Stratification of public universities and students' segregation.

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Abstract

We present a model which allows us to show that stratification of public universities according to the quality they offer and the quality of students they select is a plausible result even in a public university system where tuition fees are uniform and decided by the administration. This result is similar to that observed in private and competitive university systems. We prove that it is very unlikely that segregation and stratification could be avoided by subsidizing those universities that are more inefficient. We show also that even if stratification and segregation could be removed with subsidies, it would be at the cost of fixing quality limits at the whole university system.

JEL (H42, I28)

Key Words: school choice, state and federal aid.

1 Introduction

In the last years, university systems in the EU have been widely criticized (see *The Economist*, September 8th, 2005 and Neary et al 2003). There is some concern on whether the current structure of European universities, in which most of universities are publicly financed, will contribute to narrow the gap that exists between the EU and the US and Japan regarding human capital endowments and R+D+i outcomes .

Critics argue that the main problem of the EU university systems is the lack of competition among them. In general, universities do not compete for students due to their lack of mobility. They neither compete for public resources because the bulk of government transfers are decided on a per student basis rather than on quality measures (scientific outcome, student's performance, etc.)[1].

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[1] In some countries, like Spain, universities depend on regional government transfers and in some regions there is one public university only. Therefore, there is no competition for public transfers in those regions.

Another critic to public universities in the EU is that in most countries they exist as autonomous institutions which are often subject to rigid regulations at the national and regional level (see Mas-Colell 2003). Although there are significant differences between countries and universities, some characteristics are common to European public universities, in particular: i) universities are unable to affect their revenues because they cannot decide on tuition and fees, ii) professors' salaries are decided uniformly by the Government and public university managers can only offer marginal economic incentives aimed at improving the research productivity of their professors, and, iii) universities cannot select their students (as private universities do), because the process followed to allocate students across universities is run by the Government, etc.

Nevertheless, for the past few years some European governments are favouring university competition and are encouraging universities to reduce their financial dependency on government transfers. Universities are devoting greater efforts to find additional financial resources by engaging in income generating activities, therefore they are placing more emphasis on the efficient use of universities' resources. One of the results of those initiatives is that universities compete among themselves for research projects, applied research contracts, and corporate consulting.

The British Governent has moved one step further. In the UK, the July 1997 report of the National Committee of Inquiry into Higher Education recommended the ending of universal free higher education. In 1998 the British Government decided that universities should be allowed to raise tuition and fees significantly, shifting the costs of higher education to students. From the academic year 2006/7, a new system of tuition fees was introduced in England. These variable tuition fees of up to £3000 per year are paid up-front as previously, but new student loans are available that may only be used to pay for tuition fees, and must be repaid upon graduation, in addition to the existing loan. These reforms suggest that price competition is also encouraged in the UK (see Department for Education and Skills (2003)) although in fact, there is very little variation in the tuition fees charged by universities — nearly all charge the maximum tuition fee on all courses. Instead, the differences appear in the nature and value of various 'access' bursaries that are on offer.[2]

However, in some other EU countries (i.e. Spain, Germany, France, etc.) governments –and also some academics- are still reluctant to foster price competition among universities. Several arguments are provided by opponents to price competition or a significant rise in tuition fees. First, in a framework with larger tuition fees and lower subsidies family income might block access to higher education to low income students: segregation of students by their income might occur under price competition. This result opposes the principle of equality of opportunities. Second, family income might play too large a role

[2] See "Submission to the Independent Review of Higher Education Funding and Student Finance – call for proposals", may 2010, for further information concerning the reform on higher education in the UK.

in the distribution of students among universities. Stratification of universities by their quality might occur. Therefore, opponents to both price competition and a raise in tuition fees propose to continue with the current model, may be with some minor changes, in which governments fix low tuition and fees and devote significant amounts of resources to subsidize universities and students.

Nevertheless, the size of deficits in public finance in France, Italy, Spain, Portugal, Greece, etc. and substantial deficits predicted for years to come, suggest that cuts in funding for public services appear inevitable. The higher education sector, although strictly speaking not part of the public sector, has already borne a share of cuts, but still there is significant concern about the implications of further significant reductions in public funding. In this environment price competition among public universities or a significant increase in tuition fees is an alternative that European countries are introducing in their agendas.

It is important to highlight that we are not arguing that stratification is a bad outcome. We deal with the issue of stratification because in many European countries stratification is still considered as socially unfair and it is often identified with elitism. On the contrary, in the US stratification, which is understood as diversification, is considered as an asset of their university system (see Bok 2003, Bowen, W.G. , M.A. Kurzweil, and E. M. Tobin 2005). In fact, students sorting with stratification by ability and income and university stratification have been shown empirically (Epple et al. 2003, Hoxby 1997) as well as theoretically (Del Rey 2001, De Fraja and Iossa 2002 and Vanhaecht and W. Pauwels 2005, etc.) in competitive university systems.

In this paper we want to study to which extent a traditional public university financing scheme based on uniform and low tuition and fees succeeds in avoiding stratification of universities and segregation of students. We compare the results of such a policy with those derived from models of private competitive universities which have been proven to cause stratification and segregation.

Since in Europe there is a diversity of public university financing schemes we focus on the one that is implemented in Spain, which is characterized by: i) governments fix uniform and low tuition fees, regardless of the cost of higher education and the income of students' families, ii) the government transfers subsidies to some universities based on a per-student basis apparently aimed at allowing universities to offer the same quality of higher education.

Our results suggest that a publicly financed university system based on low and uniform tuition as well as on uniform subsidies to universities does not prevent stratification of universities. Therefore, stratification is not exclusive of private competitive university systems. Our results also suggest that it is very unlikely that segregation and stratification could be avoided by subsidizing the less efficient universities. Finally, we show that even in the case that stratification was avoided, it might be at the cost of fixing an upper-bound to the quality of education that could be supplied by universities, including those that are highly efficient. This policy is not harmless because it excludes the possibility that individuals who are willing to pay to have access to higher quality of education can do so.

At this point it is important to stress the distinction between "financing

institutions of higher education" and "financing students' attendance to universities". In this paper we focus our analysis on higher education funding schemes from the university's perspective rather than from the student's point of view. There are many instruments that can be implemented by the government (loans, grants, fellowships, vouchers, tax credits, etc.) other than charging low tuition fees to make it possible for all talented low-income students to attend the university. As a matter of fact, opponents to low and uniform tuition fees argue that they represent implicit subsidies to high-income students. However, even this are two different problems, it seems that it would be efficient that reforms on university public funding as well as reforms on students' higher education funding designed and implemented simultaneously.

This distinction is made also in the literature. On the one hand, Del Rey and Racionero (2006), Kemnitz (2004), Epple et al (2003), Cigno and Luporini (2003), Garcia-Peñalosa and Walde (2000) and Rose and Sorensen (1992), among others, analyze the effects of different higher university funding schemes from the students' perspective. They analyze the effects of pure loans, income contingent loans, grants, subsidies, etc. on students' performance and students' welfare. However, they neither analyze stratification effects nor the effects on quality of education.

On the other hand, Fethke (2005), Del Rey and Romero (2004), Ehremberg and Rizzo (2004), Koshal and Koshal (2000), Golding and Katz (1998), Greene (1994) and Ehrember and Sherman (1984) among other, analyze price determination in the higher education sector. A different approach is found in Beath et al (2005) where they approach the ways higher education funding schemes influence the trade-off between research and teaching. They prove that under some higher education funding schemes, which differ on the weight given to teaching and research, the university system may derive into a model where some universities concentrate on teaching and do minimal research, while the remainders do high quality research. However, this literature does not deal with competition for students and faculty, as we do here.

We present a model of partial competition (since universities are subject to some rigidity) among public universities. Although we assume that universities do not compete in prices, because there is a public agency that fixes tuition, they compete among themselves for faculty and for the most talented students. Further, this competition is not even since there are structural differences across universities (student's facilities, infrastructures, differences in teaching methods, management procedures, etc.). Additionally, we assume that the public agency is subject to a budget constraint that fixes a limit on its capacity to subsidize inefficient universities.

In section two we present the model, while in section three we deal with the results concerning university stratification and students' segregation. We present conclusions in section four.

2 The model

As far as the model is concerned, there are three important features that should become clearer.

First, we have to refer to the process according to which student are assigned to universities. We use a version of the procedure implemented in Spain in which public universities cannot select their students. Instead, students are allocated across universities by the administration, which takes into account: i) student's preferences (they rank universities in order of their preference), ii) the talent of students (based on test scores at secondary school), and iii) the number of students that can be admitted at each university. This system may reduce matching problems and strategic behavior[3] of students and universities.

Second, we refer to the universities' public funding scheme. University's resources come from two different sources. On the one hand, from the tuition fees charged to students, which are decided by the Government. On the other hand, some universities may receive additional transfers from the Government. The subsidy consists of a per-student transfer that is implemented aimed at allowing universities to offer the same quality of higher education, which implies avoiding stratification.

Finally, we should remark that in this set up students are inputs themselves. This means that if universities want to maximize quality, for given tuition fees, they should be able to select the best students. In addition to that, universities should take into account student's decision process when hiring their professors. The timing of the model is as follows. First, we will find the decision by students, then we will analyze the universities' decision concerning the professors they are going to hire. This decision is taken considering the decision by the students and by the other university managers. Therefore, universities will hire professors aimed at receiving the maximum number of applications so that the Government will assign them the most talented students. Finally, we will analyze the government's decision regarding the per-student subsidy that university managers are going to receive as an additional income to tuition fees charged to students.

2.1 University Managers

Public universities can hire professors and decide on the incentives they can offer them based on their talent and subject to their budget constraint. Therefore, universities can decide on the quality of their faculty.

We assume that the goal of university managers is to maximize excellence, following Epple and Romano (2003). We measure excellence according to the quality of education offered at each university. Higher education quality (H) depends on three factors. First, it depends on the average ability of professors in that university ($\bar{\mu_k}$). Second, it depends on the average talent of the student

[3] See Gale and Shapley (1962), and Roth and Oliveira (1990) for a survey on matching issues in a university framework.

body ($\bar{\phi}_k$), and third, it depends on a set of factors that are exogenously given: infrastructures, libraries, students' facilities, physical surroundings, etc. that are represented in the term A_k. Therefore, quality follows

$$H_k = \bar{\phi}_k^{\alpha} \bar{\mu}_k^{\beta} A_k,$$

where we assume that $\alpha + \beta = 1$.

University managers must consider two types of costs: i) faculty wage costs, and ii) costs that correspond to college inputs that are sensitive to student aptitude.

As far as wage costs are concerned, universities pay a fixed salary (w), which is the same for all universities and it is decided by the government. Additionally, each university can offer incentives to their professors. We assume that these incentives are related to the average quality of the professors that teach in that university[4]. Therefore, faculty's costs follow:

$$N_k w[1 + w(\bar{\mu}_k)],$$

where N_k denotes the number of professors at university k and $w(\bar{\mu}_k)$ are the incentives that can be offered to professors. In particular, we assume

$$w(\bar{\mu}_k) = \eta_k \bar{\mu}_k,$$

with $\eta_k > 0$.

As far as the costs that are sensitive to students' talent ($c(\bar{\phi}_k,)$) are concerned, we argue that there are some facilities that are essential to provide high quality education to talented students: well-endowed libraries, advanced teaching and learning methods, job market services, academic support to students, access to technology, etc. Therefore, higher average talent of the students is associated to higher the costs of teaching for that university. In particular, we take $c(\bar{\phi}_k,) = \rho_k \bar{\phi}_k$ where we assume that ρ_k (with $\rho_k > 0$) is exogenous and different across universities. One might interpret that ρ_k captures the degree of efficiency of university k. We may also argue that these costs depend on the number os students. However, in our framework we assume, for simplicity, that universities have the same number of students ($M_k = M$, $\forall k = 1...K$).

[4]The uniformity of wages is a simplification of the model. In Spain public wages are characterized by: i) in most public universities wages are fixed by the regional government, ii) the dispersion of wages is very small between regions and categories, iii) wage differences are not due exclusively to the teaching and research qualities of the faculty. However, universities can incentive professors in several manners: i) offering them a status (with higher wages) different to those that are exclusive for civil servants; ii) offering professors additional resources for research activities, iii) assigning them lower teaching responsibilities, which allows them to do research and consulting (which means higher income). In Spain, those universities that can offer higher incentives are those in which their faculty are able to generate more income from consulting and research activities, which is associated to the quality of their faculty. Therefore, the faculty at those universities benefits from the average quality of her fellows (there is some kind of peer-effects)

University's revenues depend on the tuition and fees (T) that they can charge to the (M) students. In addition to that, universities might occasionally receive transfers from the government. These transfers take the form of a per-student transfer (tsk).

Therefore, universities are subject to a budget constraint such as:

$$(T + tsk)\ M \ = \ N_k w[1 + w(\bar{\mu_k})] + c(\bar{\phi_k}). \tag{1}$$

It is obvious that we must assume that $M > N_k$.

Altogether, the problem for the university is to maximize the quality of higher education by choosing the talent of students and professors, subject to a budget constraint:

$$\begin{aligned} & Max_{\bar{\phi_k}, \bar{\mu_k}} \qquad H_k \qquad (2) \\ & s.t. \qquad (T + tsk)\ M \ = \ N_k w[1 + w(\bar{\mu_k})] + c(\bar{\phi_k},), \\ H_k \ &= \ \bar{\phi_k^{\alpha}}\ \bar{\mu_k^{\beta}} A_k, \qquad \alpha + \beta = 1, \\ w(\bar{\mu}) \ &= \ \eta_k \bar{\mu_k}, \qquad c(\bar{\phi_k},) = \rho_k \bar{\phi_k}. \end{aligned}$$

For the sake of simplicity, we will assume that universities have the same number of professors and that the number of professors is fixes. Therefore $N_k = N_l = N$.

2.2 Professors

In our framework professors offer their talent, denoted by μ_j inelastically, regardless of the wage or the incentives that they may obtain. This talent is considered as exogenous and can be observed by university managers. In our set up talent refers both to research and teaching abilities.

Professors obtain their income from two different sources. First, they receive a fixed wage (w) that is the same for all professors regardless of their talent and it is decided by the government. Second, they receive an additional income which is associated to the average talent of the other professors ($w(\bar{\mu_k})$), where k refers to the university), which is decided by each university. Total income for any professor j at university k follows[5]

$$I_{jk} = w[1 + w(\bar{\mu_k})]. \tag{3}$$

The goal of the professors is to maximize income; therefore, they will prefer to be hired by those universities that offer the highest incentives to their talent.

$$Max_{\{k,l..\}} I_{jk}, I_{jl...}$$

[5] See footnote #4 for further discussion on the professor's wage structure.

A professor j will prefer to be hired by university k instead of l if $I_{jk} > I_{jl}$ which implies :

$$w(\bar{\mu_k}) > w(\bar{\mu_l}).$$

All professors have different talents, $\mu_i \in [\mu_{\max}, \mu_{\min}]$, with $\mu_{\min} > 0$. However, in this framework the distribution of talent among them is not crucial to our results.

2.3 Students.

The goal of the student is to choose the university that offers a combination of tuition and quality, which is observable by the student, that allowed her to obtain the highest level of net income (expected net income). Therefore, they will rank first the university that offers them the highest quality at a lower price.

Net income (of a student i that attends university k (IN_{ik}) follows[6]:

$$IN_{ik} = \varpi[1 + \phi_i H_k^{\varepsilon}] - T_k. \tag{4}$$

T_k is the cost of attending university k. Income consists of a minimum wage (ϖ) that increases according to the talent of the student (ϕ_i) and the quality of the education received at the university she will attend (H_k). We assume that $0 < \varepsilon < 1$. Students will attend any of the universities if $\varpi\phi_i H_k^{\varepsilon} > T_k$ $\forall k = 1...K$. We assume that this condition holds for $\forall k = 1...K$.

Students have different talents that are bounded above and below, $\phi_i \in [\phi_{\max}, \phi_{\min}]$, with $\phi_{\min} > 0$. Given that the distribution of talent among students is not crucial to our results no assumptions are made concerning the distribution of talent. .

In this paper we do not consider students' budget constraints of any kind. We assume that students can afford attending any of the universities. We assume that they may receive transfers from their parents, they may have access to loans, or they may receive grants and fellowships from the Administration. This assumption is aimed at avoiding dealing with students sorting by income. Additionally, we assume that there are no mobility costs, which allows us to work beyond the traditional framework of spatial competition.

Once students know the combination of tuition and qualities at each university they will rank universities in order of their preference based on the net income levels they would obtain. The student will choose university k as the first in her ranking if $IN_{ik} > IN_{il}$, where l is any of the $K-1$ other universities (K is the number of universities). This means that she will rank university k first as far as

$$\varpi\ \phi_i\ \ H_k^{\varepsilon} - T_k\ >\ \varpi\ \phi_i\ \ H_l^{\varepsilon} - T_l \qquad k \neq l, l = 1, 2...K-1.$$

In case that tuition fees were the same, she will prefer the university that offers the highest quality.

[6] The possibility of being unemployed is not considered in the paper.

In order to understand the student's choice, it is interesting to show her indifference curve between tuition and the quality of education. All combinations of tuition and qualities that allow her to obtain the same level of net income follow:

$$T = \varpi \left[1 + \phi_i \;\; H^{\varepsilon}\right] - \bar{IN}_i. \tag{5}$$

$Figure 1$

As we see in Figure (1), for a given tuition, the higher the quality of education, the higher the net income students will obtain. This explains why students might be willing to pay higher tuition in order to have access to better education. They prefer allocation K to J because they will obtain a higher net income even if they pay higher tuition at K. Finally, we observe that the larger the talent of a student, the more she will be willing to pay for the same quality of education.

2.4 Public authority.

The role of the government is to guarantee that students have access to the same quality of higher education regardless of the university they will be assigned. Therefore, the goal of the government is to avoid stratification of universities and segregation of students. The instrument implemented to achieve this goal is a per-student subsidy (ts) that will be transferred to some universities. The process according to which students are allocated across universities is decided by the government following the description provided in section 2 (first paragraph).

The government is subject to a budget constraint that follows:

$$G = tsM,$$

where G[7] is the amount of resources that the government has decided to devote to subsidize universities and M is the number of students at university k .

3 Results

This section has three parts. In the first part, we derive the university's quality supply curve under the assumption that universities choose the inputs considering the per-student income as given and that they behaved competitively. The first part is provided for descriptive purposes only because the equilibrium analysis should take into account that universities cannot select their students. According to the process of allocation of students among universities that it is

[7] In this paper we do not analyze how this amount of resources is decided. Very often it does not depend on the necessities of the university system but on political preferences and budget constraints. In this paper we assume that the task of the public authority is to manage the amount of resources that have been assigned for that purpose by any government.

assumed in this paper, if universities were to maximize quality they should enroll the best students because students are inputs themselves. Therefore in order to solve the model finding the correct equilibrium we should solve the maximization problem considering that universities should know student's decision process before they hire professors.

In the second part of this section we analyze the results concerning stratification of universities and segregation of students when universities compete among themselves for students and faculty. The timing of the model is as follows. First, we will study the decision to be taken by students, which is strongly determined by the procedure implemented by the government in order to allocate students across universities. Second, we will analyze the universities' decision concerning the professors they are going to hire. This decision largely depends on the decisions made by the students, and by the other universities. Therefore, universities will hire professors aimed at receiving the maximum number of applications in order to be assigned the most talented students by the government.

In the third part, we analyze the government's decision on T aimed at avoiding stratification, subject to a budget constraint.

3.1 Quality of education supply

In a standard set up the university would choose the level of inputs considering their costs (w, ρ_k and η_k) as well as the per-student income ($T + ts$), which is exogenous to the university.

The Lagrangian follows

$$L = \bar{\phi_k^{\alpha}}\ \bar{\mu_k^{\beta}} A_k + \lambda \left[(T + tsk)\ M\ -\ Nw(1 + \eta_k \bar{\mu_k}) - \rho_k \bar{\phi_k} \right]$$

First order conditions derived from the university's problem (5) provide:

$$\frac{\bar{\phi_k}}{\bar{\mu_k}} = \frac{N\alpha\ w\eta_k}{(1-\alpha)\rho_k}. \tag{6}$$

Equation (6) together with the budget constraint yields the average talent of those professors who would be hired by the university:

$$\bar{\mu_k}^{\,d} = [(T + tsk)M - wN]\,(\frac{1-\alpha}{wN\eta_k}), \tag{7}$$

Equation (7) shows that the larger the university's income the higher the talent of the professors, on average, that the university would be willing to hire.

Finally, the university would decide the quality of higher education that it would offer, which depends on the per-student income received. That is, the quality that university k could offer depends on the income ($T + tsk$) that it would receive and on the professors' costs, and follows:

$$[T + tsk]^s = \ \frac{H_k}{A_k} \frac{(wN)^{1-\alpha}}{M} (\frac{\rho_k}{\alpha})^{\alpha} (\frac{\eta_k}{1-\alpha})^{1-\alpha} + \frac{Nw}{M}. \tag{8}$$

In equation (8) we observe that the larger the professors' (w, N_k, η_k) and students' costs (ρ_k) the larger the tuition fees that the university should fix in order to finance a given level of quality. However, both the number of students and the endowment of the university (infrastructures, management methods, etc.) would allow the university to supply that quality at a lower cost.

If universities charged the same tuition and fees (T) and if they received the same per-student subsidy (ts) from the government $(tx = T + ts)$, the quality of education that could be offered by university k would follow:

$$H_k^*(tx) = (txM - wN)(\frac{\alpha}{\rho_k})^{\alpha}(\frac{1-\alpha}{\eta_k})^{1-\alpha}A_k(\frac{1}{wN})^{1-\alpha}. \tag{9}$$

In this set up, it should be remarked that if universities received the same per-student income they would not be able to offer the same quality of education. Thus, if the government wanted universities to offer the same quality of education it should devote additional resources to the less efficient universities. Alternatively, the government could decide that universities charged different tuition fees to their students.

However, the previous analysis is incomplete. In order to analyze the allocation of students across universities (segregation) and the quality of education that will be offered at any of the universities (stratification) we must take into consideration that this is not a standard problem in which a firm can select both inputs. In our framework universities do not select students directly. Instead, students apply to universities and they are assigned to one university or another by the government depending on students' preferences and talent and on the number of students that can be registered at each given university. This means that if universities wanted to be ranked first in student's preferences they should supply the highest quality at the lowest price. That is, student's behavior determines university's decisions. This is a crucial issue as far as the professors hired by the university is concerned because their quality will finally determine student's decision. Another shortcoming of the previous analysis is that within-groups differences in student's and professor's abilities have not been considered yet.

In the following section we will analyze the decision made by students and universities assuming that the government fixes uniform tuition and fees[8] and that no subsidies are implemented. We will then analyze government's decision considering the possibility that the government decides to subsidize universities.

3.2 University competition under uniform tuition fees and no subsidies.

In this section we solve the model under the assumptions that universities do not receive subsidies and that the tuition fees are fixed uniformly by the government. We find the equilibrium considering two universities and assuming that

[8] In Spain regional governments decide on tuition fees that universities will charge to their students.

$A_l < A_k$. The results obtained under this new set up **w**ould still hold if we considered uniform tuition and fees and that the government transferred uniform per-student subsidies to any of the given universities.

We show that uniform and low tuition fees do not prevent stratification of universities and sorting of students by their talent. These results are consistent with those found in models of competition among private universities.

In order to analyze the distribution of students across universities and the quality of education offered at any university we must consider the students' decision first.

Students' decision.

Since tuition and fees are the same across universities, students will rank them based on the quality they offer (A_j, N_j, $\bar{\mu}_j$ $\forall j = k, l$ are known by students).

If peer-effects existed, students might be interested in attending the university that gathered the best students. If the M most talented students joined in one university their average talent would be $\bar{\phi}_{\max}$. Any other distribution would yield an average distribution of talent $\bar{\phi}$, such that $\bar{\phi}_{\max} > \bar{\phi}$. Therefore, the M most talented students will prefer to gather at any of the two universities if

$$H_j = \bar{\phi}^{\alpha}_{\max} \bar{\mu}_j^{1-\alpha} A_j > H_j = \bar{\phi}^{\alpha} \bar{\mu}_j^{1-\alpha} A_j \qquad \forall j = k, l. \tag{10}$$

which is always true because $\bar{\phi}_{\max} > \bar{\phi}$.

Obviously, the other students would also prefer to be admitted to the university chose by the most talented students. Therefore, due to peer-effects all students would rank first the same university, the one where the best students would be interested in gathering at.

However, which university would the M best students rank first? They would rank first university k instead of l if

$$H_k = \bar{\phi}^{\alpha}_{\max} \bar{\mu}_k^{1-\alpha} A_k > H_l = \bar{\phi}^{\alpha}_{\max} \bar{\mu}_l^{1-\alpha} A_l. \tag{11}$$

This condition requires that

$$\frac{\bar{\mu}_k}{\bar{\mu}_l} > \left(\frac{A_l}{A_k}\right)^{\frac{1}{1-\alpha}}. \tag{12}$$

Therefore, if condition (12) was satisfied, university k would be selected by these (M) students at the top in their rank of preferences. In addition to that, this rank would be the same for all students, regardless of their talent.

Once the government knew the rank of universities by students and the student's abilities it would assign the best M students to university k, while the others will be assigned to university l, such that $\bar{\phi}_k > \bar{\phi}_l$, and $\bar{\phi}_k = \bar{\phi}_{\max}$.

If the previous condition is not satisfied and instead

$$\frac{\bar{\mu}_k}{\bar{\mu}_l} = (\frac{A_l}{A_k})^{\frac{1}{1-\alpha}}, \tag{13}$$

the M best students might still be interested in gathering at one university due to peer effects. However, students should show no preference for any of the two universities and nothing can be said regarding the final distribution of students and talent.

We must stress that once students were assigned to any university by the government, they could do nothing in order to change this allocation. They cannot change their talent and they cannot pay higher tuition fees in order to be admitted.

Universities' decision.

If university k wanted to be ranked first and be assigned the M most talented students, it should hire professors with an average talent that satisfied condition (12). This result depends: 1) on the quality of the professors hired by university l, ii) on the structural differences between universities (A_k, A_l) and iii) on the universities' budgets constraints. It is interesting to note that university k could be selected first even if it hired professors that were less talented than those hired by university l. This would be possible if A_k was high enough relative to A_l

The decision of which professors are going to be hired by any university depends on the salary they can offer. In our set up, the basic salary is fixed and decided by the government and universities can offer additional income to their professors depending on their talent. Given that professors' goal is to maximize income, those universities that offered higher salaries would be in a better position to hire the most talented professors**.** Therefore, the decision by the professor depends on the incentives she can receive at each university, which depend, by assumption, on the average talent of her fellows

Incentives are subject to the budget constraint of each university. From equation (4), any of the universities could afford the following incentives:

$$\bar{\mu_k}\eta_k wN = [T\ M\ - Nw - \rho_k\bar{\phi}_k], \tag{14}$$

$$\bar{\mu_l}\eta_l wN = [T\ M\ - Nw - \rho_l\bar{\phi}_l], \tag{15}$$

where $\bar{\mu_l}w\eta_l$ and $\bar{\mu_k}w\eta_k$ are the incentives that each professor could receive were they hired by university l and k respectively. $\bar{\mu_k}$ and $\bar{\mu_l}$ represent the average talent of the professors hired by university k and l, respectively.

Equations (14) and (15) are open to many results. We will only analyze those situations which may provide segregation of students and stratification of universities as a plausible result.

A) According to expressions (14) and (15), if

$$\bar{\mu_k}\eta_k = \frac{[T\ M\ - Nw - \rho_k\bar{\phi_k}]}{N} > \bar{\mu_l}\eta_l = \frac{[T\ M\ - Nw - \rho_l\bar{\phi_l}]}{N}, \tag{16}$$

then university k could afford paying higher incentives to its professors. Alternatively, we can show that if

$$\rho_k\bar{\phi_k} < \rho_l\bar{\phi_l},\ \text{for}\ \forall\ \text{pair of}\ \bar{\phi_k}, \bar{\phi_l}, \tag{17}$$

then all professors would prefer to be hired by university k, which would be able to select the best professors ($\bar{\mu_k} = \bar{\mu_{\max}}$), so that

$$\bar{\mu_k} = \bar{\mu_{\max}} > \bar{\mu_l}. \tag{18}$$

It is straightforward to show that if the previous inequality (18) holds, so does condition (12)

$$\frac{\bar{\mu_k}}{\bar{\mu_l}} > 1 > (\frac{A_l}{A_k})^{\frac{1}{1-\alpha}},\ \text{given that, by assumption}\ A_k > A_l \tag{19}$$

Thus, if condition (17) holds, university k might be able to offer the highest quality at the same tuition fees. This university would hire the best professors and it would educate the best students due to peer-effects.

Segregation of students and stratification of universities would occur. In particular, for segregation and stratification to occur it would be sufficient if $\rho_k\bar{\phi}_{\max} < \rho_l\bar{\phi_l}$ hold.

B) On the other hand, if

$$\rho_k\bar{\phi_k} = \rho_l\bar{\phi_l},\ \text{for}\ \forall\ \text{distribution of}\ (\bar{\phi_k},\ \bar{\phi_l})$$

then professors are indifferent between being hired by one university or the other. The final result would be a random allocation of professors and a-priori we cannot guarantee

$$\bar{\mu_l} \lesseqgtr \bar{\mu_k}.$$

How this result does affect students' decision? In fact, there might still be segregation of students due to peer-effects. Let us assume that professors are distributed randomly across universities ($\bar{\mu_k}$, $\bar{\mu_l}$)

Peer-effects arise if

$$H_k = \bar{\phi}^{\alpha}_{\max}\bar{\mu_k}^{1-\alpha}A_k \gtrless H_l = \bar{\phi}^{\alpha}_{\max}\bar{\mu_l}^{1-\alpha}A_l, \tag{20}$$

In particular, if

$$\bar{\mu}_k^{1-\alpha} A_k < \bar{\mu}_l^{1-\alpha} A_l, \tag{21}$$

students will prefer university l to university k.

Otherwise, if

$$\bar{\mu}_k^{1-\alpha} A_k > \bar{\mu}_l^{1-\alpha} A_l, \tag{22}$$

students will prefer university k to university l. Therefore, segregation of students and stratification is still a plausible result.

C) Finally, if

$$\bar{\rho}_k \bar{\phi}_k > \rho_l \bar{\phi}_l, \text{ for } \forall \text{ pair of } \bar{\phi}_k, \bar{\phi}_l, \tag{23}$$

then

$$\bar{\mu}_l = \bar{\mu}_{\max} > \bar{\mu}_k. \tag{24}$$

Under condition (23) university k might have a much better environment ($A_k > A_l$) but the costs associated to educate students might be much higher also. Under inequality (24) we cannot guarantee that condition (12) is satisfied

$$\frac{\bar{\mu}_k}{\bar{\mu}_{\max}} \lessgtr (\frac{A_l}{A_k})^{\frac{1}{1-\alpha}} \tag{25}$$

Thus, under this condition we may find that university l hired the best professors but that the best students may prefer to be admitted to a different university.

What will be the decision by students? Their decision is not straightforward because it depends on the relationship:

$$H_k = \bar{\phi}^{\alpha}{}_k \bar{\mu}_k^{1-\alpha} A_k \lessgtr H_l = \bar{\phi}_l^{\alpha} \bar{\mu}_{\max}^{1-\alpha} A_l, \tag{26}$$

and on the size of peer-effects. If

$$H_k = \bar{\phi}^{\alpha}{}_{\max} \bar{\mu}_k^{1-\alpha} A_k > H_l = \bar{\phi}_{\max}^{\alpha} \bar{\mu}_{\max}^{1-\alpha} A_l, \tag{27}$$

then the M best students are still interested in gathering at university k. This situation is possible only if the difference between A_k and A_l is high enough. Although professors at university l may be better, university k offers a better environment for them. If instead

$$H_k = \bar{\phi}^{\alpha}{}_{\max} \bar{\mu}_k^{1-\alpha} A_k < H_l = \bar{\phi}_{\max}^{\alpha} \bar{\mu}_{\max}^{1-\alpha} A_l, \tag{28}$$

then the M best students prefer university l because the quality of its professors more than compensates for the low quality of its environment.

As a curiosity, it is interesting to remark that this condition introduces the possibility that professors prefer to be hired by the university that had the less talented students. This would occur if

$$\rho_k \bar{\phi}_{\max} > \rho_l \bar{\phi}_l, \tag{29}$$

because university l would be able to pay higher salaries to its professors.

Altogether, the previous results show that even if the government fixed uniform tuition fees (or alternatively that universities received the same per-student income), stratification of universities by their quality of education as well as segregation of students by their talent could be observed. It is important to remark that this result is very close to that obtained in models that analyze competition among private universities both from empirical and theoretical approaches (Hoxby (1997) and Epple and Romano (2003)).

Up to this point we have not mentioned how the administration decided the tuition that universities could charge. This decision depends on many factors: i) the number of universities, ii) the resources available to finance higher education, iii) the number of students enrolled, etc.

In this paper, since the number of students is fixed and since they do not face budget constraints, we assume that the goal of the administration is to guarantee that students receive the same quality of higher education regardless of the university they attend. This means that the aim of this policy is to avoid stratification between universities. It seems that if students received the same quality of education, segregation of students by their talent would be an irrelevant goal . We are not claiming that stratification (or diversification) is a negative outcome. We just try to represent a model that is being currently implemented in Spain and other EU members which apparently try to avoid the growth of quality differences in the education offered by public universities.

3.2.1 University competition under uniform tuition fees and public subsidies.

In the previous sections se have shown that segregation of students and stratification of universities are plausible results in a framework in which the government fixed uniform tuition fees. Under university competition, when the government decides the tuition fees (T) that will be charged by all universities, it also determines the quality of education supplied by the best university, university k , if condition (17) hold. If university l received this tuition (T), it would not be able to supply the same quality of education and segregation and stratification would occur in a competitive framework.

Another interesting result obtained in the previous section is that under certain conditions, the university that gathered the best students and the best professors might offer the highest attainable level of education. Assuming, for instance,

$$A_k > A_l, \tag{30}$$

the highest level of education attainable is

$$H_{\max} = H_k = \bar{\phi}^{\alpha}_{\max} \bar{\mu}^{1-\alpha}_{\max} A_k > H_l = \bar{\phi}^{\alpha}_{l} \bar{\mu}^{1-\alpha}_{l} A_l, \tag{31}$$

which occurs if condition (17) is satisfied because the best professors and students gather at university k.

However, it is important to remark that this result does not depend on the level of tuition fees (T), but on the fact that they are uniform. In order to avoid stratification to occur, the government might offer a per-student subsidy ts_l to university l. If subsidies existed in the form of a per-student subsidy (tsl), the per-student income for university l would be $(T + ts_l)$. Nevertheless, in order to prevent stratification to occur tsl should be large enough such that university l had enough resources so that she was able to supply the same quality that is offered at university k

$$H_l(ts_l + T) = H_k(T). \tag{32}$$

In this section we analyze whether subsidizing universities would allow the government to prevent stratification and segregation in a framework where universities compete to attract students and professors.

Results of this policy depend on the amount of resources that the government chooses to devote to subsidize universities (G), as well as on the number of students at the university that will receive the subsidies (M)

$$G = ts_l M.$$

At this stage we should remark that we assumed that the government cannot allocate students and professors through universities as a social planner so that it could guarantee that condition (32) is satisfied. Obviously, in case that the government could allocate students and professors without restriction, there would be no need for subsidies. Instead, we assumed that students choose the university and the government allocates them according to their preferences and grades.

In this set up, in order to decide on ts_l the government should know students' and universities' decision first. However, if the government policy is aimed at guaranteeing that all universities offered the same quality, some questions arise : i) how would students rank universities?, would they care whether to attend university k or l?, ii) how would universities hire the talent of their professors? and, iii) would it make sense that university's goal was to maximize quality?

If there were uniform tuition fees and if students knew ex-ante that the quality of education would be the same regardless of the university they attended, their ranking of universities would be undetermined. The fact that talented students gather or not in one given university would not matter because the government guarantees the same quality.

Since students are indifferent between universities we cannot provide any hints concerning the preferences of students, therefore the final distribution is unknown. Let us assume that students ranking and government allocation of

students provides a distribution of students ($\bar{\phi}_k$,$\bar{\phi}_l$) such that $\bar{\phi}_k^{\alpha} A_k > \bar{\phi}_l^{\alpha} A_l$, prior to government intervention. For this distribution the government should guarantee that

$$H_k = \bar{\phi}^{\alpha}{}_k \bar{\mu}_k^{1-\alpha} A_k = H_l = \bar{\phi}_l^{\alpha} \bar{\mu}_l^{1-\alpha} A_l, \tag{33}$$

which means that the government should subsidize university l so that she would be able to hire e professors (with the subsidy they would be able to pay higher salaries), such that their average talent satisfies:

$$\frac{\bar{\mu}_k}{\bar{\mu}_l} = \left(\frac{A_l}{A_k}\right)^{\frac{1}{1-\alpha}} \left(\frac{\bar{\phi}_l}{\bar{\phi}_k}\right)^{\frac{\alpha}{1-\alpha}}. \tag{34}$$

The main problem faced by the government is how it is going to decide on t_{sl} such that universities hire professors with an average talent that satisfies exactly the previous condition, in a framework where professors apply to universities according to the income they are going to receive and universities select them according to their talent.

Since we assumed that the initial distribution of students is such that $\phi_k^{\alpha} A_k > \phi_l^{\alpha} A_l$, in order for universities to offer the same quality of education**,** university l should be able to hire professors that were more talented than those that were hired by university k, such that $\bar{\mu}_l > \bar{\mu}_k$**.** However, we should highlight that differences between average talent of professors should not be larger than those that appear on the right hand side of equation (34)**.** It may occur otherwise that ex-post $H_l > H_k$. If this were the case, university k might have to be subsidized instead. If the final distribution of professors and students does not satisfy condition (34), any equilibrium would be unstable, as a consequence.

We know that a subsidy tsl received by university l will allow this university to have more resources to pay higher salaries and therefore to compete to hire better professors. The ratio of incentives that both universities can offer to hire professors follows

$$\frac{\bar{\mu}_k \eta_k}{\bar{\mu}_l \eta_l} = \frac{[T\ M\ - N w - \rho_k \bar{\phi}_k]}{[(ts_l + T\ )M\ - N w - \rho_l \bar{\phi}_l]}. \tag{35}$$

According to expression (35), the government can influence the final distribution of professors across universities through the subsidy tsl. However, the result of this policy concerning stratification and segregation of students is not straightforward.

The value of the ratio in expression (35) depends both on the students' costs ($\rho_i \bar{\phi}_i$) and the subsidy tsl. $\frac{\bar{\mu}_k \eta_k}{\bar{\mu}_l \eta_l} \lesseqgtr 1$ depending on the relationship

$$\rho_k \bar{\phi}_k + tsl \lesseqgtr \rho_l \bar{\phi}_l. \tag{36}$$

In order to analyze the effects of the subsidy, let us assume that prior to the subsidy:

$$\bar{\phi}_k^{\alpha} A_k > \bar{\phi}_l^{\alpha} A_l \text{ and } \rho_k \bar{\phi}_k < \rho_l \bar{\phi}_l, \text{ for } \forall \text{ pair of } \bar{\phi}_k, \bar{\phi}_l, \tag{37}$$

Under these conditions, we obtained that segretation of students and stratification of universities occurred. With the introduction of the subsidy it may happen:

$$\rho_k \bar{\phi}_k + ts_l < \rho_l \bar{\phi}_l, \tag{38}$$

$$\rho_k \bar{\phi}_k + ts_l = \rho_l \bar{\phi}_l, \tag{39}$$

$$\rho_k \bar{\phi}_k + ts_l > \rho_l \bar{\phi}_l, \tag{40}$$

On the one hand, if condition (38) was satisfied for $\forall$ pair of $\bar{\phi}_k, \bar{\phi}_l$, results would be the same to those obtained in the analysis of situation A) in the previous section. Therefore, segregation and stratification is still a plausible result. The subsidy would not be sufficient to correct for segregation and stratification. Moreover, the maximum level of education attainable would not change (see equation 31)

On the other hand, if conditions (39) or (40) hold, results are the same to those that we derived when analyzing situations B) and C) in the previous section, respectively. In this situation the government may correct the problems of stratification and segregation. However, this will only occur if the final distribution of professors (which is random since the distribution is not determined by the model) satisfies condition (34). Otherwise, it may happen that the subsidy shifted segregation and stratification from university k to university l. If this occurred it may also happen that the maximum level of quality of education was reduced. If segretation and stratification shifted from k to l, the maximum level of quality of education would be reduced

$$H_k = \bar{\phi}^{\alpha}_{\max} \bar{\mu}^{1-\alpha}_{\max} A_k > H_l = \bar{\phi}^{\alpha}_{\max} \bar{\mu}^{1-\alpha}_{\max} A_l, \text{ because } A_k > A_l \tag{41}$$

Therefore, under conditions (39) or (40) the subsidy would not solve the segregation and stratification problem This would occur because the subsidy would motivate the concentration of students and professors in the less efficient university (the one with a lower A)

In this case, university l would be able to pay larger incentives to professors and they would be interested in being hired by that university. Thus, university l would be able to select those professors that were more talented and therefore $\bar{\mu}_l > \bar{\mu}_k$. Nevertheless, in this set up the government cannot guarantee that the final distribution of professors across universities exactly satisfies condition (34). If this condition is not achieved, and the difference between $\bar{\mu}_l$ and $\bar{\mu}_k$ were too

large, then the government might have to subsidize university k instead. Therefore, even when the possibility that a distribution of talent of professors such that condition (34) is satisfied exists, the government cannot guarantee that this distribution is achieved in a framework where students and professors can choose any of the given universities. It is therefore very unlikely that the government could avoid stratification and segregation through per-student transfers to the less efficient universities.

To sum up, in this section we showed that it is very unlikely that the policy of subsidizing some universities might prevent from stratification. There are still two remarks to be made to the impact of such a policy. First, we cannot say anything about the distribution of students across universities because they would not care whether to attend one particular university or the other. Segregation is still a plausible result (although we think that this would not be a relevant issue was stratification to be avoided. Second, non-stratification would be accomplished at the cost of fixing an upper-bound to the level of quality that even the best universities, those with higher A_i, could offer. More important, this policy restricts the decision of those talented students who would be willing to pay higher fees and tuition in order to have access to higher quality of education.

4 Conclusions

In this paper we analyze the effects of a public university system on segregation and stratification. We are not claiming that stratification (or diversification) is a negative outcome. We just try to represent a model that is being currently implemented in Spain and other EU members which apparently try to avoid the growth of quality differences in the education offered by public universities. In this paper we showed that stratification of public universities and segregation of students by talent is a plausible result also in a public university system which presumably tries to avoid these outcomes. We show that low and uniform tuition fees at public universities does not prevent for stratification and segregation to occur.

In order to avoid stratification public administrations might decide to implement a subsidy aimed at guaranteeing that all universities offer the same quality of higher education. However, we showed that it is very unlikely that stratification could be prevented by subsidizing inefficient universities because the government does not decides neither the allocation of professors nor the allocation of students across universities, who would be indifferent between attending one university or the other. Segregation of students would still be a plausible result, although we think that this would not be a significant issue was stratification to be corrected. We also showed that even if stratification could be prevented through subsidies, although it is very unlikely, this achievement would be at the cost of fixing an upper-bound at the quality that could be offered at the best universities, hence fixing quality limits at the whole university system. Worst, it would restrict the decision of those talented students

who would be willing to pay higher tuition and fees in order to have access to higher quality of education.

Although it is true that segregation by income may occur if we considered students' income differences, it is important that we distinguish between financing higher education institutions and financing students' attendance to universities. There are many instruments that can be implemented by the administration (loans, grants, fellowships, vouchers, tax credits, etc.) aimed at guaranteeing that all talented low-income students might have access to the university. This implies that in order to guarantee access of low-income talented students to higher education, the government should implement alternative policies other than low and uniform tuition fees as well as subsidizing inefficient universities. As a matter of fact, this policy represents implicit subsidies to rich and poorly talented students and limits the quality of higher education.

A natural extension of the model would consist in allowing different jurisdictions, therefore introducing competition among regional governments because they decide on the tuition fees and the subsidies that will be received by those universities established in their jurisdictions. In this new set up, we suggest that stratification may also occur in favour of those universities that received higher subsidies and fixed lower tuition because the regional government provided more resources, even if these universities were highly inefficient. Strategic competition among governments has been partially analyzed in Fethke (2005). However, he does not analyze issues on segmentation or stratification.

The model might also be improved by changing the selection process of students. If we allowed universities to select their students, results might change. The difficulty, from a theoretical point of view, is to define the algorithm according to which stable matching would occur.

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