

# **Paying Out and Crowding Out? The Globalisation of Higher Education**

**Stephen Machin\* and Richard Murphy\*\***

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- \* *Department of Economics, University College London and Centre for Economic Performance, London School of Economics*
- \* *Department of Economics, University of Texas at Austin and Centre for Economic Performance, London School of Economics*

## Abstract

This paper presents estimates of the impact of the rapid and sizable influx of overseas students into the UK higher education system on the number of domestic students. Using administrative data on students enrolled since academic year 1994/5, we find no evidence of crowd out of domestic undergraduate students in an institutional setting where there are quotas limiting domestic growth. For domestic postgraduate students, who do not face such enrolment regulations, we find increases in the numbers of international postgraduates attending a department to be positively connected with changes in domestic numbers. We interpret this as a cross-subsidisation effect. We are careful to establish these findings causally using two different empirical methods. Firstly, we use the historical share of students from a sending country attending a university department as a shift-share instrument to predict enrolment patterns. Secondly, we use a change in Chinese visa regulations and exchange rates in combination with strong subject preferences as a predictor of overseas student growth.

JEL Keywords: Overseas students; Crowding out, Higher Education

JEL Classifications: I20; I21; I28.

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## 1. Introduction

International students bring a lot of income to universities across the world, with their numbers rising and by paying higher tuition fees than domestic students. A critical policy question is whether, because of their increasing numbers, overseas students take the places of natives or whether the additional income they generate acts to subsidise domestic students. This forms the subject matter of this paper where we ask the question: do international students crowd out domestic students from higher education, or do they crowd them in?

There have been very rapid and sizable increases in the number of international students globally, with 4.3 million higher education students currently registered as studying abroad, up from 1.3 million in 1990 (OECD, 2013). Universities in the UK have been in a prime position to recruit these international students. They are generally considered to offer high quality degrees, with a number of universities placing very high in international world rankings.<sup>1</sup> Furthermore, given that English is the major *lingua franca* of business and academia, universities in English-speaking countries have a clear advantage in attracting international students. Thus, the UK ranks second, after Australia, in the percentage of enrolled university students who come from overseas and second, after America, in total numbers enrolled (OECD, 2013).

Aggregate figures show that the total number of overseas students in UK universities has quadrupled since the 1994/1995 academic year, standing at 266 thousand full-time students by 2011/12. The postgraduate sector has seen the highest growth in overseas students both in terms of proportions and absolute numbers. There are now over five times as many overseas taught postgraduates than there were in 1994/95, increasing from 28 thousand then to 140

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<sup>1</sup> For example, in Shanghai's Jiao Tong University's ranking two UK universities appear in the top 10 world rankings and five in the top 50 (and nine in the top 100).

thousand by 20011/12. Overseas students typically pay higher tuition fees than domestic students and, as such, have become a major source of income for the Higher Education (HE) sector, with estimates suggesting they currently contribute about 11.6 percent of the total income of the sector and 39 percent of all fee income from full time home and overseas students, despite representing only 15 percent of the student body (HEIDI 2012).

This growth occurred in a regulated university sector. Due to the highly subsidized nature of domestic undergraduate studies in the UK, the Government has strict controls of the price (setting maximum binding tuition fees) and, critically for our analysis, the quantity of undergraduates places available to domestic students. This limits the scope for increases in the number of overseas students to also go hand in hand with increases in numbers of domestic undergraduates. The empirical question of interest in the undergraduate setting then is whether there is crowd out from increased numbers of foreign students or whether universities can absorb these increased numbers with no concurrent fall in domestic numbers.

By contrast enrollment at the postgraduate level has no regulations relating to the number of domestic (or foreign) students and, at the same time, foreign students pay higher fees to attend UK universities. Unlike the undergraduate case, this could therefore allow for the numbers of domestic and foreign students to be positively correlated if there is any scope for cross-subsidization of native students that could occur, because overseas students pay higher fees and in doing so generate more revenue for universities.

This makes it clear that there is a need to conduct our empirical tests of crowd out - or crowd in if there is any scope for cross-subsidization – separately at undergraduate and postgraduate level. As such, we think the rapid increase in overseas students combined with

these novel institutional features make the UK a good testing ground to see how increasing overseas enrolments can impact on the number of domestic students.

One test of whether there is crowd in or crowd out (or neither) comes from studying correlations between changes in the number of domestic students and changes in the number of international students within universities over time.<sup>2</sup> A negative association would correspond to crowd out (or displacement) and a positive one to crowd in (or subsidisation). This way of thinking is not unlike the approach taken in the literature on immigration and the labour market where researchers look for possible displacement of native workers by immigrant flows (see, *inter alia*, Borjas, 1999, or Card and DiNardo, 2000).

However, as is the case with that literature, there are concerns related to endogenous sorting. In the case of HE, common or diametric patterns of sorting to particular universities by domestic and overseas students (increases in capacity or changes in exchange rates respectively) can render such estimates as biased. To address these concerns, in our analysis we therefore use two separate methods in attempts to identify a relationship between changes in domestic and foreign students that ensures the direction of causation flows from foreign to domestic student numbers.

The first of these has parallels with the labour economics literature on immigration where authors use the fact that immigrants from particular sending countries tend to settle in places where previous migrants from their country have settled (so called ‘enclaves’).<sup>3</sup> In terms of modelling, we adopt a similar exercise in terms of enrolment choices of international students. To do so, we use the historical share of students from a sending country attending a

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<sup>2</sup> This approach is adopted in some US work, for example, Borjas (2005).

<sup>3</sup> See, for example, Card (2005, 2009).

university department combined with current national changes in the stock of students from this country as a shift-share instrument to predict exogenous variations in the number of overseas students attending that university department.<sup>4</sup>

A second approach considers the fact that there have been very rapid increases in the number of students enrolling in UK universities from China, especially in the 2000s. We use a change in Chinese visa regulations in combination with strong revealed subject preferences and price sensitivity amongst Chinese students. These factors culminated in a sharp 1,900 percent increase in Chinese students over a seven year period from 1998/9, with over 80% of this growth occurring only with Business and Management based subjects. We use these sources of variation as predictors of overseas student growth across and within universities over time.<sup>5</sup>

We analyse administrative data for the entire UK population of Higher Education (HE) students over an eighteen year period (running from academic years 1994/95 through to 2011/12) which covers the time period when rapid internationalisation of the UK HE sector occurred. We document the scale of the increased supply of overseas students to the HE sector and then analyse its effects on the number of domestic students and home fee paying students using the methods outlined above.<sup>6</sup> The empirical analysis is carried out separately for undergraduates, taught postgraduates and research postgraduates.

Given the increasing number of overseas students across the globe, the topic of whether there is any crowding out of natives by foreigners at universities is becoming increasingly policy relevant. Therefore it seems surprising that there is very little research on

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<sup>4</sup> More precisely, in most of our empirical work below, we look at field of study and university as that is the level of analysis that our data permits. See the Data Appendix for more detail.

<sup>5</sup> The recent research on the effects of imports from China on the labour market and on firm productivity utilises big shifts in the Chinese share of imports to advanced countries in an analogous way (see Autor, Dorn and Hanson, 2013, and Bloom, Draca and Van Reenen, 2011).

<sup>6</sup> Home fee students include all EU students who are those eligible for government subsidies and fee regulations and therefore face lower fees than overseas students.

this issue. The question has not been empirically examined in the UK, and there are just a couple of research papers on the question in the US. Borjas (2007) examines enrolment trends in US graduate programs from 1978 to 1998 and reports no average effect of foreign students on natives in graduate programs.<sup>7</sup> Hoxby (1998) examines if disadvantaged natives are affected by the presence of foreign students in higher education by exploiting a policy change in the fee structure of the Californian HE system. She also finds no significant effects overall, but does find indications that disadvantaged natives suffer a crowding out effect from immigrant students. Hoxby claims the likely mechanisms this works through is competition for affirmative action targets and financial aid.<sup>8</sup>

Whilst on a different research question, namely within-country variations in student enrolment, a set of research papers that study fee variations for in-state versus out-of-state students who enrol in American universities is also of some relevance to our analysis, particularly in terms of the methodological approach that is used. In this setting, out-of-state students bring in higher tuition fees in a way that is akin to overseas students in the rather different institutional setting of the UK.

A paper by Groen and White (2003) develops a model where universities want to maximise the number of high ability students, tuition revenue and future returns from alumni, but state government prefer enrolment from individuals who will continue to live in state as post-graduation they will bring in additional tax revenue. Given a belief that out-of-state

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<sup>7</sup> When extending his analysis to focus upon sub-groups, Borjas does find a significant negative effect for a subsample of native white males and demonstrates that this can neither be explained by demographics nor by a decline in demand for college places by males.

<sup>8</sup> In terms of using similar methodological approaches to our analysis (and those of Borjas and Hoxby), but in the very different context of compulsory schooling, Betts (1998) and Gould, Lavy and Paserman (2004) report that increased immigrant inflows have significant adverse effects on the educational outcomes of native students. This is, of course, a very different setting and in the context of HE (and opposite to compulsory schooling) in HE foreign students are more likely to come from higher socio-economic backgrounds. Other related schooling studies are Geay, McNally and Telhaj (2013) who look at non-native speakers in English schools and Ohinata and Van Ours (2013) who study immigrant children in Dutch schools.

students are less likely to stay, this results in tuition fees and admissions standards being lower for in-state students at public universities (and the same at private institutions). With regards to crowding out, Winters (2012) uses a state panel to estimate the extent of crowding out of out-of-state students by in-state students at four-year public state universities. He finds that larger cohorts of in-state students results in flagship public universities taking on fewer non-resident students and simultaneously raising the fee price charged to these students.<sup>9</sup>

To preview our main findings we show that, whilst there has been a big rise in the number of international students enrolling in UK universities, this has not resulted in a crowd out of domestic students. This is the case at undergraduate level and for taught and research postgraduates. Indeed, we find evidence of cross-subsidisation for postgraduates, especially on Master's programmes, as their numbers have risen as overseas enrolments have gone up. Contrarily, for undergraduates, who were subject to Government quotas during this time period we find no evidence of either crowd in, or crowd out. Thus, and with these nuanced differences for different sorts of students, our evidence points to a situation of crowd in or no effect, as we reject a null hypothesis of crowd out.

The rest of the paper is structured as follows. Section 2 offers a description of the UK higher education sector and how it has changed over time, placing a particular focus on the changing mix of domestic and foreign students. Section 3 describes the data we use and the research designs that we implement. Section 4 reports the results, while section 5 offers some conclusions.

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<sup>9</sup> In the UK the distinction between public and private universities is not very important as there are hardly any of the latter. All UK universities apart from two are government financed and face the same fee and student number restrictions. The exceptions are the charitable University of Buckinghamshire and the profit making University of Law, which combined make up less than 1% of all students (around 10,000). These universities do not record their student numbers with HESA and therefore are not included in the analysis. There are also binding maximum tuition fees for domestic undergraduates, restricting any response along the price dimension.

## **2. The UK Higher Education Sector**

### *Long Run Participation Trends*

Figure 1 shows trends in higher education (HE) participation in the UK since the academic year 1981/82. In 1981/82 the participation rate in higher education for the appropriate age cohort (i.e. the flow of individuals participating at that time) was just over one in ten. It went up very rapidly during the 1990s expansion and has continued to rise, reaching 40 percent by the academic year 2011/12.

Thus, many more young people now attend higher education than in the past. The majority of this growth has been carefully controlled by the government given the high level of tuition subsidy students received. Therefore as the number of students increased the funding of HE changed radically over time period. The system moved from one of being broadly ‘free’ (i.e. non-fee paying with maintenance grants for students) to one where students pay fees and no longer receive maintenance grants, but have to take out loans to fund their education.<sup>10</sup>

As described in the introduction, there has also been a rapid expansion of the number of non-UK students attending UK universities. There are a number of reasons for this (which we detail below) as it has become evident that universities themselves have had to become reliant on generating additional income from these international students.

Our focus in this paper is on the implications of this for UK students. Has the increased number of foreign students crowded out domestic students? Or has the increased income that universities receive from foreign students (typically charged at higher fees than domestic

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<sup>10</sup> For more detail see Dearden, Fitzsimons, Goodman and Kaplan (2008) or Dearden, Fitzsimons and Wyness (2013).



students<sup>11</sup>) enabled universities to take on home students and effectively crowded them in, thus generating a positive cross-subsidisation?

We study these questions using administrative data on the entire UK HE population over the academic years 1994/95 to 2011/12. The start year for our analysis is academic year 1994/5 as this is the first year from which there is consistently measured student data. We use data from the Higher Education Statistics Agency (HESA) covering the vast majority of students enrolled in universities over this time period, for 161 universities in our full sample and 144 in the balanced panel who are observed in every year (more details on the data are given below and in the Data Appendix).

#### *Trends in Domestic and Foreign Student Numbers from 1994/5 to 2011/12*

As already noted, the size of the UK HE sector has been rapidly growing. Table 1 shows summary statistics from our data, for the unbalanced and balanced panels of universities. As the numbers in Table 1 show, the total number of full-time students in all universities in the sample (the columns labelled ‘full sample’) increased from 1.06 million in the 1994/95 academic year to 1.65 million in the 2011/12 academic year. In 1994/95 there were 65 thousand international students enrolled – or around 6 percent. By 2011/12 this had risen to 246 thousand, or around 15 percent of all (full-time) students.

Sharp increases in the relative numbers of international students have occurred at both undergraduate level and at postgraduate level. Figure 2 shows trends over time (where the numbers of each are indexed at 1 in 1994/95) in the numbers of domestic and foreign

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<sup>11</sup> Average international fees for an undergraduate (postgraduate) course were £9,360 (£9,520) in 2009/10 (Murphy, 2014). Comparatively for domestic undergraduates universities received £3,000 in fees and a minimum of £3,947 in subsidies from the Government, dependent on subject and location.

undergraduates, taught postgraduates and research postgraduates. The relative increase is clear for all three, but is especially marked amongst full-time taught postgraduates.

### *Rules on University Admissions*

It is worth noting that because of government funding of places for home undergraduates and taught postgraduates there is a constraint on growth during this time period in the form of government quotas. Universities educating these students received funding from the *Higher Education Funding Council for England* (HEFCE), who set a Student Control Number (SCN) dictating the maximum number of home fee (subsidised) students allowed to be enrolled by each university.<sup>12</sup> Universities who took on more home students than they were allocated were issued a monetary fine per student.

However, for taught postgraduate students universities are permitted to choose not to count all of them against its Student Control Number, foregoing any government funding for these students, but allowing the number of postgraduates to grow. This is conditional on the university charging tuition fees to domestic students in excess of the governments assumed cost per student £7542 (which is a summation of teaching subsidy per student (£3,951) and assumed fee (£3,591)). This condition is not typically met by the majority of non-top 20 (non-Russell Group) universities, and so they would be constrained in increasing their number of domestic taught postgraduate students.

Universities were allowed to bid for Additional Student Numbers (ASN) to increase its SCN and its teaching grant accordingly. The way in which HEFCE awarded these ASNs changed over time. Prior to 2000/01 they were allocated according to government plans for

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<sup>12</sup> Government funding was dependent on the location of the university and the cost of the subject taught. There are four subject categories which are given cost weightings; Class D courses involves only lectures have weight 1; Class C courses have a fieldwork or studio element have weight 1.3; Class B courses are laboratory-based subjects and have a weight of 1.7; Class A courses are medicine and dentistry and have a weight of 4.

growth of student numbers by region and subject area or for specific projects. From 2000/01, this was amended so that institutions could submit proposals for ASN. For an application to be successful an institution needed to have filled its existing student places, show excellence and provide evidence that there is demand for additional places. One feature of this was for universities to use overseas students as a signal of this demand. This potentially allowed the number of overseas students to influence the number of domestic students, even with government quotas. From 2005 the government suspended competitive ASN bids and once again allocated additional places according to specific developments or goals.

Funding for research postgraduate students was not subject to these caps. Funding for these students is allocated in proportion to the number of home research postgraduates in their first 3 years of full time study (6 years for part time) in departments rated 4+ in the previous Research Assessment Exercise (RAE), weighted by London residence and subject costs. This is unrestricted funding with no caps on the maximum amounts of students at a university, however the total amount of money is capped and split amongst institutions.

By contrast to these regulations on home students, overseas students receive no government subsidies, and therefore have no limits to the number enrolled by individual institutions. The only limiting factor is the number of overseas student visas approved by the UK immigration office and from the sending country.

Hence the very large growth in the number of overseas students documented in Figure 2 and Table 1. By the 2011/12 academic year, there were 115 percent more research postgraduates, 229 percent more undergraduates and 547 percent more taught postgraduates from overseas as compared to 1994/95.

In addition to domestic students and overseas students are non-UK European Union (EU) students. EU regulations mean that all students domiciled in the EU are required to be treated in the same way. This means that all UK and EU students pay the same fees and are referred to as home students. A further consequence of this is that EU students receive the same funding as an equivalent domestic students and it is for this reason that they come under the same quota system as domestic students.<sup>13</sup>

### *Origin Countries of Overseas Students*

The composition of overseas students has for the most part remained relatively stable over this time period by broad region of origin.<sup>14</sup> Figure 3 shows Asia to be by far the largest source region of students, followed by Africa and then North America.

However, as Figure 3 also shows, there has been one large and notable change in the composition of overseas students, namely the influx of Chinese students. In 1995 there were 1,510 Chinese students amongst all UK universities studying full time at any level. This remained fairly stable until 1998, after which it began where it began to increase rapidly, almost doubling year on year from 2000 to 2003. By 2005 there were 39,820 Chinese students, corresponding to an enormous 1,900 percent increase over a seven year period. Again this remained stable until 2009 when the number began growing quickly, the Chinese now account for more than 4 percent of all students and 26 percent of all overseas students.

The rapid expansion and subsequent levelling off in these numbers was caused by a change in the Chinese visa licencing for students. In 1999 the Chinese Government introduced

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<sup>13</sup> Therefore non-UK EU students displace domestic students on a one-for-one basis. In our empirical work, we thus show results treating UK only and UK plus EU students as domestic students and home fee students. As one would expect, given that from a university funding perspective the students are equivalent, results prove to be rather similar. In 2011/2012 non-UK EU students comprised 4 percent of home fee undergraduates, percent of taught postgraduates and 21 percent of research postgraduates (see Table 1).

<sup>14</sup> Countries were grouped to the following broad regions using NSCC groupings; Africa, Asia, Europe (EU and Non EU), Middle East, North America and the Rest of the World.

new regulations<sup>15</sup> which allowed for the formations of licencing agencies making it considerably easier for self-funded Chinese students to study abroad. Although it had been possible to self-fund since 1981<sup>16</sup>, international study was still characterised by around 5000 government funded students from the leading universities being sent to strategically productive placements abroad. The opening of these agencies dramatically increased the size of the self-funded sector, in 1998 there were 11,443 self-funded students, by 2002 there were 117,000 (Li and Zhang, 2010).

The self-funded nature of Chinese students has meant they are very concentrated in certain fields of study. Figures A1 and A2 in Appendix 1 clearly show these strong subject preferences. The subjects with the largest increase in numbers were Business & Management, Maths & Computing, Economics and Engineering, whilst there is very little growth in the remaining subjects. Furthermore given that Chinese students became predominately self-funded they also became more price responsive. Prior to 1998 the demand of student places by Chinese students was unlikely to be responsive to the Great British Pound: Yuan exchange rate. After then the exchange rate became potentially more important as a determinant of the number of Chinese students, a feature we exploit in our empirical strategy below.

### **3. Data and Research Designs**

#### *Data Description*

The administrative data we use comes from the Higher Education Statistical Agency (HESA) and contains information on all full time students studying at higher education institutions

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<sup>15</sup> Regulations for the Administration of Intermediary Agencies for Self-Funded Study Abroad 1999 (PRC).

<sup>16</sup> State Council – Interim Provisions for Study Abroad with Self-funding.

between the academic years 1994/95 and 2011/12, comprising 18.6 million individuals in total. This is count data for all universities broken down across the following groups: 165 subject areas, 267 domiciles of origin, 3 levels of study, 3 fee statuses and 2 genders over 18 years.<sup>17</sup>

We conduct separate analyses for undergraduates, taught postgraduates and research postgraduates. To eliminate the issue of universities opening and closing, we study a balanced panel of universities. This is defined as including those with a positive student count for any of the levels (UG, PGT, and PGR) in all of the years. This brings our sample to 144 institutions.<sup>18</sup> Summary statistics are shown in Table 1 (in the columns labelled ‘balanced panel’). It is evident that our sample contains the vast majority of students as compared to the full sample (where there were 149 universities in 1994/95 and 161 in 2011/12), suggesting numbers from any entrants or exit are small.

There are many university courses on offer at UK universities. We have data on 165 distinct fields of study categories. During the early years of our data, the number of overseas students was relatively small in some universities and, so as to ensure that there were sufficient non-zero shares of students from countries, we aggregated groupings of related subjects. The 165 subjects are grouped into 5 subject areas; (1) Medicine, dentistry and subjects allied to medicine; (2) Sciences; (3) Social Sciences, Law and Business, (4) English, Languages and History; and (5) Creative arts, design and education.

Table 1 shows student numbers in each of these five groups, and also in twelve smaller groups which we can look at for some of our analysis (the part on Chinese student inflows)

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<sup>17</sup> So, as an example, in a given academic year we can calculate the number of male French students at Oxford paying home fees who are studying physics at undergraduate level.

<sup>18</sup> For the 41 universities that merge during the time period, we consider them as one university throughout our sample period.

when we focus on a university panel rather than a field of study by university panel.<sup>19</sup> More details on these, and other definitional aspects of the data, are given in the Data Description in Appendix 2.

### *Empirical Approaches*

Our initial research set up borrows from the related literature (in terms of approach) that studies the impact of immigrant inflows on native outcomes, further developing methods used there to our particular institutional setting. The most well-known work in this area studies the impact of inflows on labour market outcomes, but there are also studies looking at other outcomes like crime, use of public services and education.<sup>20</sup>

Considering the impact of immigrant flows on native outcomes, various authors (like Borjas, 2006, and Card, 2001, 2005) have set up empirical specifications that are designed to net out problems to do with initial conditions and mechanical biases. Peri and Sparber (2011) summarise the approaches and claim, in the context of spatial variations across cities, the best representation relates changes in native or immigrant outcomes (employment in their case) scaled by the lagged size of the spatial unit (the city). Our analogous outcomes are domestic and international student numbers studying a particular field by university, so we develop a baseline estimating equation for subject university group  $i$  in year  $t$  as:

$$(1) \quad (D_{it} - D_{i,t-1})/S_{i,t-1} = \alpha_i + \beta (F_{it} - F_{i,t-1})/S_{i,t-1} + T_t + \varepsilon_{it}$$

where  $D$  is the number of domestic students,  $F$  is the number of international students, so that  $S = D + F$ , and the equation includes a full set of field of study by university fixed effects ( $\alpha_i$ ) and time effects ( $T_t$ ) and an error term ( $\varepsilon_{it}$ ). As the model is specified in changes it accounts for

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<sup>19</sup> Results using 12 subject areas instead of the 5 broad areas are available from the authors upon request. They are similar, but because of a higher preponderance of zeros the first stage results were not as strong.

<sup>20</sup> Examples of studies of crime and immigration are, *inter alia*, Bell, Fasani and Machin (2013), on public services and immigration see Wadsworth (2013) and on education and migration see Dustmann and Glitz (2011).

underlying differences across universities and subject areas, with  $\alpha_i$  controlling for average growth rates by university field of study and  $T_t$  accounting for annual aggregate growth rates. Therefore, the identifying variation comes from deviations of growth rates from university field of study growth trends.

In (1),  $\beta$  is the key parameter of interest for whether or not there is a crowding in or out within a university. A positive  $\beta$  is suggestive of subsidisation, whilst a negative  $\beta$  implies displacement. This coefficient can be interpreted as the number of domestic students who respond to each additional overseas student (e.g. a coefficient of -1 implies one-for-one crowding out). These estimates are not affected by cell size, nor is there any artificial correlation between the dependent and explanatory variable.

Whilst equation (1) is quite stringent in that it specifies the relationship in terms of within field of study by university changes and includes a full set of fixed effects, it does not (unless these fixed effects factor out any possible bias) account for the potential endogeneity of overseas demand. This is important as universities that experience shocks, such as changes in university rankings or new teaching buildings, may affect the supply or demand of places for domestic and overseas students simultaneously. To address this issue of common unobserved shocks, we use instrumental variable techniques to generate an exogenous source of variation in the number of overseas students at university subject area level.

We adopt two approaches to do this. The first employs the shift share approach that has been commonly used in the immigration literature (e.g. by Card, 2009). This approach relies on prior immigrant settlement patterns as a source of identifying information. The idea rests on the notion that the current relative flow of immigrants to a city is related to historical population shares. The thought experiment is that a city with an historically high share of the immigrants



from a particular source country, is more likely to experience growth when the national amount of immigrants from that source country increases, compared to a city with a low historical share. The key assumption is that the national inflow rates from each source country are exogenous to conditions of any city.

When thinking of university enrolments, the conceptual analogue is that individuals from a particular origin country are more likely to go to universities, and study subjects, where previous students attended. Anecdotally, this seems reasonable in that there are well known examples of students from particular countries studying the same kind of degrees in particular countries. Obviously it is an empirical question as to how strongly the instrument predicts.

More formally, the instrumental variable we use to predict the change in the share of foreign students for field of study by university time is:

$$(2) \quad \Delta P_{it} = \sum_{c=1}^n (F_{c_{it0}}/F_{ct0}) \Delta F_{ct}$$

where we use the initial distribution of foreign students from country  $c$  and allocate the flow of foreign students from that country between period  $t$  and  $t+1$ , according to that distribution in time 0 and the total change in students from country  $c$ . We do this for 1994/95 to 1998/99 as the initial time period and predict future annual flows (2001/02 to 2011/12) to each university subject area. This means there is year on year by university subject area variation generated from a combination of national inflow figures and the historical shares.

From this we generate two instrumental variables. The first, IV1, groups all Non-EU countries together as one category. In this case  $c$  is an indicator for originating from non-home fee paying country. The second set, IV2, uses the shares on a country basis, so  $c$  represents the country of origin. IV2 has the benefit that, because it uses the proportion of students from an individual country, it allows for specific country university subject relationships. For example,

if the science department at University A has a higher than average proportion of the national total of students from Non-EU country Z, then when the total amount of students from country Z increases we expect a larger than average increase in the number of overseas science students at University A. Furthermore if another Non-EU country Y which has no students at university A had an increase in their student numbers, this would not affect the number of overseas students at university A. Contrary to this method IV1 would use the share of Non-EU students as a whole, and any increase in the number of students from country Y at the national level would be in part allocated to university A.

The disadvantage of this method is that because IV2 uses specific country university subject area pairs, the proportion may be more liable to change over time. Even though these shares were generated over a four year period between 1995-8, some countries had little to no representations in some cells that have subsequently may have become a more prominent. So any future increases in their numbers would not be reflected in predicted changes at that university subject level.

The benefit of IV1 is that it captures the international character of a university, and therefore does not rely on specific countries to be present at a university during the 1995-8 period. The key assumption remains that the national inflow rates from each source country are exogenous to conditions in a particular university department. This is likely to be the case given that we have 570 university subject cells, each only contributing a small amount to the total. Therefore throughout the first part of the analysis we use both instruments.

The shift share approach assumes that historical shares of students at university departments are informative about current flows. It turns out that this is typically true as our results that the location patterns for past students are strongly reflective of where later students

chose to study. However, for reasons we have already discussed, this is not likely to hold for China which is an important country during this period of expansion. Prior to 1998 the majority of Chinese students were granted a student visa if their choice of course was supported by the state. However, once self-sponsorship became easier, the numbers of Chinese students studying Business or Economics increased very rapidly indeed.

We thus focus on inflows of Chinese students in detail and implement an alternative IV strategy which uses the Chinese policy change as a source of exogenous variation in the change in number of Chinese students attending UK universities. After the simplification of the Chinese student visa application process the number of overseas students studying Business or Economics rapidly increased.

This increase is shown very clearly in Figure 4 which shows big increases, for these two growth subjects. Figure 4 also (like the earlier Figure 3) shows that the majority of the growth occurs between 1999/2000 and 2004/05. Then, after a lull, a second strong growth phase occurred from 2008/09 to 2011/12. Interestingly, this occurred after the Chinese Yuan huge 80 percent appreciation against the Great British Pound during 2008, as is shown in Figure A3 of Appendix 1.

It is evident that, with the increase in self sponsored students the number of Chinese students attending UK universities became increasingly dependent on the exchange rate. Table 2 shows the price sensitivity of Chinese students before and after the visa reform. The results show that changes in the number of Chinese students were uncorrelated with the exchange rate prior to the reform (when they were predominantly funded by the Chinese Government), but were significantly correlated post reform. Moreover, it is the growth subjects are the most sensitive to exchange rate fluctuations.

Therefore to implement an instrumental variable strategy in the study of changing Chinese student numbers we generate an indicator variable for each growth subject post reform, plus a growth indicator interacted with the Yuan: Pound exchange rate. We argue that these sources of overseas student growth are exogenous to university departments in the UK and so we use these combinations as instruments for the change in the number of overseas students at a university department.

#### **IV. Results**

##### *University by Field of Study Panel*

Table 3 shows estimates of equation (1) for undergraduates, taught postgraduates and research postgraduates. Two specifications are reported for each, one where the dependent variable is the proportional change in the number of home students (i.e. UK and EU students) and one where it is the proportional change in the number of domestic students (i.e. UK only). The first row of Table 3 shows ordinary least squares (OLS) estimates, and the second row shows the two stage least squares (2SLS) estimates. The first stages corresponding to the latter (which are the same for the home and domestic specifications) are reported below these, together with associated F-statistics for the instruments.

The first thing to note from Table 3 is that all the OLS coefficients are estimated to be positive, and statistically significant, implying no crowd out of domestic students. For every additional overseas undergraduate a university department takes on an additional 0.77 home students, and for research students this is 0.94. However, for the reasons articulated above, we need to consider what happens when we allow for common shocks to affect both changes in domestic and foreign students via our instrumental variable strategy.

The F-tests reported for the first stage show that the instruments are good predictors of the change in foreign students (they are all above 10, and some strongly so). Thus transposing over the enclave idea that has been exploited in the immigration literature to the inflow of foreign students to specific fields of study and university seems to work well. Moreover, the positive enclave effect is intuitively plausible (i.e. that foreign students go to study the same subjects in the same universities as previous students from their home country did). Interestingly, the 2SLS estimates are, like the OLS estimates, all positive as well. Thus our evidence is much more in line with the notion of crowding in, where foreign students bring in additional income that can cross-subsidise domestic students, rather than crowding out.

However, the pattern of causal estimates across the three groups of students reveals differences. For undergraduates the 2SLS estimates fall to 0.05 and are no longer significantly different from zero, meaning there is on average neither crowd out nor crowd in of home students. The same pattern appears when estimating the impact only on domestic students. These are the group of student for which universities face strict quotas.

For postgraduate students, where universities have more freedom to increase the number of home students, there is evidence of crowding in. For domestic research students the coefficient is not significantly different from the OLS estimate increasing a tiny amount to 0.95 from 0.93. This implies that for every additional overseas research student, a university department on average takes on 0.95 of an additional domestic student. The coefficient above unity for the taught postgraduates is suggestive that Master's courses are the major place where cross-subsidisation occurs.<sup>21</sup>

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<sup>21</sup> Up to this point we have estimated the impact within university-subject area pairs, testing whether increases in foreign student numbers are associated with a change in the number of domestic students in that university subject area. Whilst this is the approach we prefer to take as we think subject choice is an important dimension to look at, it may be that universities try to make more centralized adjustments to student

### *Variations Across Universities*

Table 4 reports separate estimates for the 20 Russell Group and 124 non-Russell Group universities in our sample.<sup>22</sup> The evidence of crowd in seems to be more marked for the former group. This is not so surprising given their reputation of producing world class degrees and their established ability to recruit international students. Moreover, these top universities charge higher tuition fees and, in doing so, generate a significant income stream that can be put towards places for domestic students. Moreover, universities can only ignore the government's quotas on domestic taught postgraduate students if their domestic tuition fees are greater than £7542, which is not typically the case for non-Russell Group Universities. For Research Postgraduates, where there are no quotas on domestic students, we do not see as much of a difference between Russell and non-Russell group universities.

### *Increases in the Number of Chinese Students*

We next move to the analysis of Chinese student inflows. To do so the estimating equation is structured as before, but the key independent variable of interest becomes changes in the number of Chinese students,  $C$ , as follows:

$$(3) \quad (D_{it} - D_{i,t-1})/S_{i,t-1} = \alpha_i + \beta (C_{it} - C_{i,t-1})/S_{i,t-1} + T_t + \varepsilon_{it}$$

Table 5 shows estimates of equation (3). The Table is structured in a similar way to Table 3, with OLS estimates in the first row, 2SLS estimates in the second and the first stages from the latter below. As with the panel analysis above, the OLS estimates all show positive

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numbers across subjects as well. We have therefore re-estimated our models looking at the aggregate number of students attending the university, thereby accounting for adjustment of student numbers across subjects. Using variation at the university rather than university/subject area level considerably reduces the number of observations, yet we still uncover significant positive relationships amongst postgraduate students. For undergraduate students, the university level aggregated estimates turn out to be much less precise, showing the need to study them within university-subject area pairs.

<sup>22</sup> The full set of results, structured in the same way as Table 3 for the Russell Group and non-Russell Group universities are reported in Tables A1 and A2 of Appendix 1.

estimated coefficients. Also in line with those results, the first stages using the reform/exchange rate instruments are strong, with one exception the research postgraduates.

The 2SLS estimates from the undergraduate and taught postgraduate regressions are both positive, although the undergraduate estimate is imprecisely determined. The taught postgraduates estimate is of similar magnitude to the earlier results and offers strong evidence of crowd in. Thus it seems that increased enrolment of Chinese students on Master's courses has become an important factor in generating income streams for UK universities that have also enabled universities to take on more domestic students in these subjects.

The estimated 2SLS coefficient for research postgraduates is the only negative one we have been able to uncover in our entire empirical analysis. It is, however, close to zero and, owing to the weak first stage, is very poorly determined. This is likely due to the relatively small increases in the number of Chinese students undertaking research degrees. Again, this offers no evidence whatsoever for the hypothesis that foreign students have crowded out domestic students in UK universities. Thus both of our causal approaches reach the same conclusion.

## **5. Conclusions**

In this paper we study the rapidly increasing inflows of international students to UK universities, asking the questions as to whether their increased enrolment and paying out of high fees has had any impact on the enrolment of domestic students. We frame this as a question of whether one can detect any evidence that their increased numbers have displaced domestic students or whether their increased numbers have gone hand-in-hand with increased numbers of domestic students.

To properly consider this question, it is important to set up a research design that allows for common shocks that could cause numbers of domestic and foreign students to covary with one another. We do this in two ways. First, in a manner similar to that adopted in the immigration literature, we use the historical share of students from a sending country attending a university department combined with current national changes in the stock of students from this country as a shift-share instrument. Secondly, we use an exogenous change in the Chinese visa regulations and exchange rate in combination with strong revealed subject preferences as a predictor of overseas student growth.

Using administrative data on the entire UK HE population over the 1994/5 to 2011/12 academic years, in both of these approaches we find no evidence that the big rise in international students enrolling in UK universities has crowded out domestic students. This is the case at undergraduate level and for taught and research postgraduates. Indeed, in the case of postgraduates we find evidence of subsidisation, especially on Master's programmes where numbers of domestic and foreign students have covaried positively with one another as both have increased significantly through time. For undergraduates, there is neither evidence of crowding in nor crowding out. We interpret this as resulting from the government quotas on the number of domestic students that operated in the time period we study.



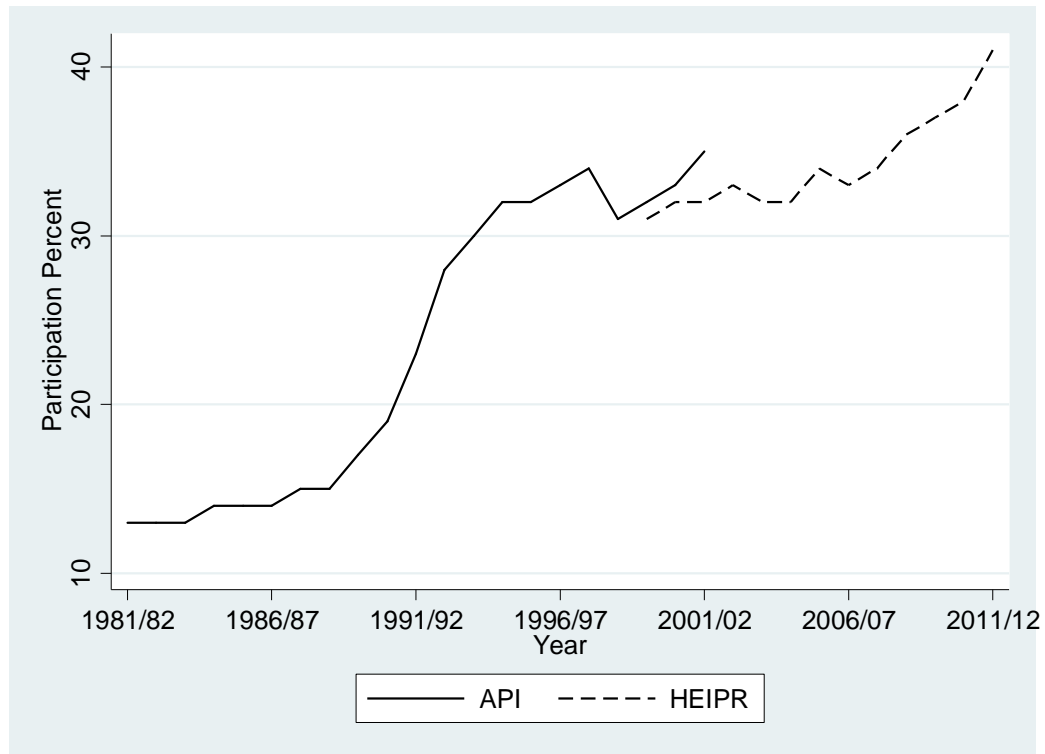
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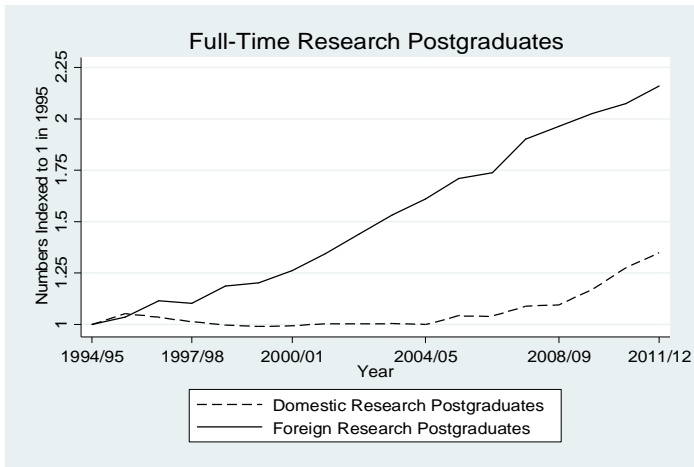
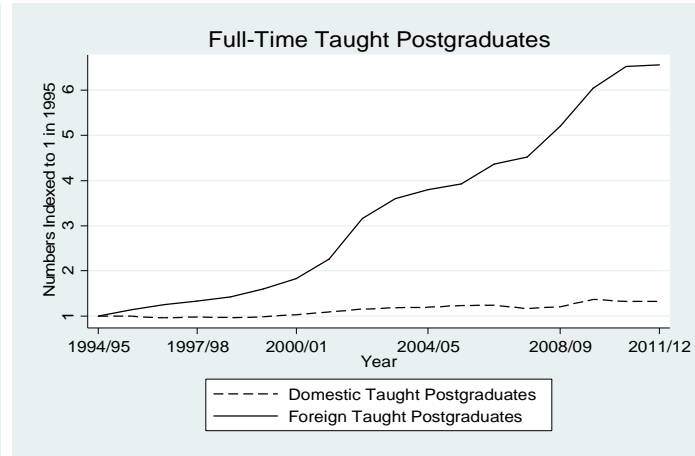
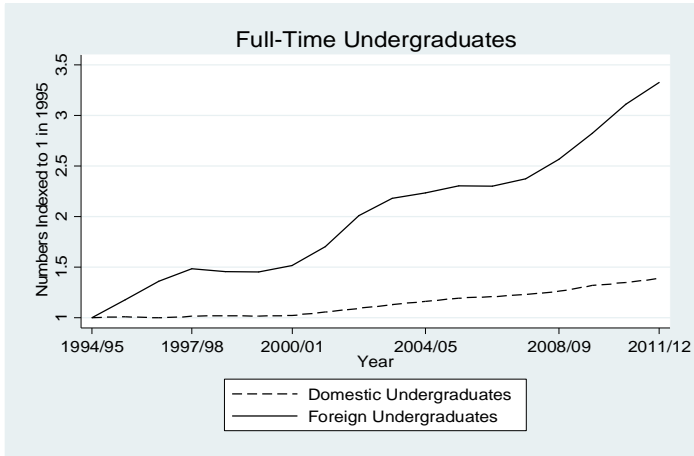
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**Figure 1: Trends in UK Higher Education Participation**



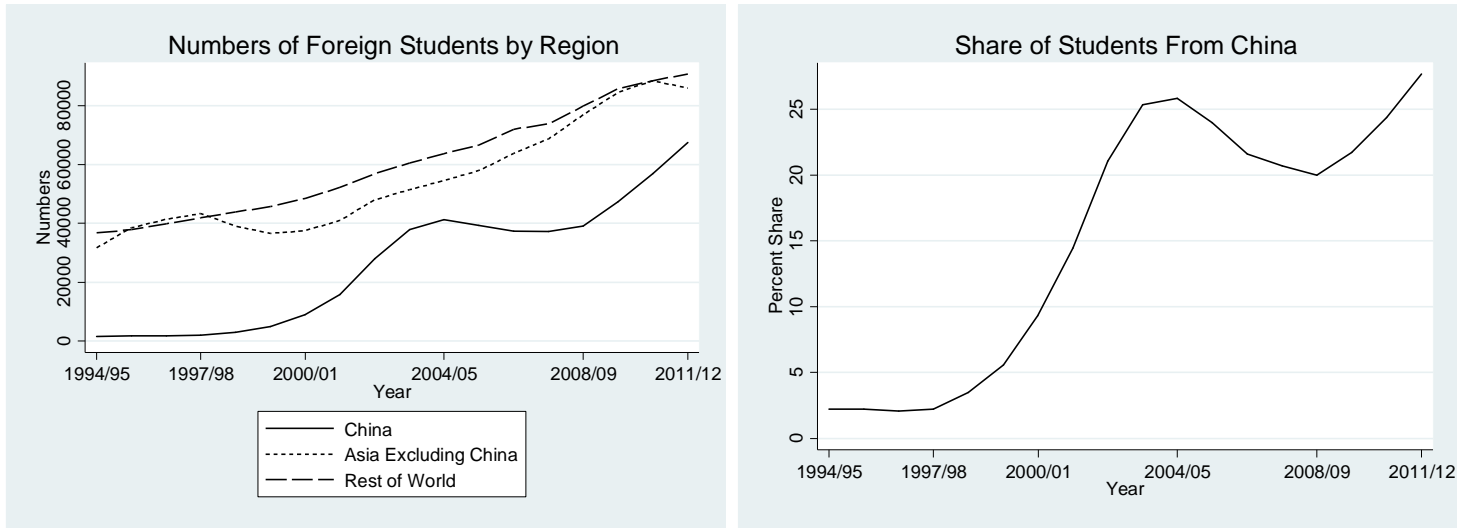
Notes: The Age Participation Index (API) is the number of domiciled young people (aged less than 21) who are initial entrants to full time and sandwich undergraduate courses as a percentage of the 18 to 19 year old GB population. The API was discontinued in 2001 and replaced by the Higher Education Initial Participation Rate (HEIPR), which has a different definition as it covers entrants to HE from different age groups (for the one reported here covering ages 17 to 20).

**Figure 2: Growth of Full-Time Students, 1994/5 to 2011/12**

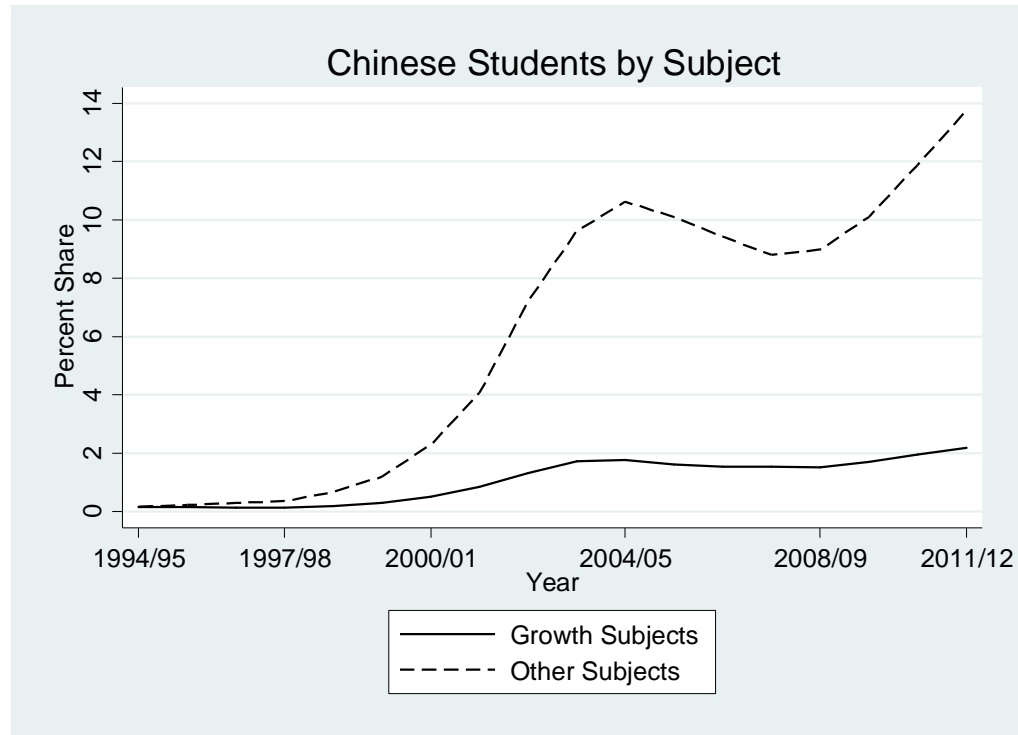


Notes: Domestic students are all students domiciled in the UK paying Home fee levels. Overseas students are all Non-UK students paying Non-Home fees. All totals rounded to nearest 100. Undergraduates; 1994/95- 854,300 domestic, 37,600 overseas; 2011/12 - 1,165,700 domestic, 123,500 overseas. Taught postgraduates: 1994/95- 59,100 domestic, 15,000 overseas. 2011/12- 77,700 domestic, 96,900 overseas. Research postgraduates: 1994/95- 27,900 domestic, 12,000 overseas. 2011/12- 37,300 domestic, 25,800 overseas

**Figure 3: Flows of International Students to UK Universities**



**Figure 4: Flows of Chinese Students to UK Universities**



Notes: Growth Subjects are 'Business and Management' and Economics.

**Table 1: Changes in Student Numbers, 1994/5 to 2011/12**

	Full Sample			Balanced Sample		
	1994/5	2011/12	Percentage Change	1994/5	2011/12	Percentage Change
<b>Undergraduate Students</b>						
Home	891.2	1240.7	39.2	873.2	1231.2	41.0
Domestic	854.3	1165.7	36.5	836.9	1157.0	38.2
Overseas	37.6	123.5	228.8	37.1	122.5	230.2
<i>Total</i>	928.8	1372.8	47.8	910.2	1361.6	49.6
<b>Taught Postgraduate Students</b>						
Home	69.1	101.2	46.5	68.0	100.1	47.3
Domestic	59.1	77.7	31.3	58.1	76.8	32.1
Overseas	15.0	96.9	547.1	14.7	95.6	550.2
<i>Total</i>	84.1	199.9	137.8	82.6	197.5	139.1
<b>Research Postgraduate Students</b>						
Home	32.7	48.0	46.7	32.1	47.3	47.5
Domestic	27.9	37.3	33.7	27.4	36.7	34.1
Overseas	12.0	25.8	114.9	11.9	25.4	113.6
<i>Total</i>	44.7	74.0	65.5	44.0	73.0	65.9
<b>Subject Areas</b>						
Medical	172.4	387.5	124.8	169.9	385.0	126.6
Science	283.9	339.8	19.7	279.8	336.4	20.2
Social Science	272.9	465.5	70.6	266.3	461.3	73.2
Languages/History	140.8	206.1	46.3	137.6	202.7	47.3
Arts & Other	187.5	247.9	32.2	183.2	246.8	34.7
Medicine & Dentistry	96.8	215.9	123.0	94.7	214.9	127.0
Biology & Veterinary	75.6	171.1	126.3	75.2	170.1	126.1
Physical Sciences	66.1	73.6	11.3	65.1	75.6	16.2
Maths & Computing	76.5	105.4	37.8	74.5	102.4	37.4
Engineering	95.7	109.1	14.0	93.8	107.1	14.1
Architecture & Technology	46.5	51.3	10.3	46.4	51.3	10.6
Law & Social Studies	120.8	193	59.8	117.8	191.0	62.1
Economics	22.7	34.7	52.9	21.7	33.7	55.4
Business & Management	127.8	237.6	85.9	126.8	236.6	86.6
Language & Humanities	140.8	206.1	46.4	137.6	202.7	47.3
Education & Creative Arts	138.5	241.9	74.7	136.5	241.8	77.1
Other & Combined	48.7	6	-87.7	46.7	5.0	-89.2
<b>Total Overseas Students</b>	64.6	246.2		63.7	243.5	
<b>Total Students</b>	1057.6	1646.7		1036.8	1632.1	
<b>Number of Universities</b>	149	161		144	144	

Notes: Totals shown in 1000s. Source: HESA administrative data on full time students at UK HE institutions.



**Table 2: Changes in the Sensitivity of the Number of Chinese Students to Pound-Yuan Exchange Rates, Pre- and Post-Reform**

	Undergraduates			Taught Postgraduates			Research Postgraduates		
	Pre-Reform	Post-Reform	Change	Pre-Reform	Post-Reform	Change	Pre-Reform	Post-Reform	Change
Business	0.118 (0.159) [300]	0.496 (0.075) [1400]	0.378 (0.176)	-1.280 (0.670) [301]	2.050 (0.361) [1600]	3.330 (0.761)	-0.827 (1.064) [281]	-0.561 (0.262) [1424]	0.266 (1.096)
Economics	0.016 (0.150) [183]	0.414 (0.116) [854]	0.398 (0.189)	0.102 (1.043) [160]	2.185 (1.521) [713]	2.287 (1.107)	-0.949 (1.271) [194]	-0.503 (0.416) [836]	0.447 (1.337)
All Subjects	-0.021 (0.030) [3156]	0.113 (0.016) [14728]	0.134 (0.034)	-0.389 (0.148) [2905]	1.000 (0.099) [14898]	1.390 (0.178)	0.028 (0.210) [3026]	0.014 (0.034) [14291]	-0.017 (0.213)

Notes: Robust standard errors in round brackets. Numbers of students in square brackets. Regressions are weighted by the appropriate mean of the student populations over the differenced years.

**Table 3: University by Field of Study (5) Panel Estimates**


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Estimates of  
 $(D_{it} - D_{i,t-1})/S_{i,t-1} = \alpha_i + \beta (F_{it} - F_{i,t-1})/S_{i,t-1} + T_t + \varepsilon_{it}$

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	Undergraduates		Taught Postgraduates		Research Postgraduates	
	Home	Domestic	Home	Domestic	Home	Domestic
Ordinary Least Squares:						
Change in Foreign Students	0.772 (0.297)	0.702 (0.288)	0.581 (0.286)	0.510 (0.257)	0.938 (0.252)	0.679 (0.157)
Two Stage Least Squares:						
Change in Foreign Students	0.060 (0.364)	0.053 (0.341)	1.442 (0.889)	1.268 (0.802)	0.949 (0.139)	0.763 (0.144)
First Stage: IV1		0.182 (0.159)		1.052 (0.288)		1.465 (0.305)
First Stage: IV2		0.496 (0.153)		-0.199 (0.170)		0.462 (0.167)
F-Test		23.04		11.32		26.86
Sample Size	7,444	7,444	6,945	6,945	6,514	6,514
Number of Universities	144	144	144	144	144	144

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Notes: All regressions include, year and subject-institution fixed effects, with robust standard errors in brackets. Regressions are weighted by the appropriate mean of the student populations over the differenced years. 2SLS F statistic is based on the Kleinbergen-Paap Wald F statistic, allowing for non iid errors.

**Table 4: University by Field of Study (5) Panel Estimates**

Estimates of						
$(D_{it} - D_{i,t-1})/S_{i,t-1} = \alpha_i + \beta (F_{it} - F_{i,t-1})/S_{i,t-1} + T_t + \varepsilon_{it}$						
	Undergraduates		Taught Postgraduates		Research Postgraduates	
	Home	Domestic	Home	Domestic	Home	Domestic
<b>A. Russell Group</b>						
Two Stage Least Squares:						
Change in Foreign Students	2.241 (1.273)	2.140 (1.304)	2.286 (0.653)	2.092 (0.628)	0.866 (0.190)	0.683 (0.162)
F-Test for First Stage	4.99		7.44		21.69	
Sample Size	1167	1167	1179	1179	1172	1172
Number of Universities	20	20	20	20	20	20
<b>B. Non-Russell Group</b>						
Two Stage Least Squares:						
Change in Foreign Students	-0.034 (0.396)	-0.030 (0.371)	0.397 (0.155)	0.335 (0.138)	0.996 (0.177)	0.804 (0.145)
F-Test for First Stage	19.64		37.62		16.55	
Sample Size	6,277	6,277	5,342	5,342	5,766	5,766
Number of Universities	124	124	124	124	124	124

Notes: All regressions include, year and subject-institution fixed effects, with robust standard errors in brackets. Regressions are weighted by the appropriate mean of the student populations over the differenced years. 2SLS F statistic is based on the Kleinbergen-Paap Wald F statistic, allowing for non iid errors.

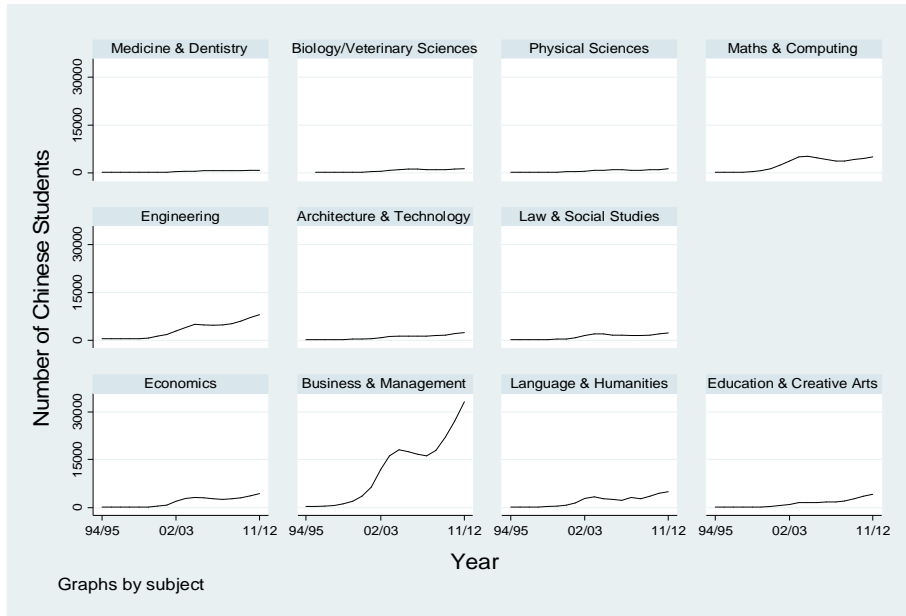
**Table 5: Chinese Students, University by Field of Study (11) Panel Estimates**

Estimates of						
$(D_{it} - D_{i,t-1})/S_{i,t-1} = \alpha_t + \beta (C_{it} - C_{i,t-1})/S_{i,t-1} + T_t + \varepsilon_{it}$						
	Undergraduates		Taught Postgraduates		Research Postgraduates	
	Home	Domestic	Home	Domestic	Home	Domestic
Ordinary Least Squares:						
Change in Chinese Students	0.487 (0.138)	0.540 (0.144)	0.388 (0.081)	0.577 (0.104)	1.111 (0.279)	1.587 (0.342)
Two Stage Least Squares:						
Change in Chinese Students	0.815 (0.586)	0.584 (0.601)	1.538 (0.828)	1.705 (0.930)	-0.112 (0.587)	-0.374 (0.958)
First Stage:						
Business X Reform		-0.029 (0.006)		-0.088 (0.028)		0.050 (0.021)
Business X Reform X Exchange Rate		0.453 (0.074)		1.490 (0.352)		-0.602 (0.254)
Economics X Reform		-0.023 (0.009)		-0.091 (0.082)		0.048 (0.031)
Economics X Reform X Exchange Rate		0.367 (0.111)		1.746 (1.055)		-0.558 (0.397)
F-Test		29.03		15.93		2.36
Sample Size	17,663	17,663	17,386	17,386	17,026	17,026
Number of Universities	144	144	144	144	144	144

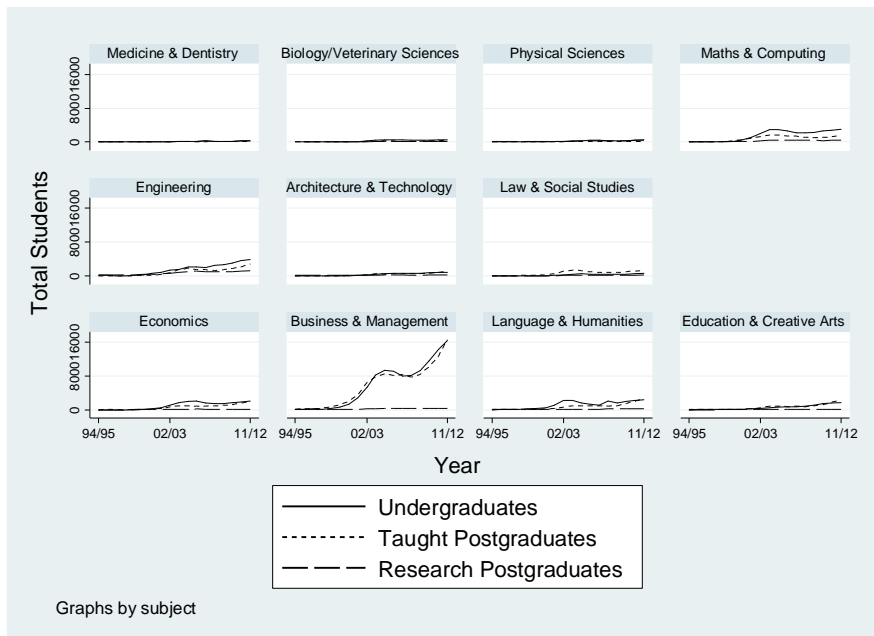
Notes: All regressions include, year and subject-institution fixed effects, with robust standard errors in brackets. Regressions are weighted by the appropriate mean of the student populations over the differenced years. 2SLS F statistic is based on the Kleinbergen-Paap Wald F statistic, allowing for non iid errors.

## Appendix 1: Additional Figures and Tables

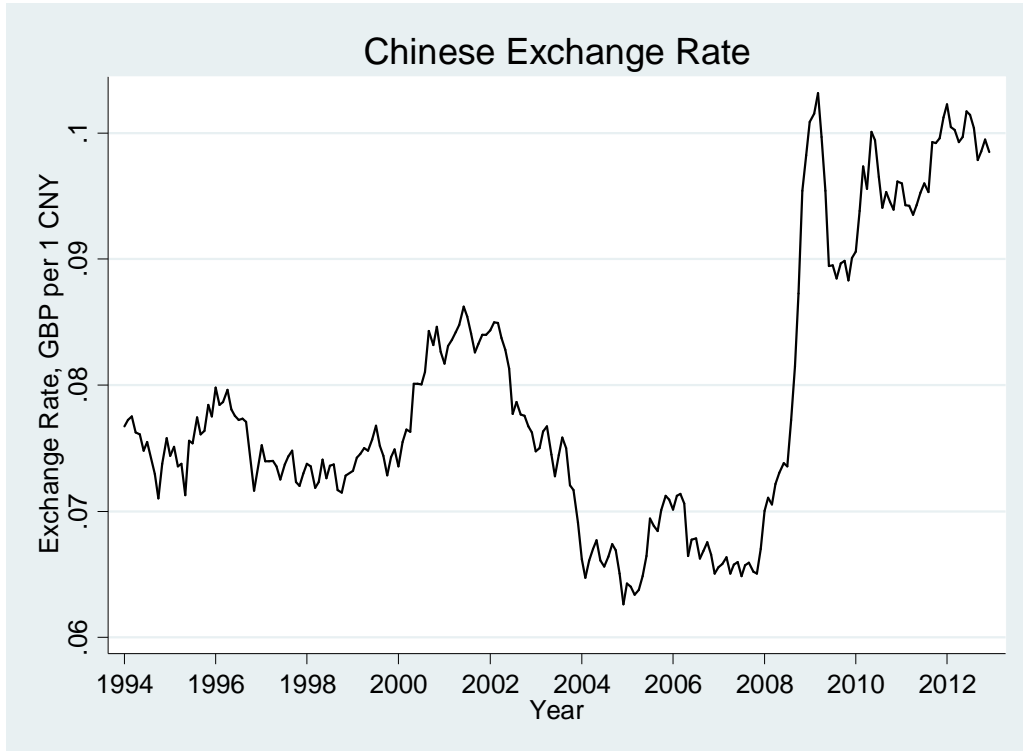
**Figure A1: Numbers of Chinese Students by Field of Study**



**Figure A2: Numbers of Undergraduate, Taught Postgraduate and Research Postgraduate Chinese Students by Field of Study**



**Figure A3: Pound-Yuan Exchange Rate**



Notes: Source International Monetary Fund. Note based on last day of month exchange rates up until 1999, when daily exchange rates are used.

**Table A1: Russell Group Universities (20) by Field of Study (5) Panel Estimates**

Estimates of						
$(D_{it} - D_{i,t-1})/S_{i,t-1} = \alpha_i + \beta (F_{it} - F_{i,t-1})/S_{i,t-1} + T_t + \varepsilon_{it}$						
	Undergraduates		Taught Postgraduates		Research Postgraduates	
	Home	Domestic	Home	Domestic	Home	Domestic
Ordinary Least Squares:						
Change in Foreign Students	0.806 (0.251)	0.714 (0.245)	2.241 (1.273)	1.943 (1.164)	0.743 (0.156)	0.554 (0.123)
Two Stage Least Squares:						
Change in Foreign Students	2.241 (1.273)	2.140 (1.304)	2.286 (0.653)	2.092 (0.628)	0.866 (0.190)	0.683 (0.162)
First Stage: IV1		0.085 (0.147)		0.865 (0.496)		0.950 (0.279)
First Stage: IV2		0.501 (0.184)		0.102 (0.444)		0.400 (0.156)
F-Test		4.99		7.44		21.69
Sample Size	1,167	1,167	1,179	1,179	1,172	1,172
Number of Universities	20	20	20	20	20	20

Notes: All regressions include, year and subject-institution fixed effects, with robust standard errors in brackets. Regressions are weighted by the appropriate mean of the student populations over the differenced years. 2SLS F statistic is based on the Kleinbergen-Paap Wald F statistic, allowing for non iid errors.

**Table A2: Non-Russell Group Universities (124) by Field of Study (5) Panel Estimates**

Estimates of						
$(D_{it} - D_{i,t-1})/S_{i,t-1} = \alpha_i + \beta (F_{it} - F_{i,t-1})/S_{i,t-1} + T_t + \varepsilon_{it}$						
	Undergraduates		Taught Postgraduates		Research Postgraduates	
	Home	Domestic	Home	Domestic	Home	Domestic
Ordinary Least Squares:						
Change in Foreign Students	0.718 (0.321)	0.703 (0.311)	0.292 (0.074)	0.260 (0.066)	0.955 (0.272)	0.689 (0.169)
Two Stage Least Squares:						
Change in Foreign Students	-0.034 (0.396)	-0.030 (0.371)	0.397 (0.155)	0.335 (0.138)	0.996 (0.177)	0.804 (0.145)
First Stage: IV1		0.223 (0.226)		1.234 (0.241)		1.827 (0.476)
First Stage: IV2		0.466 (0.165)		-0.265 (0.184)		0.449 (0.214)
F-Test		19.64		37.62		16.55
Sample Size	6,277	6,277	5,342	5,342	5,766	5,766
Number of Universities	124	124	124	124	124	124

Notes: All regressions include, year and subject-institution fixed effects, with robust standard errors in brackets. Regressions are weighted by the appropriate mean of the student populations over the differenced years. 2SLS F statistic is based on the Kleinbergen-Paap Wald F statistic, allowing for non iid errors.



## **Appendix 2: Data Description**

### *A. Basic Processing of HESA Data*

We use HESA standard population measures from 1995 to 2012 (corresponding to the academic years 1994-1995 to 2011-2012), the maximum available amount of years with consistent data definitions. We use restricted to our analysis to the change in number of full time students in university subject areas. Full time students are defined as attending an institution for periods amounting to at least 24 weeks within the year of study and during those weeks studying at least 21 hours. Changes in student numbers are calculated on an annual basis and are standardised by the according total of the previous year. Weights are used in all calculations. Each observation is weighted by the mean student population of the lagged and previous year of the appropriate university subject areas.

### *B. Higher Education Institutions*

There are 210 Higher Education Institutions in the UK over this time period. We have administrative data on 202 of these institutions. The missing universities are: Camborne School of Mines, Liverpool Hope University, Craigie College of Education, Duncan of Jordanstone College of Art, Manchester Business School, Welsh Agricultural College, University College Birmingham, and London Metropolitan University. They were not included as they either enrolled no students that met the student population definition or they had requested HESA not to release the data to researchers. Of the 202 institutions 41 merged with another university during the observation period and so had their totals retrospectively aggregated. This makes the unbalanced panel of 161 universities. Of these 17 are removed as they either open or close and therefore leaves us with a balanced panel of 144 of universities which are used in the final analysis. This consisted of the 144 universities that continually existed from 1995 to 2012.

### *C. Student Population*

We use the HESA Student record which has counts of all students registered at a reporting higher education institution (HE institution) who follow courses that lead to the award of a qualification(s) or institutional credit, excluding those registered as studying wholly overseas e.g. overseas sandwich year students. If it is known at the beginning of the course that a student will spend a block of eight weeks or more in the UK as part of their programme then they are included on the Student record throughout, and not included in the Aggregate offshore record. Moreover Postdoctoral students are also not included in the HESA Student record.

From the HESA Student record the HESA standard HE population has is derived. It includes all higher education enrolments as at 1 December of the academic year, except: dormant students (those who have ceased studying but have not formally de-registered); incoming visiting and exchange students; students studying for the whole of their programme of study outside of the UK; students who left the institution prior to 1 December of the academic year, or who commenced a programme of study after this date; students on sabbatical; writing-up students.

The population data is provided in the form of counts by specified student characteristics, e.g. total number of w level students from country x, paying fee level f studying subject y, at university z. These can be aggregated up to departmental, university or national levels for each of these categories. Brief definitions of these categories and how they are aggregated is given below.

#### *D. Student Levels*

The Level of Study refers to the qualification aim of the student. These are classified into four levels; *First Degree, Other Undergraduate, Postgraduate Taught, Postgraduate Research*.

*First Degree* and *Other Undergraduate* refer to Bachelor degrees (BSc, BA, etc.), first degrees with Qualified Teacher Status and equivalents including foundation degrees, diplomas in higher education (including those with eligibility to register to practice with a health or social care or veterinary statutory regulatory body), Higher National Diploma (HND), and Higher National Certificate (HNC). These levels were combined together to form the undergraduate population measure.

*Postgraduate Taught* includes master's degrees (MSc, MA, etc.), postgraduate bachelor's degrees at level M and postgraduate diplomas or certificates not studied primarily through research, such as the Postgraduate Certificate in Education (PGCE). It will also include doctorate students not primarily taught through research. These form the second student level.

*Postgraduate Research* refers to all students studying towards a doctorate, master's degrees and postgraduate diplomas or certificates studied primarily through research.

### *E. Country of Origin*

It is mandatory to collect the domicile of all students. These are mapped to countries using the National Statistics Country Classification 2006 grouping of countries ([www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/national-statistics-country-classification/index.html](http://www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/national-statistics-country-classification/index.html)) which provides 251 domiciles. These were reduced down to 75 countries, grouping all countries with less than 5000 students-years in the UK over the entire 18 year period into one category. This represented 6.3 percent of the total population or 9.8 percent of the Non-UK population. Where no data is supplied about the student's domicile, fee eligibility is used to assign to either UK region unknown or Non-European-Union unknown. These countries were basis to form additional regional totals; Domestic-from the UK; EU – students domiciled in the EU accounting for the growth in the EU; Non-EU – remaining countries.

### *F. Fee Levels*

Students are either eligible to pay Home Fees or Overseas fees. All students resident in the UK and the remainder of the EU are subsidised by the UK government and are eligible to pay Home Fees. Home Fee was originally set at zero (free) for undergraduate students, but was increased to £1000 per year in 1998/9, a maximum of £3000 in 2006/7.<sup>23</sup> The Home Fees for Taught and Research postgraduate students is unregulated but has remained comparatively low with median fees of £4000 in 2009/10 (Murphy, 2014). All Non-EU students are not subsidised and therefore pay the full market rate for a course. These fees are considerably more with the average Overseas fees for undergraduates were £9,360 and £9,520 for postgraduate students. The data provided information on the fee status of each student; 1) Eligible to pay home fees (87%); 2) Not eligible to pay home fees (10%); and 3) Eligibility to pay home fees not assessed (2%).

### *G. Subject of Study*

In the UK system students are studying always towards a particular subject goal. All subjects are categorised into JACS subject 161 codes consisting of a letter followed by a single digit, where the initial letter identifies the subject group.

There are 20 major subject groups: 1) Medicine & dentistry; 2) Subjects allied to medicine; 3) Biological sciences; 4) Veterinary & Agriculture science; 5) Physical

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<sup>23</sup> After the end of the same the Home Fee tuition fee cap increased to £9000 in 2012/13.

sciences; 6) Mathematical & Computer science; 7) Engineering; 8) Mineral technology; 9) Architecture, building & planning; 10) Social, economic & political studies; 11) Law; 12) Business & administrative studies; 13) Mass communications & documentation; 14) English/Classics; 15) European Languages; 16) Modern Languages; 17) Historical & philosophical studies; 18) Creative arts & design; 19) Education; 20) Combined.

During the first estimation method using the historical shares of students from country  $x$  studying subject  $y$  at university  $z$ . During the mid-1990's there were fewer overseas students and therefore the subject areas were grouped into 5 major subject groups. For the second estimation method the growth over the whole period was used and therefore allowed to have more subject groupings, including separating the sub-group Economics from the major grouping of Social Science. The coding for these subject aggregations can be found in Data Appendix Table 1.

#### *H. Currency Exchange*

The British Pound Sterling and Chinese Yuan exchange rate is obtained from the International Monetary Fund ([http://www.imf.org/external/np/fin/data/param\\_rms\\_mth.aspx](http://www.imf.org/external/np/fin/data/param_rms_mth.aspx)). This provided the daily exchange rates. The mean annual exchange rate was calculated on the academic year basis up until the September of that year. i.e. the mean exchange rate from September 1<sup>st</sup> 1994 to August 30<sup>th</sup> 1995 is used for the academic year 1995-1996. This reflects the exchange rate when potential students were deciding which country/university to attend.

#### *I. Additional Data cleaning*

HESA advised that the student totals for Cambridge in 2006 were incorrectly recorded. Correspondingly totals were interpolated by averaging preceding and proceeding years.

## Subject Coding

JACS Subject Groups	5 Subject Groups	11 Subject Groups
1 Medicine & dentistry	1 Medicine, Dentistry & allied subjects	1 Medicine & Dentistry
2 Subjects allied to medicine	1 Medicine, Dentistry & allied subjects	1 Medicine & Dentistry
3 Biological sciences	1 Medicine, Dentistry & allied subjects	2 Biology & Veterinary Sciences
4 Veterinary & Agriculture science	1 Medicine, Dentistry & allied subjects	2 Biology & Veterinary Sciences
5 Physical sciences	2 Sciences and MECT	3 Physical Sciences
6 Mathematical & Computer science	2 Sciences and MECT	4 Maths & Computing
7 Engineering	2 Sciences and MECT	5 Engineering
8 Mineral technology	2 Sciences and MECT	6 Architecture & Technology
9 Architecture, building & planning	2 Sciences and MECT	6 Architecture & Technology
10 Social, economic & political studies	3 Social Sciences, Law & Business	7 Law & Social Studies
11 Law	3 Social Sciences, Law & Business	8 Economics
12 Business & administrative studies	3 Social Sciences, Law & Business	9 Business & Management
13 Mass communications & documentation	4 English, Language & History	10 Language & Humanities
14 English/Classics	4 English, Language & History	10 Language & Humanities
15 European Languages	4 English, Language & History	10 Language & Humanities
16 Modern Languages	4 English, Language & History	10 Language & Humanities
17 Historical & philosophical studies	4 English, Language & History	10 Language & Humanities
18 Creative arts & design	5 Creative Arts, Design, Education & Other	11 Education & Creative Arts
19 Education	5 Creative Arts, Design, Education & Other	11 Education & Creative Arts
20 Combined & Other	NA Not Used	NA Not Used