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Students' consumption expenditures in economic impact studies: assumptions revisited in an input–output approach for Scotland

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ABSTRACT

This paper revisits the application of impact-study methods to the consumption expenditures of students. Whilst the academic literature on the subject is mature, it has traditionally applied simplifying assumptions concerning the exogeneity of expenditures, which tend to over- or underestimate the impact of local students, depending on the particular approach adopted. To resolve this issue, we invoke the principles of input–output analysis and specify a model where consumption expenditures can be partially endogenous and partially exogenous. The origin of the income used to fund consumption expenditures determines their exogeneity. This model is calibrated using the results from an income-expenditure survey. These general issues are relevant to any application of impact analysis where the initial injection is a consumption expenditure shock. The approach is demonstrated using Scottish data for 2013. Figures are produced, on a comparable basis, for the effects of the consumption expenditure of students from each of the Scottish higher education institutions (HEIs). We demonstrate that the biases introduced by employing the assumptions usually adopted in the literature are particularly distorting for HEIs that largely serve local students.

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INTRODUCTION

This paper revisits the application of impact study methods to the consumption expenditures of students. Whilst the academic literature on the subject is mature, it has traditionally applied simplifying assumptions about the exogeneity of student expenditures. These assumptions tend either to over- or underestimate the consumption impacts of local students, depending on the specific approach adopted. To resolve this issue, we pare back the short-hand conventions that practitioners have established over the years to measure the economic impact of student expenditures and

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instead adopt an approach that is strictly consistent with standard input–output (IO) analysis. We note that in the standard incorporation of household consumption in such analysis, part of household expenditure is endogenous and part exogenous, with the origin of the income used to fund consumption expenditures establishing their exogeneity. In the present study, exogeneity is determined using the findings of a student income-expenditure survey. These issues are relevant to any application of impact analysis where the initial injection is a consumption expenditure shock and are crucial for the accurate implementation of IO analysis in such cases.

The analysis uses Scottish data for 2013. We produce compatible disaggregated figures for the effects on the Scottish economy of the consumption expenditure of students from each of the Scottish higher education institutions (HEIs). These allow detailed comparisons between institutions to be made that focus on the differential composition of the student populations broken down by the three key domiciles: Scotland, the rest of the UK (RUK) and the rest of the world (ROW). The consumption by students from different domiciles is shown to vary in terms of its aggregate level and degree of exogeneity.

We demonstrate that measuring student consumption effects using the conventional assumptions introduces biases. These are particularly distorting for HEIs that largely serve local students. This is important as hitherto the expenditure impact of local students has been ignored as a matter of routine, for instance, in the recurring impact analyses commissioned by Universities UK. Although the impact of each local student is modest when compared with external students, for Scotland local students comprise the single largest group and, therefore, generate a significant aggregate impact.

The methodological approach we advocate has been applied to the consumption expenditures of students as part of past HEI impact studies (Hermannsson, Lisenkova, McGregor, & Swales, 2013, 2014, 2015). However, the key contribution of this paper is providing an explicit comparison with previous methodological alternatives and illustrating how different approaches convey the student populations of different types of institutions. This is achieved by reviewing past practice, outlining a preferred method building on the principles of IO analysis, and demonstrating the application of this method to a whole system of HEIs, encompassing a diverse range of institutions. We further stress that whilst this paper deals exclusively with the consumption expenditure impacts of students, these are only part of a bigger picture concerning the economic and social impacts associated with HEI students. For instance, urban and planning studies identify a variety of interactions between students and their host communities, such as those operating through urban amenities, gentrification and, more generally, housing and labour markets (Allinson, 2006; Munro & Livingston, 2012; Munro, Turok, & Livingston, 2009; Sage, Smith, & Hubbard, 2012). In turn, students make up only one element of the entire higher education (HE) sector, which exerts a variety of impacts on the economy and wider society.[1] However, as the student population increases, attracting and retaining students becomes a more important economic priority as is evident from tourism marketing specifically targeting those potentially wishing to study in the UK.[2]

The paper is structured as follows. The next section discusses the literature on the expenditure impacts of students and conceptual issues in traditional practice. The third section gives a formal account of how consumption expenditures can be treated within an input–output framework. The fourth section outlines the data sources and the determination of key parameter values. The fifth section generates estimates for the aggregate impact of student expenditures. The sixth section demonstrates their sensitivity to alternative assumptions concerning exogeneity and the treatment of Scottish government support for student consumption. The seventh section provides estimates of the student impact disaggregated by individual HEIs. The eighth section concludes.

PREVIOUS RESEARCH

The application of impact study methods to HEIs and their students has been the subject of an extensive literature. Florax (1992) lists over 40 HEI expenditure studies, and much has been

Table 1. Overview of selected studies on the impact of students' consumption expenditures.

Subject of study	Students included	Study area	Evaluation perspective	Source of multiplier
Stirling University (Brownrigg, 1973)	All	Travel-to-work area around the university	Ex ante	Keynesian multiplier
University of Nottingham (Bleaney et al., 1992)	All	Travel-to-work area around the university	Ex post	Keynesian multiplier
University of Lancaster (Armstrong, 1993)	All	Lancaster and Morecambe Council District	Ex post	Keynesian multiplier
University of Portsmouth (Harris, 1997)	All	Portsmouth travel-to-work area	Ex post	Local IO table estimated from a one-off survey
University of Stirling, University of Strathclyde and St Andrews University (Love & McNicoll, 1988)	Rest of the world only	Scotland	Ex post	Keynesian multiplier
University of Aberdeen (Battu et al., 1998)	All fulltime students	North East Scotland	Ex post	Keynesian multiplier
Claremont Graduate University (Steinacker, (2005)	External only	Claremont travel-to-work area	Ex post	IO multipliers adjusted using location quotients
UK HEIs in aggregate (Kelly, McLellan, & McNicoll, 2009)	External only	UK	Ex post	IO multipliers
Valencian public universities (Pastor Perez & Guevara, 2013)	Students reporting to stay locally because of the university	Valencian Community	Ex post	IO multipliers
All HEIs in Scotland individually (Hermannsson et al., 2013)	Exogenous expenditures of all students	Scotland	Ex post	Official Scottish IO table
Scottish HEIs in aggregate (Hermannsson et al., 2014)	Exogenous expenditures of all students	Scotland	Ex post	Official Scottish IO table
All HEIs in London individually (Hermannsson et al., 2015)	Exogenous expenditures of all students	England	Ex post	IO table for England
UK HEIs in aggregate (Kelly et al., 2014)	External only	UK	Ex post	IO multipliers

Note: HEIs, higher education institutions; IO, input–output.

written since. As Armstrong (1993, p. 1653) points out, interest in this area was initially triggered by the rapid growth of the HE sector in the 1960s and was renewed in the 1990s as the sector expanded further and participation rates increased.

Academic work investigating student expenditure multipliers sits within a wider tradition of demand-driven impact studies. These studies use regional modelling methods, such as export base, Keynesian, input–output or social accounting matrix multipliers to estimate the total effect on economic activity resulting from a specified exogenous demand stimulus.[3] This general framework is summarized by equation (1):

$$q = mf \tag{1}$$

where q is output; m is the endogenous multiplier process; and f is exogenous final demand.

In this paper we focus on the regional modelling approaches used to analyze the impact of student consumption expenditures. We explore in detail the implications of some of the simplifying assumptions that have been sanctioned by tradition. The primary focus is on IO methods, although we recognize that many of the assumptions have carried over from older Keynesian multiplier studies. The features of selected studies are summarized in Table 1. Typically, these studies look at the impact of student expenditure as part of the larger effect of the HEI itself. Most are retrospective in nature, although Brownrigg (1973) is an ex ante appraisal. Typically, the impact associated with a single HEI is given for that HEI's local area, but some studies look at the impacts associated with several HEIs in regional and national contexts.

Not all HEI impact studies sit within this regional modelling paradigm. There is a longstanding tradition in the United States of using bottom-up accounting methods limited to identifying first-round effects. This follows Caffrey and Isaacs (1971), a monograph commissioned by the American Council for Education (ACE), which contains a comprehensive accounting study of the direct backwards linkages of an HEI within a local economy and became the foundation of the so-called ACE model, which has been widely applied in the United States and beyond.

Furthermore, there is a plethora of commercial models that mix elements of different approaches, but these are too numerous and heterogeneous to summarize here. Siegfried, Sanderson, and McHenry (2007) critically review methods applied in US advocacy work and offer a rigid prescription of dos and do nots. Whilst we are sympathetic, we are concerned this may provide a false sense of security as ultimately practitioners need to understand the models they are working with and should be able to articulate the reasoning for their assumptions from first principles.

Conceptual issues and conventions in the literature

Regional impact models impose a clear line of causality; exogenous elements of final-demand expenditure drive and determine the subsequent endogenous impacts. Other key features are that these models are linear with an assumed passive supply, so that an increase in demand leads solely to an adjustment in quantity with no change in price. These approaches essentially assume excess capacity, constant returns to scale and no resource constraints. Regional computable general equilibrium (CGE) models relax some of these assumptions. See Partridge and Rickman (2010) for a review.

In the standard IO analysis, exogenous final demand typically includes exports, government expenditure and investment, whilst intermediate inputs (components of the supply chain) are treated as endogenous. However, the position of household consumption is equivocal. With type I multipliers, household consumption is an element of final demand. In such treatments, all household consumption is exogenous and becomes a major driver of economic activity.[4] However, in industrial or regional development analysis, a type II multiplier method is typically invoked in which at least some consumption is endogenous. Typically, household consumption funded from domestic wages is treated as endogenous, whilst consumption funded from other sources

is considered as exogenous (Emonts-Holley, Ross, & Swales, 2015). The crucial issue for modelling the impact of students' consumption expenditures is, therefore, determining the extent to which such expenditures are exogenous or endogenous. That is, the extent to which they act as an additional economic stimulus (e.g., expenditures supported by a student loan) or as part of the type-II multiplier process (e.g., expenditures supported by locally earned wages).

Work on the impact of student consumption commonly makes a distinction between students from different domiciles. It focuses on the potential differential demand impact of local students as against students who have moved into the area. Whilst this proves to be a useful distinction, it has often been applied inappropriately. Usually, the concern is whether the student would have come to, or remained in, the area without the HEI. Typically, in the existing literature, only if a student is an actual or potential migrant will their consumption count and be subject to subsequent multiplier effects.

For instance, Siegfried et al. (2007, p. 552) are unreserved in their prescription:

> What should be counted as new first-round economic activity is tuition, room and board, and other spending by students who alternatively would not have attended a local institution, and revenues from students from inside the area who, in contrast, would have instead attended a college elsewhere (import substitution).

We label this general approach – that is, that the exogeneity of the whole of a student's consumption depends solely on whether they are an actual or a potential migrant – the 'conventional' method. This is in contrast to the approach that is consistent with standard IO principles, which we label the 'standard IO' method.

Whether local students are counted as potential migrants is usually contingent upon the geographical scope of the study. Many studies of individual HEIs focusing on the impact on the local economy conclude that in the absence of the HEI local students would have overwhelmingly pursued their education elsewhere (e.g., Armstrong, 1993; Battu, Finch, & Newlands, 1998; Bleaney, Binks, Greenaway, Reed, & Whynes, 1992; Brownrigg, 1973; Harris, 1998). On these grounds, these studies treat all consumption expenditures of local students as 100% exogenous import substitution. We refer to this as the 'import substitution' approach.

Conversely, when systems of HEIs are examined within a regional or national economic context, the convention is to consider the consumption of students who move into the region to study as the only exogenous element of student expenditures (as in Love & McNicoll, 1988; Steinacker, 2005; Kelly, McLellan, & McNicoll, 2009; and Kelly, McNicoll, & White, 2014). We label this the 'external-only' approach. This is based on the judgement that local students do not bring any new spending to the region or nation being examined and, hence, their consumption expenditures are 100% endogenous.

Recent work has refined this conventional approach by drawing on survey evidence to classify students based on their migration preferences. In such study, only if the student stated that they would have moved in the absence of the HEI being studied is their consumption counted as exogenous (Pastor, Pérez, & de Guevara, 2013).

We argue that this conventional treatment of student consumption expenditure is not consistent with core IO principles and in particular risks either double-counting or failing to account for exogenous elements of student consumption. One key strength of IO analysis is that it can track the local supply-chain and consumption-multiplier effects of exogenous demand in a rigorous and consistent manner. This means that all economic activity in an area can be attributed to elements of final demand. Inappropriate exogeneity attribution generates inconsistency and potential double-counting or undercounting.

Imagine a student, Emily, travelling from London to study for a postgraduate music degree at the Royal Conservatoire in Glasgow. She is financing her consumption through playing third cello with the Scottish Chamber Orchestra (SCO). In the conventional approach, as recommended by

Siegfried et al. (2007), all her consumption counts as an exogenous demand stimulus. However, this simply violates standard IO norms. In a type II multiplier analysis, her consumption is, quite rightly, allocated to production within the entertainment sector and would be attributed to the final demand that this sector ultimately supports. To count her consumption as exogenous would be simply double-counting. Without the HEI, it is unlikely she would be in Scotland, but the consumption expenditures made by the replacement third cellist would. In our approach, none of Emily's consumption would be counted as exogenous (Hermannsson et al., 2013, 2014, 2015).

Compare Emily with Euan. He has been born and bred in the New Gorbals. He is an avid nationalist, would never consider leaving Scotland and would say so in a questionnaire. He is on the same course as Emily, but has a European Union scholarship that covers all his consumption expenditure. Again, in the conventional approach, none of his consumption counts, as he is not an actual or potential migrant. However, his consumption is clearly all exogenous, as it is not financed by current economic activity in the region, and this is how we would classify it. True, without the HEI he probably would still be in Scotland, but he would need to find some other income source to fund his consumption.

The relevant question in both cases is not whether the individual student is a migrant or a potential migrant, but rather how their consumption is financed. Migration does play a role, given the link between the student's domicile and their consumption exogeneity, as we shall see in the fourth section. However, this is not a binary, all-or-nothing relationship. Further, it operates through expenditure profiles and income sources, not migration propensities. This requires information not about the student's hypothetical alternative locational preferences, but rather their actual financial circumstances.[5] This implies that the implementation of such an approach requires information on both student expenditures and their income sources.

STUDENT CONSUMPTION EXPENDITURES IN AN INPUT–OUTPUT FRAMEWORK

In the IO model, the gross output vector in the economy ($\underline{q}$) is determined as the product of the Leontief inverse $(I - \underline{\underline{A}})^{-1}$ and the vector of final demands for domestic goods ($\underline{f}$)[6]:

$$\underline{q} = (I - \underline{\underline{A}})^{-1}\underline{f} \tag{2}$$

Equation (2) expresses equation (1) in matrix form. It has a key characteristic for our work. This is, as discussed in the previous section, it satisfies the accounting requirement that the whole of total output in an actual economy can be attributed in this way to elements of actual final demand. Further, this accounting identity is retained in standard simulations using the IO model.

In order to quantify the demand impact of student consumption, we begin by calculating the output vector, $\underline{q}^j$ supported by the exogenous consumption expenditure vector of a student of domicile type j, f^j. Adapting equation (2), this is given as:

$$\underline{q}^j = (I - \underline{\underline{A}})^{-1}\underline{f}^j \tag{3}$$

To calculate the exogenous consumption demand, $\underline{f}^j$, we first multiply the average aggregate consumption figure for student type j, e^j, by the degree to which this expenditure is exogenous, $\varkappa^j$. This gives a figure for exogenous consumption expenditure per student of domicile j, e^j. To convert this to exogenous expenditure on domestic output, d^j, we subtract the imports. The IO accounts have information on the proportion of consumption expenditure that goes to imports, δ, and we assume that this does not vary across student types. We then use a student household consumption vector, $\underline{b}^s$, to give the proportion of student consumption that is spent on the output

of each individual industry. Information on this sectoral distribution of student consumption is obtained from Kelly, McNicoll, and McClellan (2004). This produces the result:

$$\underline{f}^j = \underline{h}^s d^j = \underline{h}^s(1-\delta)e^j = \underline{h}^s(1-\delta)c^j x^j \tag{4}$$

Equations (2) and (4) can be used to calculate the output vector supported by the exogenous consumption of student type j as:

$$\underline{q}^j = (1-\underline{A})^{-1}\underline{f}^j = (1-\underline{A})^{-1}\underline{h}^s d^j = \underline{m}^s d^j \tag{5}$$

In equation (5), $\underline{m}^s$ is the student multiplier vector, where each element, m_i^S, is the output in industry i associated with a unit increase in exogenous student consumption on domestic goods. If all the elements of the vectors $\underline{q}^j$ and $\underline{m}^s$ are summed to produce the corresponding scalars, equation (5) can be restated as:

$$q^j = m^s d^j \tag{6}$$

We have information on the number of students of type j in each Scottish HEI k, represented as $s^{j,k}$. Together with equations (6), this gives the total Scottish output, $q^{j,k}$, supported by the total domestic consumption, $d^{j,k}$, of this group of students:

$$q^{j,k} = q^j s^{j,k} = m^s d^j s^{j,k} = m^s d^{j,k} \tag{7}$$

The student numbers, their exogenous domestic consumption demand and the supported output scalars can be summed across HEIs or student types to produce the total numbers, final demands and outputs for all students of domicile type j in Scotland ($s^{j,T}$, $d^{j,T}$, $q^{j,T}$) or for all students in a specific Scottish HEI ($s^{T,k}$, $d^{T,k}$, $q^{T,k}$):

$$\sum_k z^{j,k} = z^{j,T} \qquad \sum_j z^{j,k} = z^{T,k} \qquad z = s, d, q \tag{8}$$

Summing across student types and HEIs simultaneously gives the total student population and the domestic final demand and output totals associated with exogenous domestic consumption (s^T, d^T, q^T), so that:

$$\sum_j \sum_k z^{j,k} = z^T \qquad z = s, d, q \tag{9}$$

Table 2. Variable and parameter values and data sources.

Variable		Domicile			Source
		SCOT	RUK	ROW	
Number of students (FTEs)	$S^{j,T}$	138,716	22,888	48,077	Higher Education Statistics Agency (HESA)
Proportion of students	$\sigma^{j,T}$	0.66	0.11	0.23	HESA
Consumption per head (£)	c^j	8678	10,011	10,011	Warhurst et al. (2009)
Degree of exogeneity (%)	X^j	0.41	0.73	1.00	Warhurst et al. (2009)
Share of imports	δ	0.32	0.32	0.32	Scottish Government (2016)
Student multiplier	m^S	1.53	1.53	1.53	Kelly et al. (2004), Scottish Government (2016)

Note: FTEs, fulltime equivalents; ROW, rest of the world; RUK, rest of the UK; SCOT, Scotland.

DATA SOURCES AND PARAMETER VALUES

Table 2 gives the values for the key variables and parameters required to calculate the aggregate impact of student consumption in Scotland for 2013. The first row shows the total number of students in Scottish HEIs and their disaggregation by domicile, $s^{j,T}$, which are identified by the superscripts SCOT, RUK and ROW. These data are obtained from the Higher Education Statistics Agency's (HESA) Students in Higher Education database. The figures shown in Table 2 are for all the Scottish HEIs, but they are also available for individual institutions. The disaggregated figures are analyzed in greater detail in the seventh section.

The figures in the second data row in Table 2 give the proportion of students studying in Scotland, $\sigma^{j,T}$, from each of the three domiciles. Note that over two-thirds are Scottish, just over one-tenth from the RUK and almost one-quarter from the ROW. There is a strong convention for Scottish students to study in Scotland, often at a local HEI. This is reinforced by some differences in the education system between Scotland and the RUK and the absence of tuition fees for Scottish students studying in Scotland.

To calculate the variables reported in rows 3 and 4, that is, students' consumption per head (e^j) and the degree of exogeneity of this consumption (x^j), we follow the approach set out by Hermannsson et al. (2014, appx). The figures are derived primarily from a Scottish government-commissioned report, in which 4803 Scottish HE students completed a comprehensive income and expenditure survey for the academic year 2007–08 (Warhurst et al., 2009). The survey was carried out in two stages. First, a brief screening survey was disseminated with the help of HEIs in Scotland to identify eligible respondents, i.e., Scottish-domiciled undergraduates. The full survey was then administered to all 9265 students who were deemed eligible through the screening survey, of which 58% provided a response. The survey contains detailed information about students' expenditures, incomes and debt, as well as their educational and social circumstances. The findings of the survey are publicly available, and the methodology is described in detail in the project report (Warhurst et al., 2009, ch. 1, appxs). This is the latest date for which Scottish data of this kind are available. We project these nominal figures forward to 2013 prices using a gross domestic product (GDP) deflator.

The average consumption expenditure of Scottish-domiciled students is £8678. In the absence of a direct figure for the average consumption for the RUK and ROW students, we use the value given in the same source for the average consumption expenditures of Scottish students living independently, which is £10,011.

To determine the degree of exogeneity of student consumption, we again use the income information given by Warhurst et al. (2009). The results are summarized in Table 3. It is most straightforward to begin with students domiciled in the ROW, whose income and expenditure figures are shown in column 3. We assume that the ROW students have no income from employment

Table 3. Student income sources and gross and exogenous consumption spending per student (£).

Domestically sourced income	Scotland	Rest of the UK	Rest of the world
Income from employment (£)	2709	2709	
Student loans	1992		
Grants and bursaries	1057		
Commercial credit	482		
Within household transfer	631		
Other income (£)	794		
Unattributed income	1495		
Gross consumption spending	8678	10,011	10,011
Exogenous consumption spending	3531	7302	10,011

Source: Warhurst et al. (2009). Adjusted to 2013 prices using a gross domestic product (GDP) deflator.

in Scotland and that all their consumption is financed from outwith Scotland.[7]. Therefore, for students from the ROW, the degree of exogeneity, x^{ROW}, is taken to be 1.00.

The second column of Table 3 summarizes the situation for the RUK students. We assume that they undertake the same amount of paid employment as Scottish students, but that the rest of their consumption is funded from sources outwith Scotland. This means that of their £10,011 average annual consumption, £2709 is financed endogenously. Therefore, for the RUK students, the degree of exogeneity, x^{RUK}, is 0.73.

The situation for Scottish students is summarized in the first column of Table 3. We take consumption funded by student loans, grants and bursaries, and commercial credit to be exogenous as is consistent with the IO model. On the other hand, Scottish-domiciled student consumption funded by income from employment, within-household transfers and other income are judged to be endogenous. Unfortunately, in the data there is a gap of £1495 between the entries for total consumption and total income, which is labelled as unattributed income here. We have erred on the side of caution in estimating the impact of student expenditure and we attribute this shortfall to forms of intra-household transfers. Therefore, it is treated as being endogenous.[8] Therefore, we judge the proportion of the Scottish-domiciled student's consumption expenditure that is exogenous, x^{SCOT}, to be (1992 + 1057 + 482)/8678, which is 0.41.[9]

The value of δ given in Table 1 is taken from the share of imports in general household consumption in the Scottish IO tables (Scottish Government, 2016). The figure is 0.32. Finally, the vector that gives the pattern of student consumption across commodities, b^S, is taken from Kelly et al. (2004) and does not vary across the different student types. Using equation (5) and summing all the elements of the student multiplier vector gives the multiplier value for the increase in output for each unit increase in student domestic expenditure, m^S, of 1.53.

AGGREGATE IMPACT OF EXOGENOUS STUDENT CONSUMPTION IN SCOTLAND

Substituting the variable and parameter values given in Table 2 into equations (4)–(9), we calculate the impact of total exogenous student consumption on total Scottish output. This produces the per capita and aggregate expenditure, output and activity figures reported in Table 4. These are disaggregated by the students' domicile.

The first column gives the total number of students under each classification. This replicates information from the first row of Table 2. The second column shows the domestic exogenous consumption expenditure per student, d^i, for the three domicile types. These are the total exogenous consumption expenditures taken from Table 3 adjusted to remove direct imports, as shown in equation (4). Note that these values are assumed not to vary across individual Scottish HEIs. That is, an RUK student at St Andrews University is assumed to have the same average consumption expenditure as one at Glasgow University. The large variation in consumption per head reflects the fact that we assume that both actual consumption expenditure, e^i, and the degree of exogeneity, x^i, of that expenditure varies by student type. The average annual level of exogenous domestic per capita consumption expenditure, d, is the weighted sum of the individual values:

$$d = \sum_j \sigma^{j,T} d^j \tag{10}$$

This comes to £3474. For Scottish students the figure is £2073, with the corresponding values for the RUK and ROW students roughly 100% and 180% higher respectively than their Scottish counterpart. These differences, together with the variations in the level of these three student populations, drive the results presented in this section.

Table 4. Aggregate impact of student exogenous consumption expenditure in Scotland, 2013, disaggregate by student domicile.

Domicile	Number of students ($s^{j,T}$)	Exogenous domestic expenditure per student (d^j) (£)	Domestic-supported output by exogenous consumption per student (q^j) (£)	Domestic GVA supported by exogenous consumption per student (£)	Employment supported by exogenous consumption per student FTEs	Total exogenous domestic expenditure (£, millions)	Total supported output (£, millions)	Total supported GVA (£, millions)	Total supported employment (FTEs)
Scotland	138,716	2401	3676	1947	0.03	333.1	509.9	270.1	4630
RUK	22,888	4965	7601	4026	0.07	113.6	174.0	92.1	1580
ROW	48,077	6807	10,421	5519	0.09	327.3	501.0	265.4	4549
Total	209,681	3691	5651	2993	0.05	774.0	1184.8	627.6	10,759
Percentage of total output/GVA/employment						0.33%	0.51%	0.51%	0.42%

Note: FTE, fulltime equivalent; GVA, gross value added; ROW, rest of the world; RUK, rest of the UK.

Column 3 reports the Scottish output supported by the exogenous consumption expenditures of individual members of the different student groups, q^j. These figures are generated using equation (6). This implies multiplying the domestic expenditure per student, d^j, given in column 2 of Table 3 by the multiplier value, 1.53, given in Table 2. The divergence in values of d^j is therefore replicated in variation in values of q^j.

As mentioned in the third section, IO analysis can also quantify the levels of other variables supported by elements of final demand, as long as these additional variables can be linked systematically to output. Using this approach, figures for per capita gross value added (GVA) and employment, which correspond to the figures for output given in column 3, are produced, using the output-GVA and output-employment coefficients published with the Scottish IO tables (Scottish Government, 2016). This information is reported in Table 3, columns 4 and 5. Note that the GVA entries are less than the output figures. This reflects the fact that the output figures include both GVA and the value of intermediate inputs.

Multiplying the entries in columns 1 and 2 gives the values of total exogenous domestic expenditures made by students in Scotland, broken down by domicile. These are reported in column 6. Their higher exogenous expenditure per head necessarily means that the RUK and ROW students' share of exogenous domestic student consumption expenditure is greater than their share of the student population. Of the £728.5 million exogenous student consumption, 60% comes from students from outwith Scotland. However, by the same token, we estimate that Scottish students are still providing just over 40% of the exogenous demand stimulus.

Multiplying the figures in columns 1 and 3 gives the Scottish output supported by exogenous student expenditure shown in column 7. In aggregate, students support just over £1.1 billion of output in the Scottish economy, around 0.5% of the Scottish total. Finally, again the linked GVA and employment figures are given in columns 8 and 9. These show that student consumption supported £590 million GVA in Scotland and over 10,000 fulltime employees, 0.5% and 0.4% respectively of the corresponding Scottish totals.

STUDENTS' CONSUMPTION IMPACTS UNDER ALTERNATIVE APPROACHES

In the fifth section we gave our best estimate of the impact of exogenous student consumption expenditure. In this section we investigate the sensitivity of these results to alternative assumptions concerning the calculation of these effects. We look at two aspects in particular. We show the impact of treating the student consumption expenditures financed by transfers from the Scottish government as exogenous expenditure switching. We then demonstrate the effect of adopting the alternative exogeneity assumptions typically adopted in the existing literature.

Scottish government funding

A part of Scottish student consumption is funded by grants provided by the Scottish government. In the analysis so far we have taken these expenditures to be exogenous, which is the standard treatment of government expenditure in IO analysis. However, as the Scottish government is a devolved administration, it is constrained in its ability to run deficits as it has only limited borrowing powers. Therefore, it is appropriate to treat Scottish government finances as subject to a binding budget constraint, so that its expenditure on HEI students displaces other public expenditure in Scotland.

One way of dealing with this is to treat student consumption funded by the Scottish government not as additional exogenous expenditure but rather as exogenous expenditure which has been switched to student consumption. Assume that the proportion of the exogenous expenditure

Table 5. Domestic exogenous expenditure per student of different types for various assumptions.

	Degree of exogeneity (x^j)			Domestic expenditure per student (d^j) (£)		
Domicile	Standard IO	External only	Import substitution	Standard IO	External only	Import substitution
Scotland	0.41	0.00	1.00	2401	0	5901
RUK	0.73	1.00	1.00	4965	6807	6807
ROW	1.00	1.00	1.00	6807	6807	6807
All/average	0.60	0.37	1.00	3691	2304	6208

Note: IO, input–output; ROW, rest of the world; RUK, rest of the UK.

of type j students funded by the Scottish government is g^j. Adopting this approach, the output generated by the exogenous expenditure from student type j is now given as:

$$q^j = (m^s(1 - g^j) + \Delta m g^j)d^j \tag{11}$$

where $\Delta m = m^s - m^g$ and m^g is the multiplier for general government expenditure.

Only Scottish-domiciled student are supported by the Scottish government, with Table 2 showing that grants and bursaries make up 30% of their exogenous expenditures. Therefore, $g^{SCOT} = 0.3$, whilst g^{RUK} and $g^{ROW} = 0$. The value of m^g, the general government expenditure multiplier, is calculated as 1.77, so that $\Delta m = -0.24$. Applying equation (11) rather than equation (6) reduces the measured impact of Scottish-domiciled student consumption expenditure by £171 million, a 34% reduction. This drop is larger than the share of government expenditures in student consumption due to the negative switching multiplier. This in turn is driven by more leakage in students' consumption expenditures than general public expenditures. The reduction in the total impact on Scottish output of the consumption of all students is 15%. The total impact is now measured at £1.1 billion.

Alternative exogeneity assumptions

In our standard IO calculations, we identify the degree of exogeneity of student consumption in some detail. The procedure is explained in the third to fifth sections and the results are shown in Tables 2–4. The resultant exogeneity estimates for each student type are repeated in the first data column of Table 5. The corresponding per capita domestic consumption expenditure figures are presented in column 4.

In this section we compare those results with the figures from two alternative approaches that are common in the literature. In the third section we labelled these the external-only and import substitution approaches. The difference between these methods rests on the assumptions adopted concerning the degree of exogeneity of the consumption expenditures made by the different student groups. Under the import substitution assumption, all expenditures are considered exogenous, based on the argument that the students' expenditures are only realized because of the presence of the HEI. Under the external-only assumption, the import substitution argument is invoked for external students, but not for local students.

In the external-only approach, all consumption expenditure from students domiciled outwith Scotland is treated as exogenous, whilst the consumption of domestic students is treated as endogenous. This implies values for $x^{SCOT} = 0$ and x^{RUK}, $x^{ROW} = 1$, which are shown in column 2 of Table 5. As stated in the second section, this is the broad method adopted by Love and McNicoll (1988), Steinacker (2005) and Kelly et al. (2009, 2014). It is the approach that has been favoured when assessing the impact of a network of HEIs on a large region or nation. In the import substitution case, all student consumption is taken to be exogenous, so that x^{SCOT},

x^{RUK} and x^{ROW} all equal 1. This is shown in column 3 and is the method favoured by Brownrigg (1973, Bleaney et al. (1992), Armstrong (1993), Harris, (1998) and Battu et al. (1998). These are studies of the impact of individual HEIs on their local economies.

Note that in all three approaches, the consumption from the ROW students is taken to be wholly exogenous. This expenditure is treated in exactly the same way as the consumption expenditures made by foreign tourists, as all externally financed. The variation in the impact figures therefore depends on the exogeneity values for Scottish and the RUK students. For the standard IO estimates, exogenous expenditures make up a proportion of both these consumption streams. However, under the alternative approaches, the degree of exogeneity for the RUK students is always taken to be 1 and that for Scottish students either 0, under the external-only calculations, or 1, for the import substitution case.

This means that the student expenditure impact measured under the import substitution method will always give the highest impact value. For each type of student, the degree of exogeneity of their consumption is at least as high in this case as under either of the other two approaches. However, it is not possible to rank a priori the standard IO as against the external-only impact figures. This is because the degree of exogeneity is higher for domestic students with the standard IO, but higher for the RUK students under the external-only approach.

Columns 4–6 of Table 5 give figures for the exogenous domestic expenditure per student of each domicile under the three different impact measures. The final row gives the average exogenous expenditure per student across all the student types for that approach, d. This is the weighted sum of the values for each student type, given by equation (10).

The domestic exogenous consumption of the average student in Scotland in the standard IO estimate is £3691. The corresponding import substitution and external-only calculations are £6208 and £2304, 68% higher and 38% lower respectively. In estimating the total output driven by student consumption, these exogenous domestic expenditure figures are all then scaled up by the same multiplier value, 1.53.

In the third section we argued against the existing conventional approach to determining the exogeneity of student consumption in demand-driven impact analyses. The results generated in the present section reveal that these concerns are non-trivial. The nature of the assumptions adopted clearly has an important and systematic effect on the size of the measured impact. In particular, the results suggest that conventional studies of the impact of individual HEIs on their local economy are likely to overestimate the effect of student consumption, whilst conventional impact analysis of whole systems of HEIs typically underestimate these effects.

IMPACT OF STUDENTS AT INDIVIDUAL INSTITUTIONS

Table 6 presents the data for student numbers and the Scottish output supported by their consumption for each of the 18 Scottish HEIs operating in 2013. The first four data columns show the total number of students, measured in fulltime equivalents (FTEs) and the disaggregation by place of domicile. The average number of students per HEI is just over 11,600, but the actual size and composition of the student population varies widely across HEIs.

The data in columns 5–8 give the total output in Scotland supported by their exogenous consumption expenditures. These are derived using equations (7) and (9) and are given in millions of pounds sterling. These results are also shown in Figure 1, where the HEIs are also ranked. As is evident from Figure 1, Scottish HEIs vary significantly in terms of both 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. The largest impact, £195 million, is given by students at the University of Edinburgh. This value is over 60 times larger than the smallest, provided by the students at the Scottish Rural College (SRUC), who support £3.1 million of output in the Scottish economy.

Table 6. Students' consumption impacts by institution.

	Student numbers FTE				Output impact of student spending (£ millions)				Output impact as a percentage of Scottish output
	SCO	RUK	ROW	Total	SCO	RUK	ROW	Total	
Aberdeen	8366	2114	4443	14,923	26.6	16.1	46.3	88.9	0.04%
Abertay	3750	387	696	4833	11.9	2.9	7.3	22.1	0.01%
Caledonian	13,721	638	1817	16,176	43.5	4.8	18.9	67.3	0.03%
Dundee	8214	1556	2623	12,393	26.1	11.8	27.3	65.2	0.03%
Edinburgh	12,097	7115	9797	29,009	38.4	54.1	102.1	194.6	0.08%
Glasgow	18,724	2721	6325	27,770	59.4	20.7	65.9	146.0	0.06%
GSA	828	407	494	1729	2.6	3.1	5.1	10.9	0.00%
Heriot Watt	4369	996	3510	8875	13.9	7.6	36.6	58.0	0.02%
Napier	8646	838	2778	12,262	27.4	6.4	28.9	62.8	0.03%
QMU	3343	1054	1173	5570	10.6	8.0	12.2	30.8	0.01%
Robert Gordon	6999	244	2480	9723	22.2	1.9	25.8	49.9	0.02%
Royal Conservatoire	502	213	214	929	1.6	1.6	2.2	5.4	0.00%
SRUC	749	37	40	826	2.4	0.3	0.4	3.1	0.00%
St Andrews	2728	2669	4639	10,036	8.7	20.3	48.3	77.3	0.03%
Stirling	7657	1007	2562	11,226	24.3	7.7	26.7	58.7	0.03%
Strathclyde	17,419	444	2798	20,661	55.3	3.4	29.2	87.8	0.04%
UHI	6778	186	456	7420	21.5	1.4	4.8	27.7	0.01%
UWS	13,826	262	1232	15,320	43.9	2.0	12.8	58.7	0.03%
	138,716	22,888	48,077	209,681	440.3	174.0	501.0	1115.2	0.48%

Note: FTE, fulltime equivalent; GVA, gross value added; ROW, rest of the world; RUK, rest of the UK; SCO, Scotland; GSA, Glasgow School of Art; QMU, Queen Margaret University; SRUC, Scottish Rural College; UHI, University of the Highlands and Islands; UWS, University of the West of Scotland.

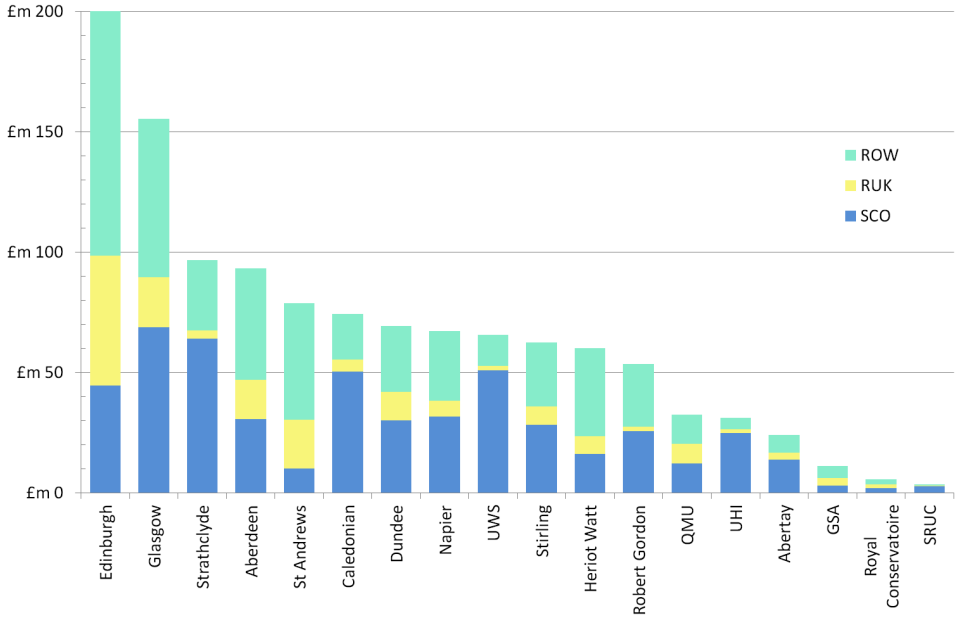

Figure 1. Type II output impact of students' consumption expenditures by institution and student origin, ranked by size of impact (£ millions).
Notes: GSA, Glasgow School of Art; QMU, Queen Margaret University; SRUC, Scottish Rural College; UHI, University of the Highlands and Islands; UWS, University of the West of Scotland.

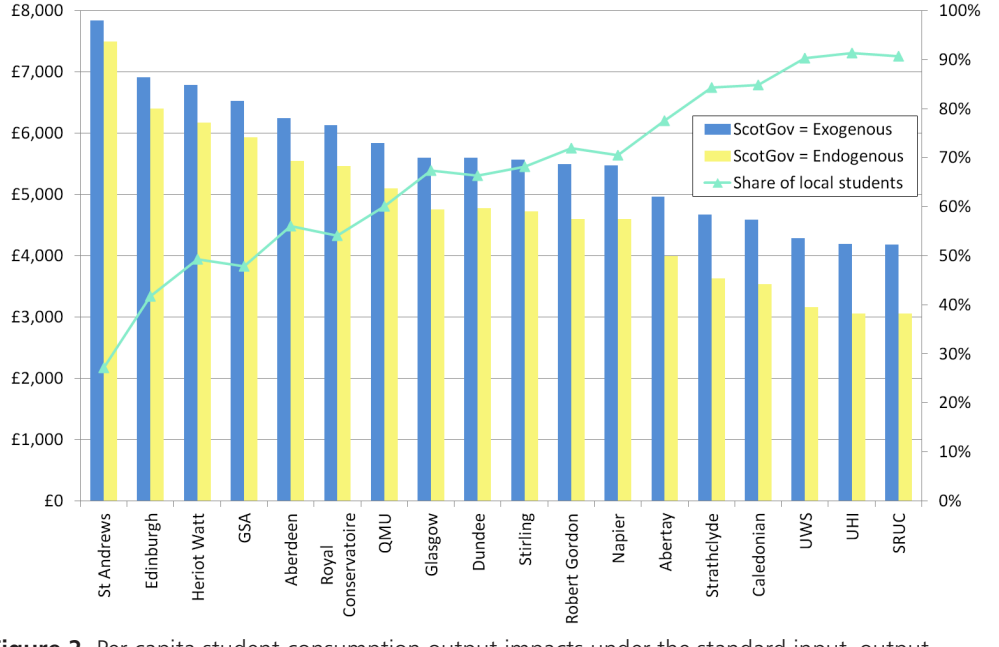

Figure 2. Per capita student consumption output impacts under the standard input–output approach, higher education institutions (HEIs) ranked by the scale of the impact.
Notes: Dark bars treat Scottish government expenditures as exogenous and light bars as subject to a binding budget constraint, i.e., expenditure switching. Also shown is the percentage share of local students.

For one-third of Scottish HEIs, the exogenous domestic consumption of the Scottish students has the largest impact. Similarly, although there is clear positive relationship between the size of the student population and total exogenous student consumption, this correlation is not perfect. For example, the University of Dundee has fewer students but a higher supported output than University of the West of Scotland (UWS).

The exogenous consumption of students at HEIs located in Edinburgh generates in total £349.3 million output, with a slightly lower figure for those located in Glasgow at £317.5 million.[10] What is clear from these data is that whilst Glasgow HEIs have the largest total number of students and the top three domestic student consumption entries, Edinburgh is the major university for the RUK and ROW students by some distance and other Edinburgh HEIs, such as Napier and Heriot-Watt universities, also have large non-Scottish consumption expenditures.

It is interesting to compare the impact of the consumption expenditure of the average student across institutions. These values are shown in Figure 2. Their calculation where the expenditure supported by the Scottish government is counted as exogenous uses the following formula:

$$\frac{q^{T,k}}{s^{T,k}} = \sum_j q^j \sigma^{j,k} \tag{12}$$

where $\sigma^{j,k}$ is the proportion of students in HEI k that are of type j.

Where the Scottish government expenditure is taken to be exogenous, the impact per student is shown by the dark bars in Figure 2. The average student at St Andrews University generates the largest impact at £7837, almost double the impact of a representative student at the SRUC, £4178. Equation (13) shows that the scale of the average impact is driven by the composition of the student population. Figure 2 plots the proportion of the student population in each HEI that is Scottish. We note a strong negative correlation with the consumption impact per student. For the University of St Andrews, just over one-quarter of all students are Scottish, whereas at the

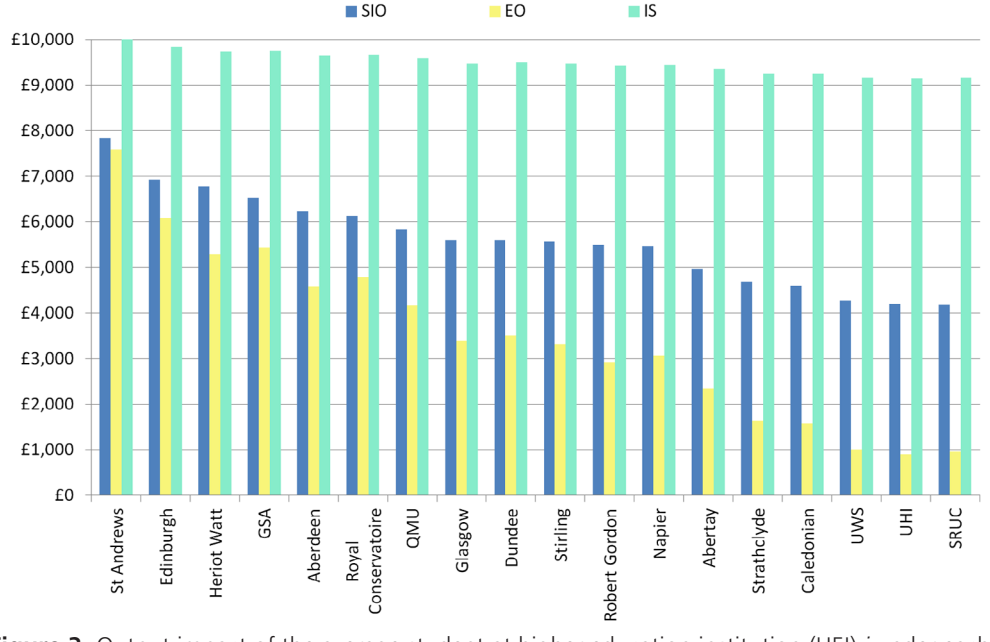

Figure 3. Output impact of the average student at higher education institution (HEI) *i* under each of the three assumptions (standard IO, external only and import substitution), ranked by the size of the impact estimated under the standard input–output approach (£).

SRUC over 90% are Scottish. The impact of the average student at the SRUC is close to that of the representative student of Scottish origin, which is £3174.

In the sixth section we introduced a possible adjustment to the impact estimate. Because of the budget constraint under which the Scottish government operates, this adjustment treats Scottish government-funded student consumption as expenditure shifting, rather than a pure expenditure injection. Where the student consumption supported by Scottish government funding is treated as exogenous expenditure switching, the formula determining the output resulting from the exogenous consumption of students of HEI k is given as:

$$y^{T,k} = (m^S(1 - g^j) + \Delta m g^j)d^{T,k} \tag{13}$$

We revealed that treating Scottish government funding of students in this way reduces the impact attributed to Scottish students by 34% and the impact of the average student in Scotland by 15%. However, the composition of the student populations across HEIs is heterogeneous and therefore we expect this change to increase further the heterogeneity of the impacts of students at individual institutions. Figure 2 also shows, using red bars, the average impact per student as estimated treating the expenditures of the Scottish government as exogenously switched. Those HEIs that already demonstrate the strongest per student consumption impacts are least sensitive to the acknowledgement of the Scottish government's budget constraint. The rationale is straightforward. Only Scottish students receive funding from the Scottish government and it is only their exogenous consumption impact that is affected by this constraint. However, this adjustment to the calculation of the student consumption impact does not change the ordering of the HEIs in Figure 2.

In Figure 2, the impacts of student populations attending individual institutions have been generated using the standard IO exogeneity estimates. However, it is of interest to analyze the biases induced by using the external-only and import substitution approaches outlined in the sixth section. In Figure 3 we show the impact on Scottish output of the consumption from the average student at each Scottish HEI calculated under the three alternative sets of assumptions. For each we use equations (4), (6) and (12) with the exogeneity values given in Table 5.

The import substitution assumption produces very high values which vary within a very narrow range across institutions. In this case, the degree of exogeneity of consumption is constant across different student types and the consumption impact values vary only through differences in the average consumption expenditure per student. On the other hand, the external-only figures show the greatest variation across institutions. This measure clearly produces an ordering of per capita student consumption impacts across HEIs that differs from the other two approaches. Compared with the standard IO estimates, both the import substitution and the external-only measure perform least badly for HEIs with the lowest share of local students. However, where HEIs have a large proportion of Scottish students, these alternative measures either grossly over- or underestimate the consumption impacts.

CONCLUSIONS

Our best estimate is that in 2013 total HE students' consumption expenditures supported 0.48% of Scottish output and GVA and 0.39% of Scottish employment. Approximately 43% of this impact is attributable to local students, while the remainder is generated by students from the RUK (15%) and the ROW (42%). Two-thirds of students at Scottish HEIs are Scottish, but they draw more heavily on local (endogenous) income sources. This implies that a smaller share of their expenditures is exogenous and this reduces their output and employment impacts. Unsurprisingly, the HEIs with both a large student population and a high external student share have the largest

impacts. Students from five HEIs account for over half the consumption impact in Scotland, and Edinburgh University students alone account for 17%.

There are two primary shortcomings that affect much of the academic literature estimating the consumption impact of HEI students. These concern the exogeneity assumptions. First, these are typically binary. That is, the whole of the student's consumption expenditure is assumed to be either exogenous or endogenous. Second, the basis for this judgement is solely conjecture (or surveyed hypothetical intentions) about the migration propensities of the students; if the student is a migrant or potential migrant, then all the consumption is exogenous; if not, then none is.

We have replaced this procedure by one more soundly based on standard IO principles. This is that the exogeneity of student expenditures is an empirical matter, determined by the origin of the income source, which is informed by income-expenditure surveys of actual behaviour. This method satisfies the accounting identity that all economic activity can be attributed to exogenous final demand and therefore guards against double-counting. In this approach, a student's consumption will typically be funded partly exogenously and partly endogenously.

We have demonstrated the applicability of this approach with Scottish data. In practice, this is constrained by the limitations of the survey evidence and some simplifying assumptions still need to be applied when calibrating the model. However, this is a far more nuanced treatment of the exogeneity of students' consumption expenditure than under traditional assumptions in the literature and it is straightforward in principle to refine the application of the framework through more appropriately designed student income-expenditure surveys.

The analysis shows that students from different domiciles are heterogeneous in terms of the level and degree of exogeneity of their aggregate consumption expenditure. We demonstrate that the biases introduced using the usual counterfactual assumptions are particularly distorting for HEIs that largely serve local students. A 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.

The framework set out in this paper has been used for a very specific case. However, it has more general applicability for quantifying economic impacts where consumption expenditures are not completely endogenous. Examples are the analysis of the demand-side effects of changes in benefit payments and certain forms of tourism expenditures.

If estimates of expenditure impacts of HEI students influence policy decisions, such as on funding or planning issues, it is crucial that these estimates are accurate. The framework presented here is an important contribution to informing the work of consultants and others carrying out such studies by appealing to first principles, rather than past practice. The framework can be extended with the judicious use of more detailed data, for instance, to look at particular student groups in more detail or to introduce a multiregional dimension by identifying the impacts of mobile students at both origin and destination. However, as stressed in the introduction, we see the greatest potential in building bridges across fields by combining the analysis of a range of economic and social impacts of mobile and static students. This implies, for example, the joint treatment of the effects on consumption, labour markets, urban buzz and housing markets, noting that these can be both positive and negative (Munro et al., 2009).

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NOTES

1. For reviews, see Drucker and Goldstein (2007), McMahon (2009), Drucker (2016) and Hermannsson (2016).
2. In 2013, UK HE entrants made up 58% of the corresponding age group, which is below the median among Organisation for Economic Co-operation and Development (OECD) countries (OECD, 2016). For tourism marketing specifically aimed at students in London, Scotland and Wales, see http://www.studylondon.ac.uk/, http://studyinscotland.org/ and http://studyinwales.ac.uk/.
3. For overviews of these approaches, see Armstrong and Taylor (2000), Loveridge (2004), and Miller and Blair (2009).
4. Much of the IO work in environmental economics adopts this approach. The IO framework is employed to attribute pollutants generated in production to the ultimate public and private consumption that the polluting activity directly or indirectly serves (Wiedmann, 2009).
5. Demand-driven type-II IO analysis has a very clear implicit counterfactual position. If the exogenous source of demand for an activity disappears, that activity disappears together with all the direct, indirect and induced demand-linked activities. There is no speculation about where the workers will go, what will happen to the buildings and land. Of course, IO can be used in conjunction with other approaches that might employ such a speculation, but if so, the user should be wary not to breach the implied assumptions underlying the IO method.
6. We use the convention that underlined lower and upper case letters indicate vectors and matrices respectively.
7. This is a simplifying assumption, but alternative treatments can easily be accommodated within the model if suitable information on the labour market participation of foreign students becomes available
8. If the difference is financed through increased commercial credit, it ought to be treated as exogenous. In that case, the value of x^{SCOT} would be 3,531/8,678, which equals 0.58.
9. Where a proportion of the consumption of a particular group is exogenous, it is not that some consumption (say transport and food) is exogenous and others endogenous, but that a share of each element of the consumption of that group in the base year is funded from an exogenous, the remainder from an endogenous, income source.
10. The Edinburgh HEIs are Edinburgh, Heriot-Watt and Napier universities, Queen Margaret University (QMU) and Scotland's Rural College. The Glasgow HEIs are Glasgow, Glasgow Caledonian and Strathclyde universities, the Glasgow School of Art (GSA) and the Royal Conservatoire.

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