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MEASURING EDUCATION SERVICES AS INTANGIBLE SOCIAL INFRASTRUCTURE

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Abstract

The starting point for this paper is that society's consumption of education services is the acquisition of schooling knowledge assets whose change in value should be included in saving and net investment. We estimate the nominal value of education services produced by the public sector by using the Jorgenson-Fraumeni lifetime income approach. Enrolments by education type are multiplied by the amount by which lifetime earnings at that age, sex, and education change with additional qualifications taking account of the extra time required to achieve that additional education. Implementing this approach requires a number of assumptions on estimating wages net of experience, taking account of international students who pay for the cost of their tuition, survival rates, the discount rate and deflators. The model is estimated using data for the UK under a range of assumptions. The ratio of our preferred measure to education expenditures is just under three, suggesting that society obtains a very high economic benefit from education.

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1. Introduction.

The public sector produces services such as education and health that can be viewed as intangible social infrastructure which add to investment, savings and wealth. Typically this is not included within the national accounts framework. These services provide benefits to society in many forms including increasing the productivity of workers as well as social gains such as arguably contributing to stable democracies. This paper considers the worker productivity aspect of education services through using the lifetime income approach put forward by Jorgenson and Faumeni (1989, 1992a, 1992b).

The next section sets out the conceptual framework for modeling education services as social infrastructure. Section three sets out the lifetime income model. We then apply this approach to data for the UK over the period 2002 to 2014. Section 4 discusses the data used and section 5 presents results.

2. Framework: Education as Social Infrastructure.

Many studies show that returns to education accrue to private individuals in the form of higher wages rather than as paybacks to producers of education services. A fundamental feature of the educational process as modelled, e.g., by Jorgenson and Fraumeni (1989; 1992a; 1992b), is the lengthy gestation period between the application of the educational inputs (mainly the services of teachers and the time of their students) and the emergence of human capital embodied in graduates of educational institutions. In the Jorgenson and Fraumeni framework, the *household* invests time and money via purchases of teacher services (either at cost for public institutions in national accounts or actual outlays in the case of private services) to build human capital.

Household production is out of scope for GDP as traditionally defined, and the JF approach to modelling human capital production and investment is usually considered relevant for building a “human capital” satellite account and not necessarily relevant as an approach for measuring educational output in headline GDP. In this paper we reconsider the utility of the JF approach for measuring educational output.

Our approach begins with the view that the service capacity of a nation’s education system is, in effect, social infrastructure. In this view, spending by educational institutions to improve the capacity of the educational system to deliver improved teacher services would be inside the asset boundary of GDP, i.e., such spending would be considered an intangible investment as in Corrado, Hulten, and Sichel (2005, 2009). In other words, a school system's expenditures on teacher training is an investment if it increases the effectiveness of the system to deliver educational services in future periods.[1]

But what about the output of educational institutions? If an education system plays a part in producing human capital, we need a framework that views the production of education services as the production of a societal asset as opposed to regarding education services as an input to the production of human capital within households. The basic idea is that society's consumption of education services is in fact the acquisition of schooling knowledge assets, ΔE, whose change in value $P^{ES}\Delta E$ should be included in saving and wealth *even though it is not used in current production (or consumed)*. Rather, the assets are held in inventory, within the school system, until students graduate and enter the working age population, after which the value is unchanged (by the shool system).[2] In this view, the real output of an education system, Q_{ES} is the knowledge stock of this year's graduates plus the increment to knowledge held by students still within the system, or $Q_{ES} = E^{Grads} + \Delta E^{InSchool}$. Under certain assumptions, this implies $Q_{ES} \equiv \Delta E$ because at any point in time the value of last year's graduates is unchanged (and entrants at the lowest level are assumed to have a zero stock).

The production function F^E for education services is then given by:

(1) $$Q_{t,ES} = F^E\left(K_{t,ES}, L_{t,ES}\right)$$

which implies

(2) $$E_t = F^E\left(K_{t,ES}, L_{t,ES}\right) + E_{t-1}$$

where E_{t-1} is the beginning-of-period knowledge stocks held by this year's students, and education services production is the schooling-produced increment to those stocks. There is no depreciation of schooling-produced knowledge stocks while students are enrolled in school. K_{ES} and L_{ES} are the education system's fixed capital and labor services inputs.

[1] This expanded view of investment by educational institutions has been implemented in the database produced by the SPINTAN project, which covers 22 EU countries, the United States, Brazil, and China. See www.spintan.net for further details.

[2] Note that this “inventory” view follows the logic of Ruggle's approach to accounting for consumer durables (Ruggles, 1983; see also Moulton, 2001) and the SNA's approach to the treatment of valuables.

These simple accounting relationships are directly related to the JF lifetime-income approach to human capital measurement. Some observers have suggested that the JF “market” component of human capital production be used to replace the existing measures of education services in conventional GDP (e.g., Ervik, Holmoy, and Haegeland, 2003). Our “inventory" approach is a different adaptation of the JF model for inclusion in conventional accounts. Like the JF work, however, and as discussed in Christian (2014), our approach includes values, volumes, and prices as basic elements, and in that capacity embraces human capital within the conventional boundary of the SNA.

Mincer's seminal contribution (Mincer, 1974) mapped the theory of investments in human capital to the empirical literature on the returns to schooling. According to Mincer's model, at the end of each period of schooling, individuals (a) have a level of human capital consistent with that level of schooling, and (b) choose the optimal level of schooling (i.e., years in school) up to the point that the opportunity cost of one more year of schooling equals foregone earnings. This implies an individual's return to schooling must be commensurate with these foregone earnings. The Mincer framework underpins the lifetime income approach of Jorgenson-Fraumeni which is discussed in the next section.

After recognition of schooling-produced knowledge assets, real investment in national accounts includes the net acquisition of knowledge capital held within the education system ΔE, which is equivalent to the real gross output of the education system. Investments in schooling-produced knowledge assets tend to be a function of the age structure of a society, and thus a relatively stable fraction of GDP in most advanced countries, suggesting that the implications of capitalizing education as social infrastructure for *real* GDP and productivity change will largely depend on trends in the implied price index for education services. Notwithstanding, recognition of schooling assets as societal wealth packs an extra punch for net saving and real net expenditures (relative to real GDP, that is) due to the fact that in moving from GDP to real net expenditures, no depreciation charge is taken.

3. The Jorgenson Fraumeni framework

This section suggests a method of integrating the Jorgenson-Fraumeni (1989, 1992a,b) lifetime income approach to measuring human capital with the treatment of education as social infrastructure as argued above. The Jorgenson-Fraumeni framework is set out below, followed by a discussion of conceptual issues that arise when using the framework to estimate the value of a society’s investments in education.

3.1 The Jorgenson-Fraumeni (JF) framework

Lifetime income

We begin by abstracting from non-market activities, employment outcomes and labour force dropouts and simply assume that any student enrolled in school will, in the following year if they leave education, earn the market wage corresponding to that level of education.

The JF framework calculates the values of human capital stocks based on lifetime incomes by sex (s), age (a) and education level (e). Their original papers calculate this for all persons in the population. A more common approach is to calculate the stock only for the working population, e.g. Gu and Wong (2010), Wei (2004).

Let: pop = population

y = current market income

li = lifetime income

δ = the discount rate

g = average income growth

senr = the enrolment rate

sr = the survival rate.

The JF framework calculates lifetime income by s, a and e for essentially two groups. Assume no-one of age 35 and above is enrolled in education. The first group, for those aged 35 and over, is the most straightforward. The simplest assumption is to say that lifetime income is 0 beyond some age, say 80. For those aged 80, lifetime income (*li*) in year t is just current labour income.

(3) $$li_{s,a=80,e,t} = y_{s,a=80,e,t}$$

For those aged 79 lifetime income is current labour market income plus discounted future income of those aged 80 with the same education and gender, conditional on survival:

(4) $$li_{s,a=79,e,t} = y_{s,a=79,e,t} + sr_{s,a=80,e,t}\frac{1+g}{1+\delta}y_{s,a=80,e,t}$$

In general the lifetime income of those aged 35+ is given by:

(5) $$li_{s,a,e,t} = y_{s,a,e,t} + sr_{s,a+1,e,t} \frac{1+g}{1+\delta} li_{s,a+1,e,t} \mid a \geq 35$$

This valuation for individual i at time t is the value of current income plus the income of those one year older of the same age, sex and educational attainment times growth in income discounted to the present, plus the income of those two years older and so on up to age 80. It therefore assumes that the best estimate of a person's income next year is that earned this year by a similar person who is one year older. The nature of the income growth term, *g*, is discussed further below.

For persons aged between 5 and 34, lifetime income takes account of if they are enrolled in education or not. For these age groups:

(6) $$li_{s,a,e,t} = y_{s,a,e,t} + sr_{s,a+1,e,t} \frac{1+g}{1+\delta}\left[senr_{s,a,e,t} li_{s,a+1,e+1,t} + (1 - senr_{s,a,e,t}) li_{s,a+1,e,t} \right] \mid 5 \leq a < 35$$

Thus, if a person aged a is enrolled in education level e, their lifetime income depends on that for a person one year older with level e+1. If the same individual is not enrolled in education their lifetime income depends on that for an individual one year older with education level e. Finally lifetime income for those aged 0 to 4 is calculated the same way as for those aged 35 and over except that earnings are zero and education is set at the lowest level.

Value of human capital.

The total value of the human capital stock in year t can be calculated by summing the lifetime earnings by s, a and e:

(7) $$HC_t = \sum_s \sum_a \sum_e pop_{s,a,e,t} li_{s,a,e,t}$$

Note if the working population is used as the weighting factor in (5) then those enrolled in compulsory education (usually aged 5-15) no longer feature. This is an issue for calculating the output of the education sector as discussed below.

Christian (2010) defines net investment in human capital (NIH) as the effect of changes from year to year in the size and distribution of populations. This is given by:

(8) $$NIH_t = \sum_s \sum_a \sum_e (pop_{s,a,e,t+1} - pop_{s,a,e,t}) li_{s,a,e,t}$$

This in turn can be broken down into various components such as births, deaths, *"net investment from education of persons enrolled in school"* and depreciation and aging of persons not enrolled in school.

In measuring the nominal value of education as social infrastructure we concentrate on the portion of the population enrolled in education. The term corresponding to those enrolled in school is therefore given by:

(9) $$NIH(enr)_t = \sum_s \sum_a \sum_e (enr_{s,a,e,t+1} - enr_{s,a,e,t}) \left[\frac{1+g}{1+\delta} sr_{s,a+1,e,t} li_{s,a+1,e^*,t} \right]$$

where *enr* are school enrolments, and

$li_{s,a+1,e^*,t} = [senr_{s,a+1,e,t} li_{s,a+1,e+1,t} + (1 - senr_{s,a+1,e,t}) li_{s,a+1,e,t}]$ via equation (6), as these persons are enrolled in education their current market income is zero. The value of educational services (VES) can be estimated by rewriting equation (9) as (Christian, 2010):

(10) $$VES_t = \sum_s \sum_a \sum_e enr_{s,a,e} (li_{s,a+1,e=1,t} - li_{s,a,e,t})$$

Enrolments are multiplied by the amount by which lifetime earnings at that age, sex, and education change with the addition of one extra year of education and the one extra year of age required to achieve that additional education.

3.2 Valuing net Investment in human capital for persons enrolled in education.

There are a number of issues to resolve in order to value equation (7). These include the attribution of lifetime earnings to education, the nature of the income growth term *g* and the survival probabilities *sr*.

Attribution

What is the income of a person one year older with the same education level capturing? In Mincer's canonical wage equation, in which individual j's wage is a return to human capital, there are two key terms, one a return to schooling and the other a return to work experience, suggesting $HC_j = E_j + LX_j$ where HC_j is individual j's total human capital and LX_j is the portion acquired through work, i.e., labor market, experience. From the point of view of the schooling system, this suggests schooling-produced knowledge assets can be defined as the present discounted value of expected wages of graduates upon entry to the labor market, i.e., when the return to experience is virtually nil. Then the income stream arising from education services should be constant at the graduation earnings through time. In that case the lifetime income stream only depends on how long the person is in the workforce after graduation.

The other extreme is to assume that all future labour income is attributable to the level of educational attainment of the individual. This amounts to using the full JF calculation — however, in our context it is difficult to justify this assumption. (This assumption is embedded in previous work such as by Christian (2010) and Gu and Wong, 2010). A practical solution might be to derive the wages on graduation as a T-year average from the point of graduation. This could be justified by assuming some degree of asymmetric information whereby firms do not pay the full marginal product immediately in case the worker turns out to be a lemon. T could be set at say 3 years.

Another approach is to use Mincer regressions, controlling for other influences such as experience – this was the method used by O'Mahony and Stevens (2009) and O'Mahony et al. (2012). This method also allows for direct modelling of the probability of employment. However this method also leads to difficult econometric issues, mostly relating to identifying the difference between age and experience. This method is not pursued further in this paper.

The calculations should also take account of the opportunity costs of staying in education beyond the age of compulsory education. However these foregone earnings are likely to be small relative to lifetime earnings. Finally we need to take account of foreign students.

Survival rates

If we concentrate on the working population then sr takes account of both mortality and retirement. These in turn can be calculated using life tables and age-specific retirement rates. Arguably survival rates should also depend on the probability that a person is employed (and not unemployed or exited the labour force). If we ignore employment probabilities we are estimating the potential human capital only adjusting for permanent exits such as death and end of working life retirement. This would be equivalent to ignoring utilisation rates for physical capital. We deal with this by multiplying current income by employment rates, as is standard in calculations of human capital stock for the working population (Jones and Fender, 2010).

Growth in income and the discount rate

Constructing values for equation (10) requires assumption about the growth in income (g) and the discount rate (δ). A relevant question in our context is, does the g that determines income growth include productivity and/or inflation gains. In other words, are nominal holding period gains to schooling part of the value of human capital? It seems that something of the sort must be there if g is, say 2 or 3 percent as in the human capital measurement literature, and thus part of the nominal change in human capital may be in fact be a holding period (i.e., capital) gain in a national accounting sense, e.g., as in the total change in the value of schooling produces assets is given by

$$\Delta(P^{ES}E) = P^{ES}\Delta E + \Delta P^{ES}E \qquad (11)$$

where from before $P^{ES}\Delta E$ is the acquisition value of schooling-produced human capital, and the second term on the RHS is the holding gain (where other changes in volume and higher order terms are ignored). Looking at this equation makes it abundantly clear that the value of school system production is the first term on the RHS. The second term is not included as per the usual exclusion of asset valuation changes from GDP. In this case it makes sense to set *g=0* if, as argued above, changes in individual's income after graduation mostly reflect experience and training which again suggests a zero value for *g*. On the other if education effectiveness needs time to mature, especially perhaps for university graduates, and it is thought desirable to take a T-year average as discussed above, then setting *g>0* is likely necessary. In the estimates below we set g equal to 1%, which is half the usual assumption employed in Human capital stock calculations (Jones and Fender,2010; Christian (2010); Gu and Wong, 2010).

In addition we need to assume a value for δ. In the JF framework this is the annual discount rate to construct the present value of the future income stream but is not discussed in any detail in that literature. Theoretically, this should be a rate of time preference, which in this case would be a social rate. An empirical strategy for estimating the social rate of time preference (SRTP) for a country is set out in the OECD capital manual; updated SRTP estimates for each SPINTAN country are reported in Corrado and Jaeger (2015). Based on the latter work, in this paper we set δ equal to 2%, again lower than commonly assumed.

Education progression

The UK data are available by type of qualification rather than years of education, divided into 4 groups GCSE or equivalents (the typical exam qualification attained usually at age 16), A level or equivalents (the typical exam qualification for those who stay on at school, usually attained at age 18), further education (FE – post secondary but below tertiary, typically vocational qualifications that can either be a follow on from GCSE or sometimes from A level) and Higher Education (HE- tertiary education leading to degrees or equivalents). This means that assumptions need to be made to implement equation (10) in regard to progression across different types of qualifications. We aggregate all students up to age 16 and compare their li with the li of someone aged 17 who has an A-level. FE are compared with GCSE for those aged up to 18 and with A levels for older students. HE is compared to A level rather than FE as most students go to University following A levels rather than progression via FE qualifications).

Foreign Students

The knowledge assets of graduates exiting the country needs to be excluded in this calculation if the probabilistic full resource cost of the annual education of foreign students is charged to them (i.e. their charges reflect the costs of their education discounted by the probability they enter the domestic labor force). In this way P^{ES} retains its interpretation as the domestic price of schooling-produced domestic knowledge assets because the cost incurred in producing a foreign graduate is fully offset in revenues, which are subtractions from nonmarket production values estimated on the basis of production costs.

Deflators

These calculations are in nominal values. Real education output can be estimated as weighted enrolments, with weights equal to the present value of the lifetime return to an additional year in education. For example Gu and Wong (2010) estimate a volume index of education output as:

(12) $$\ln Q_t - \ln Q_{t-1} = \sum_{s,a,e} \bar{v}\left[\ln enr_{s,a,e,t} - \ln enr_{s,a,e,t-1}\right]$$

Where $\bar{v}$ is the share of individuals with s, e, a in the total value of investment in education, averaged over year t-1 and t. The price index of education services (P^{ES}) can then be estimated by dividing the nominal value of education services by the volume index of education services.

Christian (2012) also discusses the alternative of measuring real net investment in education by deflating nominal net investment in education by the consumer price index. This he terms an outcome based measure as it captures the amount of goods and services that could be consumed by the education services rather than the amount produced, i.e., it captures the opportunity cost of foregoing current consumption for investments in schooling. A third alternative is to divide $P^{ES}E$ by the number of school system graduates in the workforce (aged < 35).

Interestingly Gu and Wong cite Diewert (2008) as showing that "valuing output at average costs in measuring output and productivity growth is a second best option while the best option would be to use final demand prices to value output. The use of the final demand prices should correspond to the [lifetime] income-based approach in the context of education services."

Education services and education expenditures

What is the relationship between the nominal value of investment given by equation (10) and expenditures on education as currently measured in national accounts (i.e., education costs)? It could be a measure of rate of return, or effectiveness of the school system, i.e.

(13) $$P^{ES}\Delta E = \gamma * Education\ Expenditures$$

where γ (≅ 1+rate of return) can be equal to, greater than, or less than one. We usually think of “effectiveness” as a correction for quality, but here it is more like a rate of return. If γ is greater than 1 it can be interpreted as a measure of societies return from investing in education and compared to returns from investment in other assets. If γ is less than one, then one could say that there is a penalty exacted from society due to the resources of the school system not being used effectively—or, put differently, due to the labour market not using schooling-produced human capital effectively (i.e., when there is long-term unemployment).

The potential policy relevance of γ suggests that the assumptions used to derive equation (10)—the treatment of employment probabilities, the use of a T-period average for wages, and choice of discount rate—need to be conceptually valid and empirically well understood. Given the large number of assumptions required γ is best compared over time or across countries rather than putting too much weight on its absolute value. Note further that if the LHS of equation (13) replaces education expenditures in intangibles-augmented growth accounts, the contribution of the education services sector to productivity growth is boosted (or diminished) directly by γ.

4. Data sources

We use standard data sources to carry out the computations described above for the UK. These were:

- The Labour Force Surveys and Annual Population Survey – for earnings, population and employment rates by gender, age, and qualification.
- Enrolment rates from Education statistics, this uses both published data and unpublished tabulations from HESA for foreign students
- Life Tables for survival probabilities
- Education expenditures from COFOG tables.

We exclude enrolments of part-time students in FE and those aged greater than 21 as these students are likely to be taking courses that are paid for by the individuals themselves or by their employers.

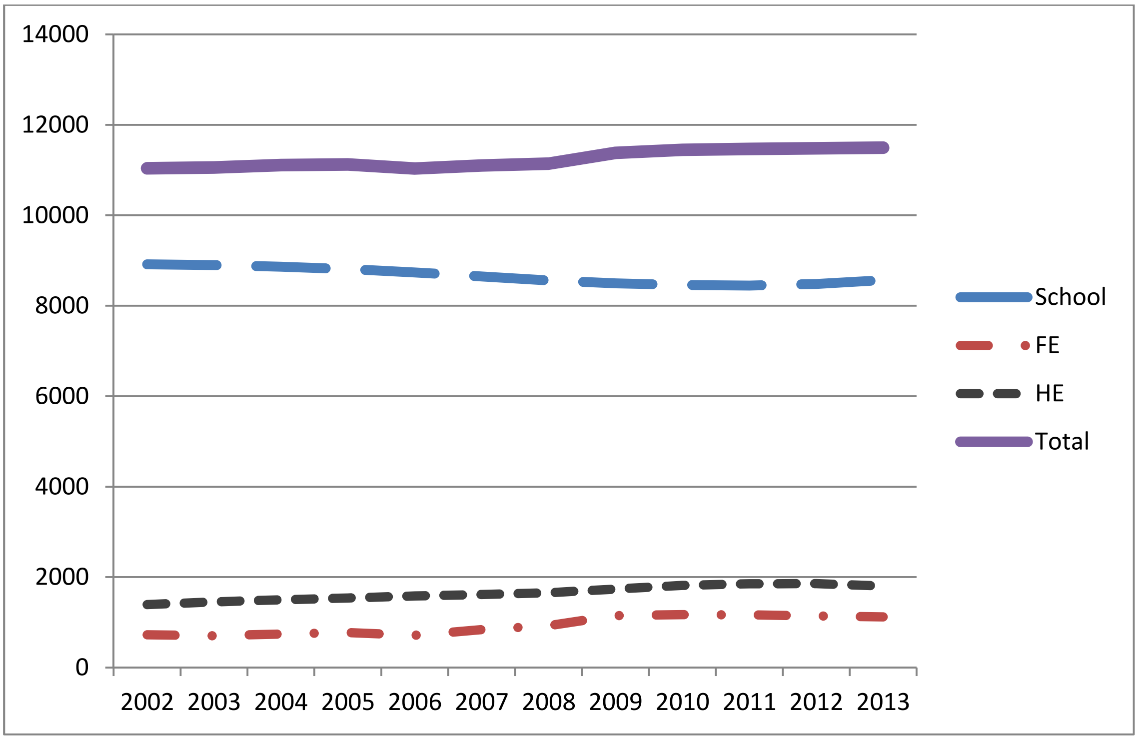
In the case of foreign students we distinguish between EU and non-EU students – only the latter are considered ‘foreign’. Below we show a variant where we exclude all foreign students by this definition. This will underestimate education services to the extent that some of these students remain and work in the UK post-graduation. Against this some EU nationals do return to their native countries. There are no reliable data available on foreign nationals working in the UK cross classified by if they were educated in the UK or abroad.

5. Results

It is useful first to look at enrolment rates to get an idea of the composition of the UK education sector. Chart 1a shows the total numbers and the division by three groups, school, further education (FE) and higher education (HE). School is by far the largest group, reflecting that pupils typically spend 11-13 years in this form of education whereas they spend only 3-4 years in higher education and about two years in FE. Chart 1b shows the growth rates, indexed at 2002=100. This shows a slight upward trend in aggregate. This is the result of two opposing trends – generally downward trend in school enrolments at least to 2012 and increases in both FE and HE. The latter shows a dip in 2014 as a consequence of the introduction of full cost fees for most university programmes. FE is much more volatile and suggests a financial crisis impact with high growth rates during the crisis period and some fall off after that.

Chart 1. Enrolments in UK Education, 2002-2014

1a. Numbers enrolled



1b. Index 2002=100.

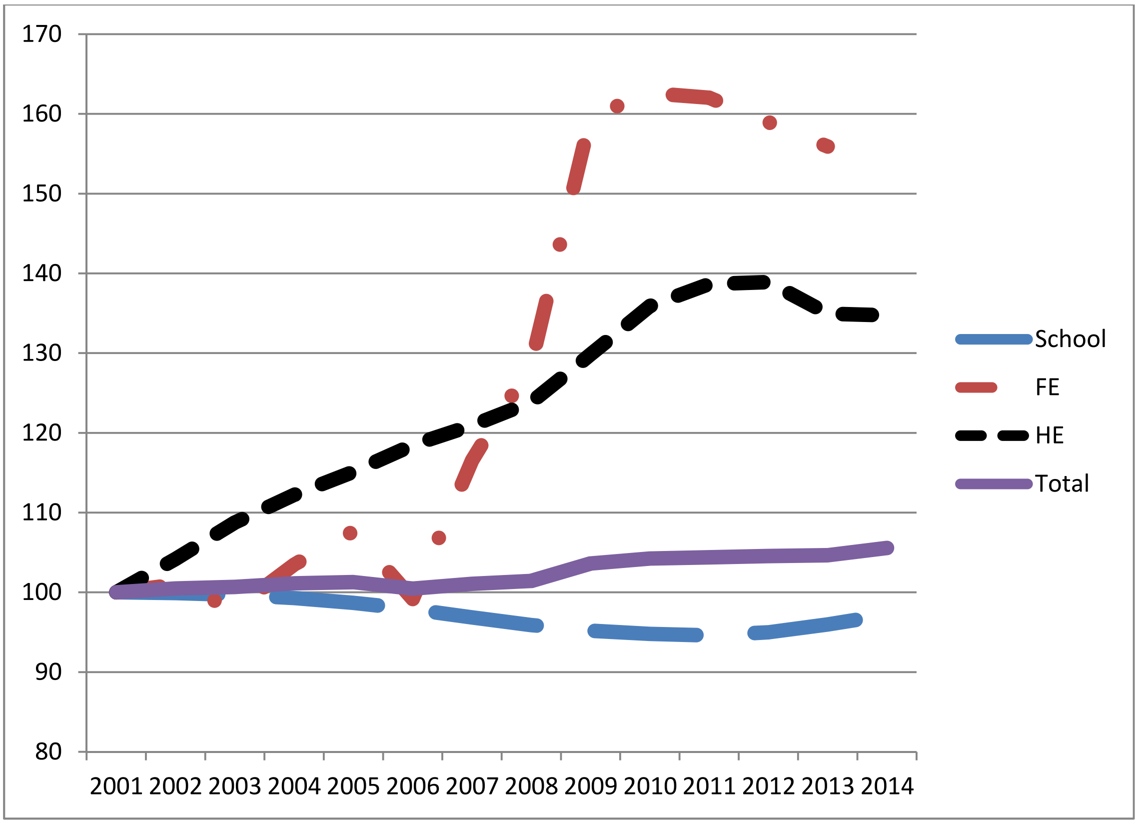


Chart 2 shows the growth in foreign compared to domestic HE students in the period under study. This illustrates that much of the growth in this sector in recent years has been in the international market with foreign students in 2014 comprising nearly 20% of the student population, from 13% in 2002.

Chart 2. Domestic and International Students in Higher Education, UK, 2002-2014

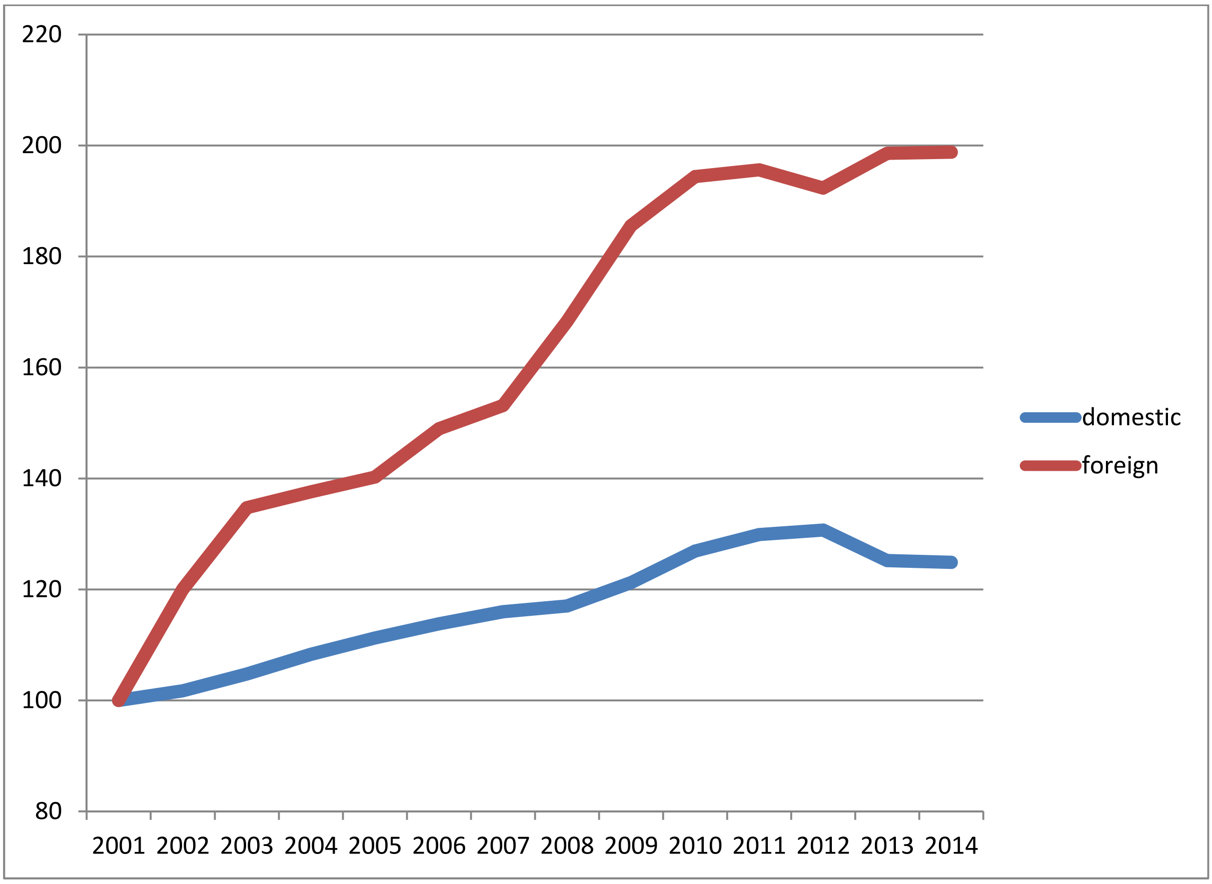
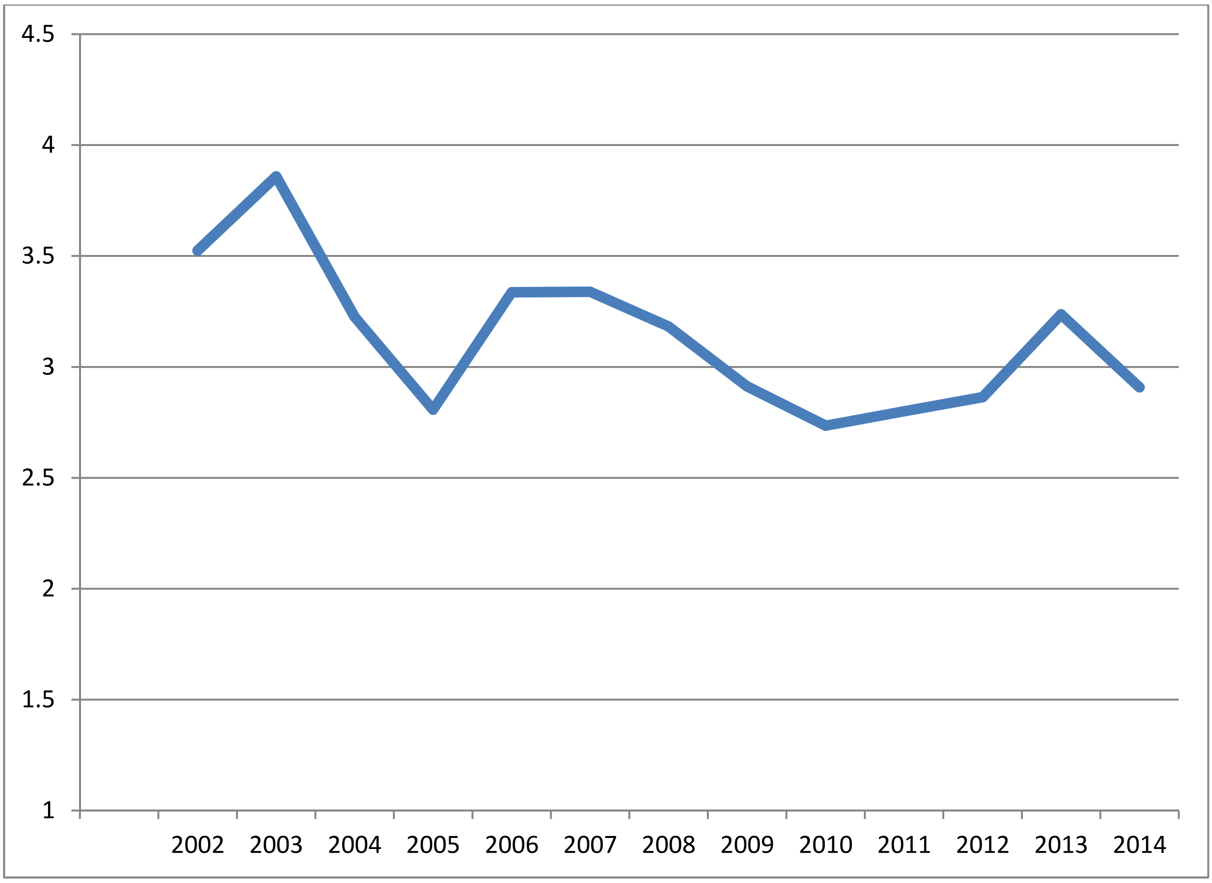


Table 1 shows the results for 2013 under a number of scenarios, both the nominal value of education services and the ratio of that value to nominal expenditures on education. The first row shows the results when there are no adjustments for attribution. This suggest a high ratio of education outputs to expenditures in the UK, and higher for similar exercises for the US where the ratio is about 3 (Christian, 2014). When we account for attribution however, the nominal values decline by 30%. Similarly, removing foreign students reduces this by about 15%. Taken together the two adjustments lead to nominal values of education services that are about 60% of the unadjusted values. With these adjustments the " rate of return" from educational services goes down to 170% which is still very high. Therefore on this measure society obtains a very high economic benefit from education.

	Value of educational services	Ratio to Expenditures.
A. Baseline: (including employment propensity)	368,551	4.62
B. A + adjustment for attribution	258,298	3.24
C. A+ adjustment to remove foreign students	317,740	3.98
D. A+ adjustments for attribution & removing foreign students	218,716	2.74
E.Baseline with: g=0.02, d=0.035	382,251	4.79

Finally in this section we present time series for the ratio of outputs to expenditure, shown in chart 3 – this uses the figures adjusted for both attribution and the removal of foreign students. Here the results are no so sanguine as they show a downward trend. Underlying this is the reduction in school enrolments which coincided with an increase in expenditures in that sector.

Chart 3. Ratio of the value of educational services to expenditures, UK 2002-14



6. Conclusions

Using a lifetime income framework this paper estimated values for education services that far exceed expenditures for the UK in 2013, although there is some suggestion that the ratio of education services values to expenditures has been declining over the past decade or so, largely due to declining enrolments in schools coinciding with increased expenditure. Ideally we would want to use separate deflators for output and spending to consider real ratios. This is the next step in the analysis. It would also be useful to compare with other countries.

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