q}^s = \sum_n m_n^s c_n^s s_n = m^c \sum_n x_n (1 - \delta) c_n^s s_n \quad (6.a)$$

However, we may want to obtain a scale independent metric of the impacts of the group of students attributable to particular regions or institutions (who are in turn made up of

combinations of student groups with different expenditure characteristics). The obvious solution here would be to divide through the impact estimate with the final demand. However, since in this case the variation between different student types comes through the final demand but not the expenditure structure as such, dividing through with final demand would only give us the consumption multiplier m^c , which is the same for all students. However, it is of course possible to divide through equation 6.a with the number of students (s_{ni}) to obtain an indicator of the output impact of the consumption expenditures of the average student. If we use a "hat" to denote the average impact of students at institution i , this can be expressed as

$$\hat{q}_i^s = \frac{\bar{q}_i^s}{\sum_n s_{ni}} \quad (7)$$

where $\sum_n s_{ni}$ represents the total of all students (sum over all n types) at HEI i .

As we saw in Table 2 there are two elements that drive the difference in impacts between students of different origins. First, students from different origins differ in their gross consumption expenditures, which are estimated at £6,230 for each local students and £7,178 for each student who moves into Scotland for study (either from the Rest of the UK or the Rest of the World). Secondly, how these gross expenditures translate into economy-wide impacts varies as the share of exogenous expenditures differs between different student types. This, in turn, affects the gross-expenditure/output multiplier m_n^s . However, in this study the share of exogenous expenditures x_n is determined empirically, whereas in previous literature this parameter is based on simplifying assumptions

For the External Only (EO) approach the assumption is that $x=0$ for local students but that $x=100\%$ for incoming students. In the case of Scotland this would mean that $X_{SCO}=0$ and $X_{RUK}=X_{ROW}=1$. For the All Included (AI) approach we are effectively assuming that $X=1$ for all students, so that in the case of Scotland this would mean that $X_{SCO}=X_{RUK}=X_{ROW}=1$. Therefore, we can see that the EO approach underestimates the impact of local students and overestimates the impact of RUK students, but is an accurate assumption for ROW students. The AI approach, however, overestimates both the impacts of Scottish and RUK students, while being accurate for the case of those coming in from the rest of the World.

These broad brush approaches have been used as simplifying assumptions, but with the availability of better data it is possible, as we have demonstrated, to estimate the exogenous share of students' expenditure more accurately and therefore we can determine the degree to which the simplifying approaches are off the mark.

Table 3: Exogeneity shares (x_n) and impacts per student (q^s) under different assumptions about the exogeneity of students' consumption expenditures.

Approach	Exogenous expenditures as a share of gross expenditures			Impact of average student £			
	x_{SCO}	x_{RUK}	x_{ROW}	\hat{q}_{SCO}^s	\hat{q}_{RUK}^s	\hat{q}_{ROW}^s	\hat{q}_{All}^s
Endogenous Exogenous Attribution (EEA)	0.41	0.73	1	3,097	6,403	8,779	4,417
External Only (EO)	0	1	1	0	8,779	8,779	2,544
All Included (AI)	1	1	1	7,610	8,779	8,779	7,949

A priori we know that the average expenditure per student under the EEA approach \hat{q}_{All}^s is less than under the AI approach. However, for the EO approach the ranking of impacts vis-à-vis the EEA approach is not clear ex ante and depends on the composition of the student population into local and external students. Table 3 above summarises the treatment of students' consumption expenditures under each of the three approaches and how this results in significantly different impacts. The left hand panel presents the exogeneity shares x_n , whilst the right hand panel presents corresponding per student impacts. The rightmost column shows the average across all students at Scottish HEIs. The three different approaches result in significantly different results. The impact of the average student is £4,417 under the Endogenous-Exogenous Attribution approach. However, the commonly applied External Only approach results in an average impact of 2,544, which is just under 60% of our baseline approach. Alternatively, the All Included approach results in an average per student impact amounting to £7,949. That is nearly twice that of the Exogenous-Endogenous Attribution (EEA) approach and more than three times that of the EO approach. As is expected, these variations in x_n impact student groups in different ways. For students from the rest of the World, there is no change in estimated impacts as these are treated the same under all approaches. However, the EEA approach assigns a significantly weaker impact per RUK student, or £6,043 compared

to £8,779 under the EO and AI approaches. However, the biggest influence of these different approaches is on how we estimate the impacts of the local students, with impacts per Scottish student ranging from £0 under the EO approach to £7,610 under the AI approach, and £3,097 under the EEA approach.

4.2 Re-examining the exogeneity of devolved public expenditures

Part of Scottish students' expenditures are funded by grants provided by the Scottish Government. In the previous section we treated these expenditures as exogenous, as in Input-Output analysis government expenditures are typically treated as exogenous. In this subsection we revise this assumption and explore what implications it has for the impacts of students' consumption expenditures. This is important as the devolved Scottish Government effectively has a binding budget constraint, so that the Scottish Government's expenditure on HEI students displaces other public expenditure in Scotland. This is because the Scottish Government is financed through a block grant from the UK Government using the population-based Barnett formula (Christie and Swales, 2009)⁷; has no borrowing powers and only a limited ability to shift expenditure between accounting periods.

Hermannsson *et al.* (2010a) shows that the Scottish Government's budget constraint has an important impact on estimates of the expenditure effects of the HEI sector as a whole. Furthermore, Hermannsson *et al.* (2010b) extends this analysis to individual institutions and shows that the effect of this constraint varies significantly among HEIs.

Given available information on the extent that students' consumption expenditures are contingent upon Scottish Government funding, adjusting the attribution of students' expenditures so that these are treated as endogenous is straightforward. Warhurst *et al.* (2009, Table 2.4, p. 24) report that 'Education Related Grants and Bursaries' constitute £759 of students income. This amounts to 12.2% of Scottish students' average expenditures and is to a significant extent funded by the Scottish block grant⁸.

⁷ The Scottish Parliament does have the power to vary the standard rate of income tax by up to 3p in the pound. We abstract from this possibility here since all of the Scottish political parties are committed to not using this power. Lecca *et al.* (2010) give an analysis of the consequences of this tax-raising power being exercised by the Scottish Parliament.

⁸ The category also includes support from private charities. Here the conservative stance is adopted that the charities are funded from Scottish contributions and therefore represent a re-distribution within the Scottish economy rather than an additional injection.

Table 4 reveals how this acknowledgement of the binding budget constraint of the Scottish Government impacts the exogeneity share of students' expenditures and the output impact of the average student. As we can see the degree of Scottish students' expenditures is significantly reduced, from 41% to 29%, or approximately by a third. Incoming students are not affected by this as they are not funded by the Scottish Government, hence their consumption impact is unchanged whether we take into account the budget constraint of the Scottish Government or not. As we can see from the right hand column of the table, the impact of the average Scottish student is reduced by £928, whereas the impact of the average student over the entire student population is reduced by £659 or just under 15%.

Table 4 Exogeneity shares (x_n) and impacts per student (q^s) under the EEA-approach given different assumptions about the exogeneity of Scottish Government expenditures.

Approach	Exogenous expenditures as a share of gross expenditures			Impact of average student £			
	x_{SCO}	x_{RUK}	x_{ROW}	\hat{q}_{SCO}^s	\hat{q}_{RUK}^s	\hat{q}_{ROW}^s	\hat{q}_{AU}^s
EEA (ScotGov = Exogenous)	41%	73%	100%	3,097	6,403	8,779	4,417
EEA (ScotGov = Endogenous)	29%	73%	100%	2,169	6,403	8,779	3,759

Estimates of the output impacts of the entire student population in Scotland under the two assumptions are presented in Table 5 below. As we can see, once these changes in the impact of the individual student have been scaled up using the number of students, the reduction in impact adds up to £106. As the impact of incoming students is unchanged by this the relative composition of the impact of the student population is altered, with Scottish students only accounting for 41% of the total impacts compared with 50% earlier and incoming students now driving 59% of the impact as opposed to 50% earlier. Therefore, in the case of devolved regions we would advocate treating regional government expenditures as endogenous.

Table 5 Comparison of output impacts under the EEA-approach treating Scottish Government expenditures as exogenous (top rows) or as endogenous (bottom rows).

	ROS	RUK	ROW	Total
ScotGov = Exogenous	354	141	216	711
<i>Share of total</i>	<i>50%</i>	<i>20%</i>	<i>30%</i>	<i>100%</i>
ScotGov = Endogenous	248	141	216	605
<i>Share of total</i>	<i>41%</i>	<i>23%</i>	<i>36%</i>	<i>100%</i>

5 Impact of students at individual institutions

As we have seen it is clear that traditional simplifying assumptions adopted systematically over- or underestimate the consumption impact of students at the aggregate level. However, we know that HEIs are heterogeneous (Hermannsson et al, 2010b) and serve widely different student population. Therefore, we are curious to know to what extent the biases of the two traditional approaches impact individual institutions differently and how widely impacts of the average student differ across individual institutions.

From Table 3 we know that the impact of the average student differs significantly depending on origin. Therefore, we know that the impact of the student population at an individual HEI will be driven by two factors: the scale of the student population and its composition.

Going back to equation 6.b, the output impact driven by the consumption expenditures of students at institution i can be represented as:

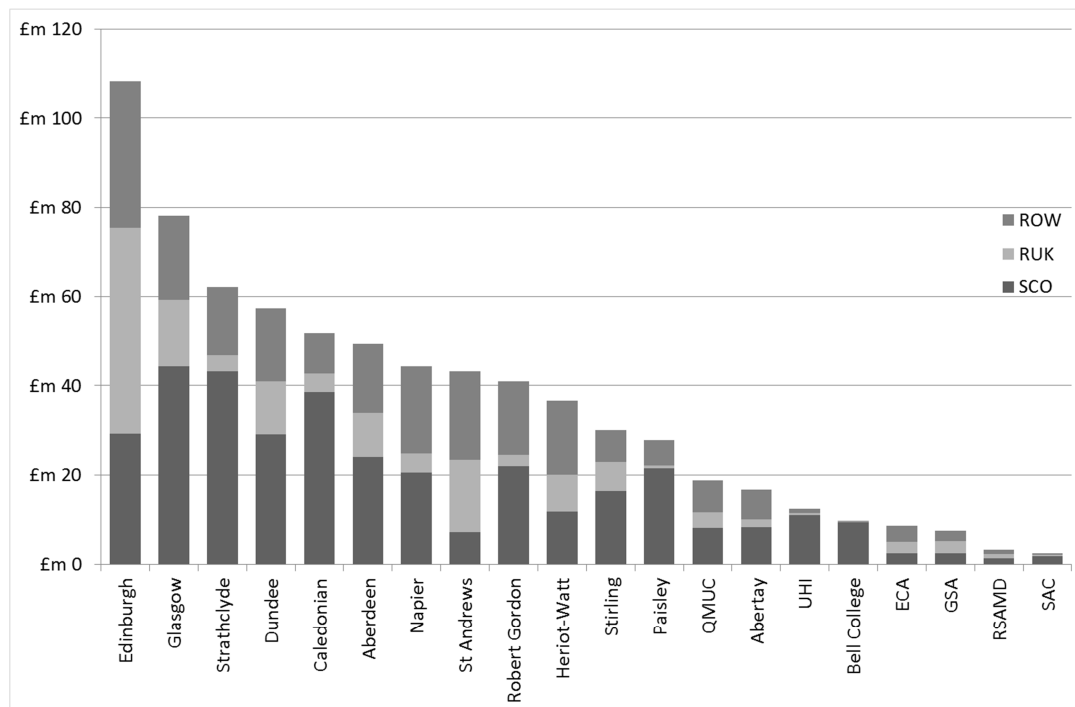
$$\bar{q}_i^s = \sum_{ni} m_{ni}^s c_{ni}^s s_{ni} = m^c \sum_{ni} x_{ni} (1 - \delta) c_{ni}^s s_{ni} \quad (6.b)$$

Table 6 below presents the Type-II output impact of students at different institutions. The first set of columns reveal the absolute size (as measured in FTEs) and composition (%) of the student population by origin, then we present estimates of students' exogenous consumption expenditures under the EEA approach and the next set of columns reveal the output impact of these exogenous injections. All these figures are broken down by student origin. Finally, we present the impact of the average student at each institution. A further graphic summary of the impacts of students' consumption expenditures at each institution is provided in Figure 2.

Table 6 Students' consumption impacts by institution

	Number of FTE students by origin (v_n) and % share of each group								Exogenous student spending ($C_n^s X_n^s(1-\delta)$) £m				Type-II Output impact of student spending ($m^c C_n^s X_n^s(1-\delta)$), £m				Output impact of average student (\hat{q}_{All}^s), £
	S_{SCO}		S_{RUK}		S_{ROW}		ΣS_n		SCO	RUK	ROW	Total	SCO	RUK	ROW	Total	
Aberdeen	7,749	70%	1,557	14%	1,774	16%	11,079	100%	13.4	5.5	8.7	27.6	24.0	10.0	15.6	49.5	4,471
Abertay	2,704	72%	278	7%	749	20%	3,731	100%	4.7	1.0	3.7	9.3	8.4	1.8	6.6	16.7	4,484
Bell College	3,067	99%	19	1%	4	0%	3,091	100%	5.3	0.1	0.0	5.4	9.5	0.1	0.0	9.7	3,126
Dundee	9,462	72%	1,810	14%	1,868	14%	13,140	100%	16.3	6.5	9.1	31.9	29.3	11.6	16.4	57.3	4,360
ECA	799	49%	379	23%	442	27%	1,620	100%	1.4	1.4	2.2	4.9	2.5	2.4	3.9	8.8	5,420
Edinburgh	9,495	46%	7,201	35%	3,745	18%	20,440	100%	16.4	25.7	18.3	60.3	29.4	46.1	32.9	108.4	5,303
Caledonian	12,466	88%	629	4%	1,054	7%	14,149	100%	21.5	2.2	5.2	28.9	38.6	4.0	9.3	51.9	3,667
GSA	789	53%	423	28%	289	19%	1,501	100%	1.4	1.5	1.4	4.3	2.4	2.7	2.5	7.7	5,122
Glasgow	14,267	76%	2,360	13%	2,145	11%	18,773	100%	24.6	8.4	10.5	43.5	44.2	15.1	18.8	78.1	4,162
Heriot-Watt	3,859	55%	1,276	18%	1,892	27%	7,027	100%	6.7	4.5	9.2	20.4	12.0	8.2	16.6	36.7	5,227
Napier	6,627	70%	675	7%	2,220	23%	9,522	100%	11.4	2.4	10.8	24.7	20.5	4.3	19.5	44.3	4,656
Paisley	6,940	90%	114	1%	661	9%	7,716	100%	12.0	0.4	3.2	15.6	21.5	0.7	5.8	28.0	3,632
QMUC	2,648	66%	549	14%	817	20%	4,013	100%	4.6	2.0	4.0	10.5	8.2	3.5	7.2	18.9	4,705
Robert Gordon	7,121	76%	395	4%	1,867	20%	9,383	100%	12.3	1.4	9.1	22.8	22.1	2.5	16.4	41.0	4,367
RSAMD	439	65%	135	20%	105	15%	678	100%	0.8	0.5	0.5	1.7	1.4	0.9	0.9	3.1	4,629
St Andrews	2,370	33%	2,512	35%	2,245	31%	7,128	100%	4.1	9.0	11.0	24.0	7.3	16.1	19.7	43.1	6,052
SAC	603	89%	46	7%	26	4%	675	100%	1.0	0.2	0.1	1.3	1.9	0.3	0.2	2.4	3,542
Stirling	5,344	75%	1,011	14%	811	11%	7,165	100%	9.2	3.6	4.0	16.8	16.5	6.5	7.1	30.1	4,206
Strathclyde	13,913	86%	611	4%	1,729	11%	16,253	100%	24.0	2.2	8.4	34.6	43.1	3.9	15.2	62.2	3,825
UHI	3,599	95%	72	2%	114	3%	3,785	100%	6.2	0.3	0.6	7.0	11.1	0.5	1.0	12.6	3,331
Total/average	114,262	71%	22,052	14%	24,555	15%	160,870	100%	197	79	120	396	354	141	216	711	4,417

Figure 2: The Type-II output impact of students' consumption expenditures by institution and student origin, ranked by size of impact (£m).

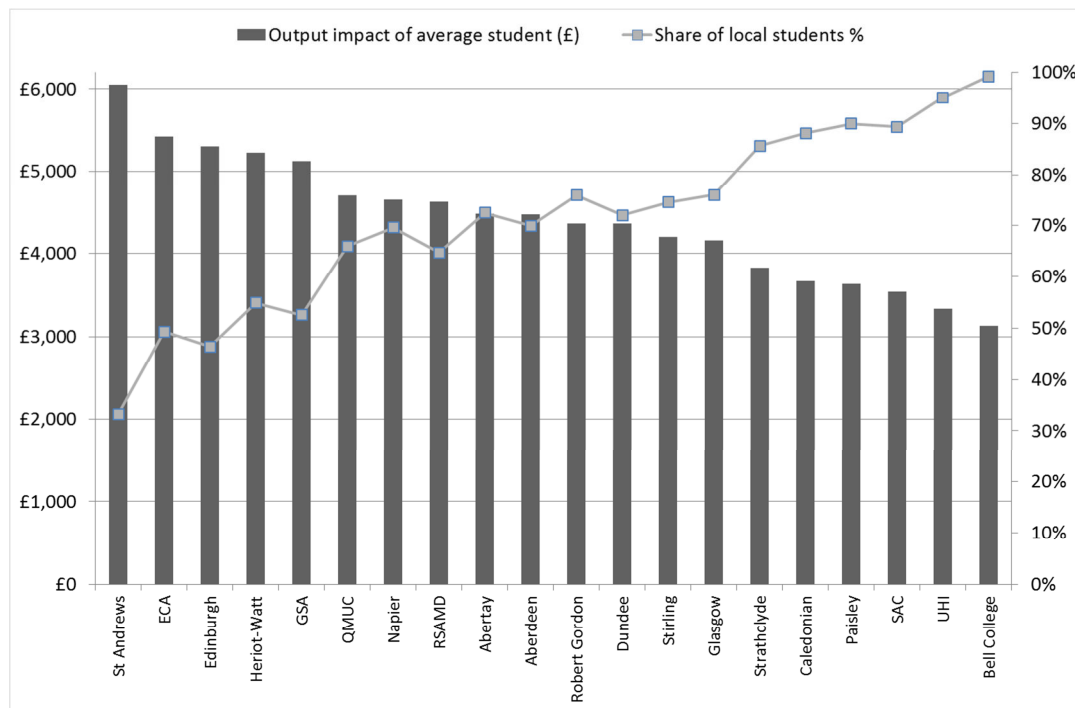


As is evident from Figure 2 above Scottish HEIs vary significantly both in terms of the scale of the impact of their students' consumption expenditures and the extent to which this impact is being driven by local or incoming students. This again reflects the scale and composition of the respective student populations. The largest impact is driven by students at the University of Edinburgh (£108), this is 45 times larger than the smallest impact, that of the students at the Scottish Agricultural College, who support 2.4m of output in the Scottish economy. The composition of this impact also differs significantly. Edinburgh, St Andrews, Heriot-Watt, the Edinburgh College of Arts and the Glasgow School of Arts stand out when it comes to attracting external students (this is more readily visible in Figure 3). Furthermore, several HEIs have quite mixed student populations, such as Glasgow, Strathclyde, Dundee, Aberdeen, Napier and Stirling, while some are almost entirely attended by local students (UHI, Bell College, SAC).

These institutions are of course vastly different in terms of the size of their student populations with the largest student population (Edinburgh) being 30 times that of the smallest one (SAC). Therefore, in order to abstract from scale, it is useful to look at the impact of the average student at each of these institutions. This is revealed in the final column of Table 6 above, but to clarify the

presentation this is also presented in a diagrammatical format, ranked by scale, in Figure 3 below, which also presents the share of local students in the student population.

Figure 3 The output impact of the average student (\hat{q}_{All}^s) (£) and the share of local students (%) at each HEI ($s_{sco}/\sum_n s_n$), ranked by size.

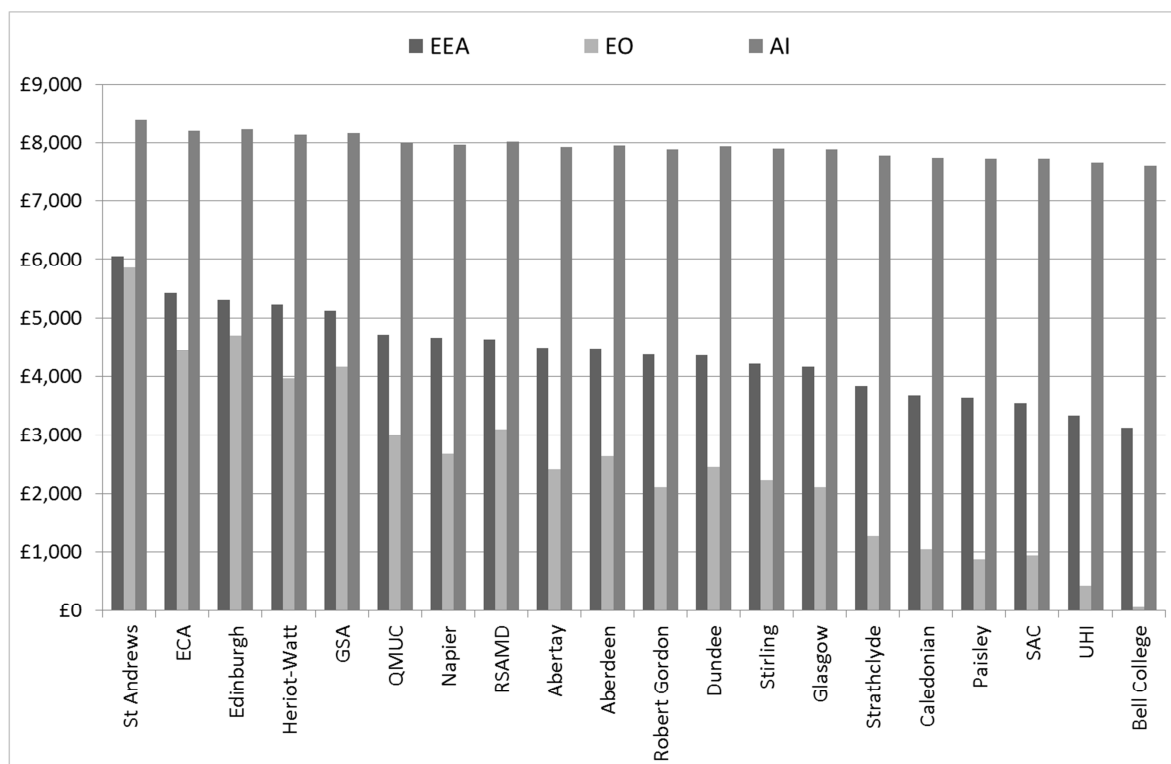


As we can see from the diagram, the average student at St Andrews drives the largest impact at £6,052, almost double the impact of a representative student at Bell College £3,126. It is clear that the scale of the average impact is driven by the composition of the student population and is negatively associated with the share of local students in the student population. For the University of St Andrews only one third of all students are Scottish, whereas at Bell College almost all are. The impact of the average student at Bell College is very close to that of the representative student of Scottish origin (\hat{q}_{SCO}^s) £3,097.

So far we have analysed the impacts of student populations attending individual institutions only in terms of the Endogenous-Exogenous Attribution approach, which we argue is superior to previous methods used in the literature. However, it is of interest to analyse the biases induced by the External Only (EO) and All Included (AI) assumptions, and how these affect individual institutions differently. Drawing on Table 3 on the impact of the average student of each type under each of the

3 assumptions, it is straightforward to multiply these with the shares of different student types at each HEI, presented in Table 6 above, in order to derive the expenditure impact of the average student at each institution under each of the three assumptions. The results are presented in Figure 4 below.

Figure 4 Output impact of the average student at HEI i under each of the three assumptions (EEA, EO and AI), ranked by the size of the impact estimated under the IO-Accounting approach (£).



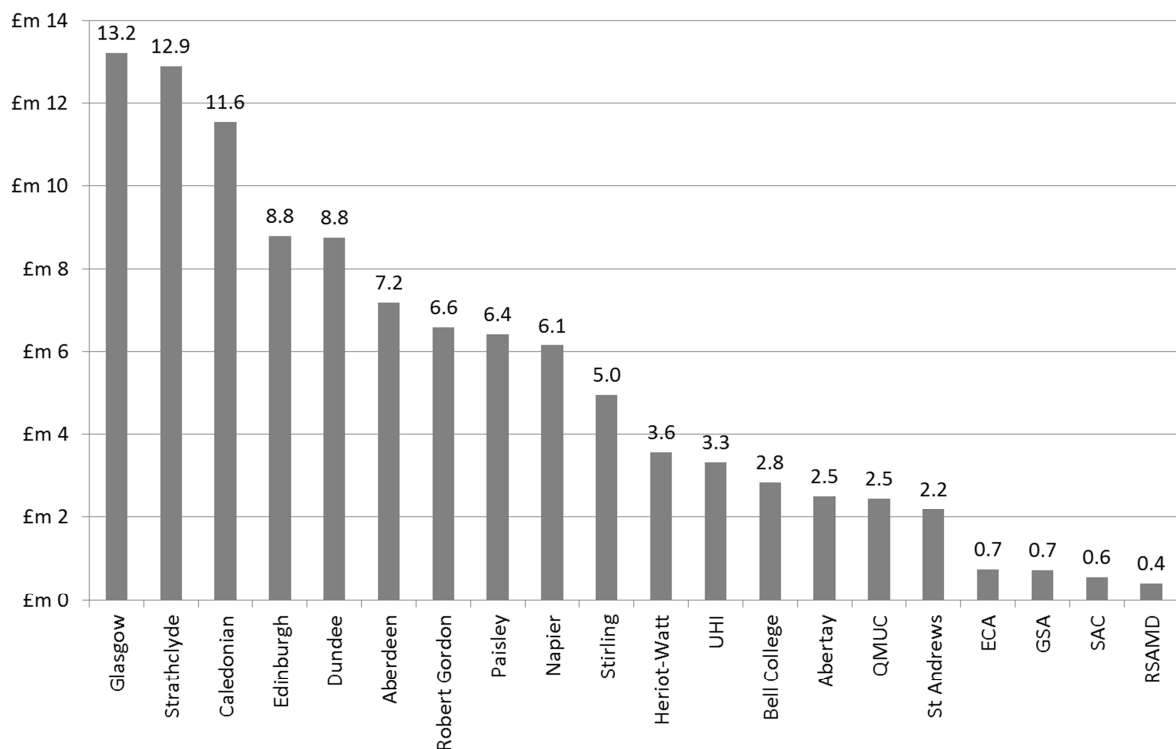
The AI assumption overstates impacts significantly vis-à-vis the EEA approach in all cases. It performs least bad in the case of the institutions with the lowest share of local students. The External Only assumption provides a reasonable approximation when analysing the impact of student populations where local students are a relatively small share. In the best case, that of St Andrews, this assumption only underestimates impacts of the average student by £192 or 3%. However, for institutions where the student population is mostly local this assumption is entirely inappropriate.

5.1 *Balanced expenditure impacts of students at individual HEIs*

Again, we are interested in knowing how acknowledging the binding budget constraint of Scottish Government funding alters the impacts of students' consumption expenditures. We demonstrated in Section 5.1 that treating Scottish Government funding of students as endogenous reduces the

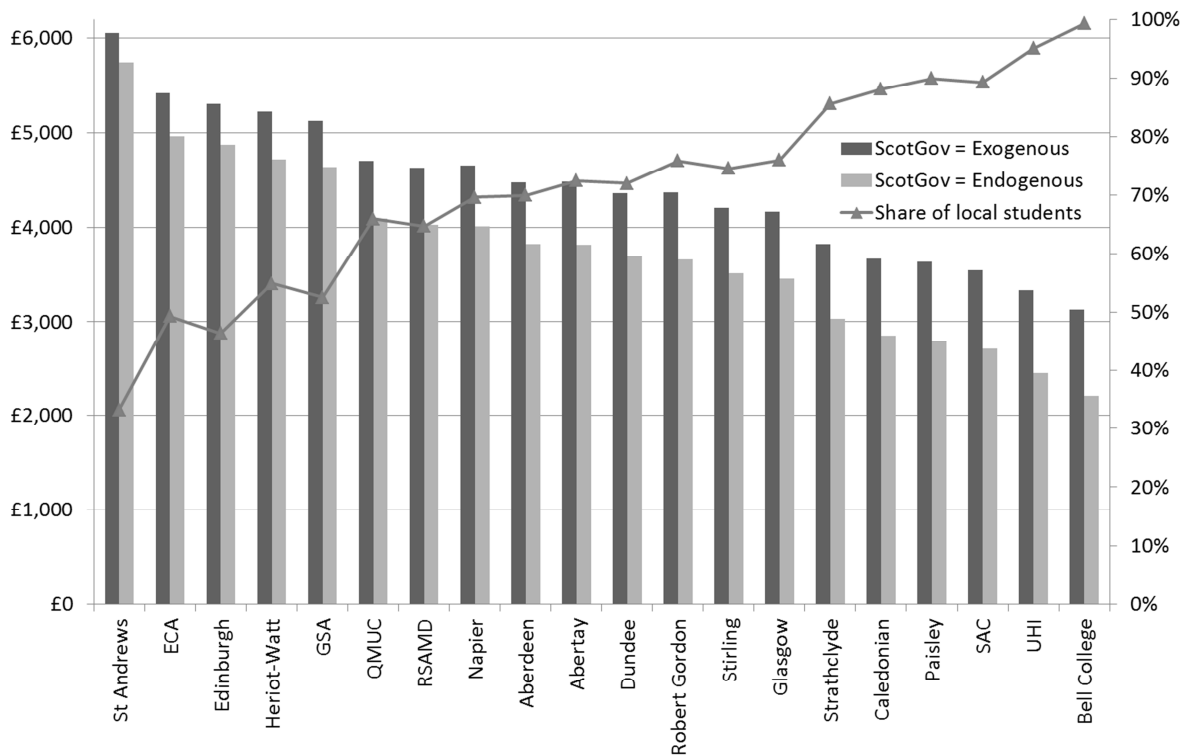
impact attributed to Scottish students by 30% and the impact of the average student in Scotland by 15%. However, we know that the composition of the student populations at different HEIs is heterogeneous and therefore, a priori, we expect this change to further increase the heterogeneity of the impacts of students at individual institutions.

Figure 5 Reduction in the output impact of the student population from reclassifying Scottish Government student support as endogenous (£m, ordered by scale).



As is evident from Figure 5 treating Scottish Government funding of student consumption affects the estimated impact of the student body at each HEI quite differently, with the biggest reductions at the three Glasgow based universities: Glasgow, Strathclyde and Caledonian. Whereas, large universities on the East Coast such as Edinburgh, Dundee and Aberdeen seem to be less sensitive to this change. From the figure, it is difficult to gauge the underlying causes of this change in impact as it reveals effects of scale and the composition of the student body simultaneously. Therefore, it is again useful to analyse the average impact per student.

Figure 6 Comparison of output impacts under the EEA-approach treating Scottish Government expenditures as exogenous (dark bars) or as endogenous (light bars) and the share of local students (%) at each HEI, ranked by scale of impact.



In Figure 6 we show the average impact per student as estimated using EEA approach under firstly the conventional assumption of treating public expenditures as exogenous (dark bars) and secondly treating the expenditures of the Scottish Government (funded via the block grant from Westminster as determined by the Barnett formula) as endogenous (light grey bars). Furthermore, we show how this is influenced by the composition of the student body as proxied by the share of Scottish students (right hand scale). The broad result that this figure reveals is that those HEIs who already demonstrate the strongest per student consumption impacts are least sensitive to the acknowledgement of the budget constraint of the Scottish Government. The rationale is straightforward, the larger the share of incoming students the less is the impact of reducing the exogeneity of Scottish students' consumption expenditures from $X_{SCO} = 41\%$ to $X_{SCO} = 29\%$. Whereas, institutions that cater more for local students have student bodies that demonstrate a smaller consumption impact but this impact is more significantly affected from the change in X_{SCO} as their share of Scottish students is higher.

Table 7 examines this issue in slightly more detail by reporting the impacts of the average student at each HEI under the alternative assumptions about the exogeneity of Scottish Government expenditures, along with the rank of these impacts and the composition of the student body at each institution. The table reveals how the average impact of students and its sensitivity to the budget constraint of the Scottish Government is shaped by the composition of the student body. If we compare the third column, which shows the change in impact of the average student (\hat{q}_n^s) from varying assumptions about X_{SCO} and the tenth column showing the share of Scottish students in the student population there is a clear negative link. The composition of the incoming students, i.e. RUK v ROW, is of a second order importance. This is more clear when we examine impact of acknowledging the budget constraint of the Scottish Government using an ordinal scale. In three cases HEIs exchange ranking for the impact of average students when we move from $X_{SCO}=0.41$ to $X_{SCO}=0.29$. These pairs are Napier and RSAMD; Aberdeen and Abertay; and Dundee and Robert Gordon. For example in the case of Aberdeen and Abertay, the latter shows a bigger impact under conventional assumptions, despite a higher share of Scottish students in the student population. This is because Abertay has a higher share of incoming students from the ROW (where $X_{ROW} = 1 - X_{RUK} = 0.71$). However, once we introduce the budget constraint of the Scottish Government and $X_{SCO}=29\%$ this effect is dominated by the higher share of Scottish students.

Table 7 Consumption impact of the average student at Scottish HEIs under the EEA approach adopting alternates assumptions about the exogeneity of Scottish Government supported expenditures (£), ranking of these impacts and the composition of the student body at each institutions (%).

Institution	Impact of average student (\hat{q}_n^s) (£)						Ranking of student impacts			Student composition (%)		
	(a) ScotGov = Exogenous	(b) ScotGov = Endogenous	(a - b) Change in impact of average student	Rank (a-b)	% decline in impacts (a-b)/(a)	Rank (a- b)/(a)	Assumption (a)	Assumption (b)	Change in rank (b-a)	SCO	RUK	ROW
Aberdeen	4,471	3,823	-648	12	-15%	12	10	9	1	70%	14%	16%
Abertay	4,484	3,812	-672	10	-15%	11	9	10	-1	72%	7%	20%
Bell College	3,126	2,206	-920	1	-29%	1	20	20	0	99%	1%	0%
Dundee	4,360	3,692	-668	11	-15%	10	12	11	1	72%	14%	14%
ECA	5,420	4,962	-457	18	-8%	18	2	2	0	49%	23%	27%
Edinburgh	5,303	4,872	-431	19	-8%	19	3	3	0	46%	35%	18%
Caledonian	3,667	2,850	-817	5	-22%	5	16	16	0	88%	4%	7%
GSA	5,122	4,635	-487	17	-10%	17	5	5	0	53%	28%	19%
Glasgow	4,162	3,457	-705	7	-17%	7	14	14	0	76%	13%	11%
Heriot-Watt	5,227	4,718	-509	16	-10%	16	4	4	0	55%	18%	27%
Napier	4,656	4,010	-645	13	-14%	13	7	8	-1	70%	7%	23%
Paisley	3,632	2,798	-834	3	-23%	4	17	17	0	90%	1%	9%
QMUC	4,705	4,093	-612	14	-13%	14	6	6	0	66%	14%	20%
Robert Gordon	4,367	3,663	-704	8	-16%	9	11	12	-1	76%	4%	20%
RSAMD	4,629	4,029	-600	15	-13%	15	8	7	1	65%	20%	15%
St Andrews	6,052	5,744	-308	20	-5%	20	1	1	0	33%	35%	31%
SAC	3,542	2,714	-828	4	-23%	3	18	18	0	89%	7%	4%
Stirling	4,206	3,515	-691	9	-16%	8	13	13	0	75%	14%	11%
Strathclyde	3,825	3,032	-794	6	-21%	6	15	15	0	86%	4%	11%
UHI	3,331	2,449	-882	2	-26%	2	19	19	0	95%	2%	3%

6 Conclusions

This paper sets out a model to formally address a recurring problem in applied impact studies, that is how to distinguish between, and account for, endogenous and exogenous consumption expenditures. In standard IO analysis these are typically treated as either fully exogenous or wholly endogenous. Such as is manifested in the Type-I and Type-II assumptions. However, in many instances consumption expenditures are neither wholly endogenous nor exogenous. This is for example found in the cases of tourists, students and benefit claimants. To address this we set out a general model degree of exogeneity is treated as an empirical matter and demonstrate its application to the case of university students in Scotland. Students are heterogeneous in terms of their expenditures. Some are 100% exogenous (foreign students), but for local students much is endogenous. Previous attempts at analysing student impacts have applied simplifying assumptions to deal with this. We find these to be inaccurate, in particular with regard to the treatment of local students. Using conventional approaches their impacts are either overstated (100% exogenous) or understated (100% endogenous). However, we demonstrate the choosing between such limiting cases is not necessary given the availability of survey evidence. The biases involved are particularly distorting for HEIs that largely serve local students. Further influence on the exogeneity of the consumption expenditures is the public sector budget constraint, which is arguably binding for devolved government expenditures in the UK context. We find that acknowledging this budget constraint reduces the exogeneity (and the hence the impact) of local students' consumption expenditures by about a third.

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