

# Does a public university system avoid the stratification of public universities and the segregation of students?

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## Abstract

We present a model which allows us to show that even in a public university system where tuition and fees are fixed by the administration, a stratification of public universities according to the quality they offer and the quality of students they select, can be observed. This result is similar to that observed in private and competitive university systems. We also show 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 corrected with subsidies it would be at the cost of fixing the upper-bounds at the quality that could be offered at any university, hence 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, public 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 public universities at the EU will allow to close the gap on human capital endowments and on I+D+i outcomes that can be observed between the EU economies and the US and Japanese economies.

Critics argue that the main problem of the EU public university systems is the lack of competition among universities. 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

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student basis rather than on quality measures (scientific outcome, student's performance, etc.)<sup>1</sup>.

Another critic to the public university systems in the EU is that in most countries public universities 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, there are some specific characteristics that public universities share, in particular: i) universities are unable to affect their revenues because they cannot decide tuition and fees, ii) professors' salaries are decided by the Government and universities cannot offer economic incentives aimed at improving the research productivity of their professors, and, iii) universities cannot select their students (as private universities do) because traditionally the distribution of students corresponds to the Government, etc.

Nevertheless, for the past few years some 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 and, 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, both from the public and private sectors. Additionally, some governments, like in the UK, have accepted that universities raise tuition and fees significantly, shifting the costs of higher education to students. This suggests that price competition is also encouraged in the UK (see Department for Education and Skills (2003)).

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. Opponents to both price competition and a raise in tuition and 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. Several arguments are provided. First, in a framework with larger tuition and fees and lower subsidies family income would play too large a role in the process by which students would be distributed among universities. Second, stratification of universities by their quality and segregation of students by their income might occur under price competition. They argue that low-income talented students might be excluded, which does not satisfy the principle of equality of opportunities.

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.

It is important to highlight that we are not arguing that stratification is not positive. We deal with the issue of stratification because in many European

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<sup>1</sup>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.

countries until recently, stratification (elitism) has been considered as socially unfair. On the contrary, in the US stratification (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 this paper we want to study whether 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 there is a diversity of public university financing schemes within the EU we focus on the one that is implemented in Spain, which consists of: i) governments fix uniform and low tuition and 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. Furthermore, 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. Additionally, 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 at all universities, including those that are highly efficient. This policy is not harmless because it excludes the possibility that individuals who are willing to pay for higher quality can do so.

At this point it is important to point out 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 and 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 and fees argue that they represent implicit subsidies to rich students. Nevertheless, it is important that reforms on university public funding as well as reforms on higher education funding addressed to students might be 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 remainder 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 be clarified.

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<sup>2</sup> of students and universities.

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

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<sup>2</sup>See Gale and Shapley (1962), and Roth and Oliveira (1990) for a survey on matching issues in a university framework.

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 and fees, they should be able to select the best students. In other words, universities should know student's decision process before they hire 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 universities. 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 concerning tuition and fees that are going to be charged to students by universities.

## 2.1 Professors

In our framework professors offer their talent, denoted by  $\mu_{jk}$ , ( $k$  refers to university) 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 ( $w(\bar{\mu}_k)$ ), which is decided by each university. Total income follows

$$I_{jk} = w[1 + w(\bar{\mu}_k)_k]. \quad (1)$$

Professors will prefer to be hired by those universities that offer the highest incentives to their talent, thus a professor  $j$  will prefer to be hired by university  $k$  instead of  $l$  if  $I_{jk} > I_{jl}$  which implies:

$$w(\bar{\mu}_k)_k > w(\bar{\mu}_l)_l.$$

Professors have different talents and the distribution of this talent among them is assumed to be uniform. That is,  $\mu_j \in [\mu_{\max}, \mu_{\min}]$ , with  $\mu_{\min} > 0$ . Nevertheless, this assumption is not crucial to our results.

## 2.2 Students.

The goal of the student is to choose the university that offers a combination of tuition and quality, which is observable that allows her to obtain the highest level of 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  $k$  follows:

$$IN_{ik} = \varpi[1 + \phi_i H_k^e] - T_k. \quad (2)$$

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

Students have different talents and the distribution of this talent among students is assumed to be uniform. That is,  $\phi_i \in [\phi_{\max}, \phi_{\min}]$ , with  $\phi_{\min} > 0$ . Nevertheless, this assumption is not crucial to our results.

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  $IN_k > IN_l$ , for  $\forall k \neq l, l = 1, 2 \dots K$  where  $K$  is the number of universities. This means that she will rank university  $k$  first as far as

$$\varpi \phi_i H_k^\varepsilon - T_k > \varpi \phi_i H_l^\varepsilon - T_l \quad \forall k \neq l, l = 1, 2 \dots K.$$

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

In order to find the student's choice, we will use the indifference curve of the student concerning tuition and the quality of education. All combinations of tuition and qualities that allow her to obtain the same level of net income follow:

$$T = \varpi [1 + \phi_i H^\varepsilon] - \bar{IN}_i. \quad (3)$$

*Figure 1*

As we see in Figure (1), for a given tuition, the higher the quality of education students receive the higher the net income they will obtain. This explains why students might be willing to pay higher tuition in order to have access to better education. They prefer point  $K$  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.

### 2.3 University Managers

Public universities can hire professors and decide on the incentives they can offer them based on their talent. Nevertheless, they are subject to some rigidity because they cannot change the number of professors and students.

We assume that the goal of the 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 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  $\alpha + \beta = 1$ .

There are two costs to be considered by university managers: i) 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 which depend on the average ability of professors to do research. Therefore, professors' costs follow:

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

where  $w(\bar{\mu}_k)$  denotes 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 services that are necessary in order 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. We assume that the higher the average talent of the students the higher the costs. In particular, we take  $c(\bar{\phi}_k) = \rho_k \bar{\phi}_k$  where we assume that  $\rho_k$  is exogenous and different across universities. One might interpret that  $\rho_k$  captures the degree of efficiency of university  $k$ .

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 subsidies from the government. We take for granted that these transfers, denoted by ( $ts$ ), are related to the number of students. To make things easier, we take that the number of students is the same at all universities.

We assume that universities are subject to a budget constraint

$$(T + ts) M = N_k w [1 + w(\bar{\mu}_k)] + c(\bar{\phi}_k), \quad (4)$$

where  $N_k$  denotes the number of professors. We 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:

$$\begin{aligned}
& \underset{\bar{\phi}_k, \bar{\mu}_k}{\text{Max}} && H_k && (5) \\
& \text{s.t.} && (T + ts) M = N_k w[1 + w(\bar{\mu}_k)] + c(\bar{\phi}_k), \\
& H_k &= & \bar{\phi}_k^\alpha \bar{\mu}_k^\beta A_k, & \alpha + \beta = 1, \\
& w(\bar{\mu}) &= & \eta_k \bar{\mu}_k, & c(\bar{\phi}_k) = \rho_k \bar{\phi}_k.
\end{aligned}$$

## 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. This implies that the government wants to avoid stratification of universities.

The instrument implemented to achieve this goal is a per-student subsidy ( $ts_k$ ) that will be transferred to the university that offers low quality higher education. The government is subject to a budget constraint as follows:

$$G = ts_k M,$$

where  $G$  is the amount of resources that the government has decided to devote to subsidize universities ( $G$ )<sup>3</sup> and  $M$  is the number of students at the university that will receive the subsidies.

Finally, the government decides the tuition and fees that universities can charge to students.

## 3 Results

This section has two parts. In the first part we obtain the quality supply curve of the university. Universities choose the inputs considering the per-student income -tuition and fees- as given and behave competitively. We provide this supply curve for descriptive purposes only because the equilibrium analysis should take into account that universities do not select their students. If universities want to maximize quality they should attract the best students because students are inputs themselves. This means 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

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<sup>3</sup>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, availability of resources, etc. In this paper the task of the government is to manage the amount of resources that have been assigned for that purpose.



among themselves for students and faculty. 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 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. Finally, we will analyze the government's decision on  $T$ , 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 ( $w, \rho_k$  and  $\eta_k$ ) as well as the per-student income ( $T + ts$ ) as exogenous.

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

$$\frac{\bar{\phi}_k}{\bar{\mu}_k} = \frac{N_k \alpha \eta_k}{(1 - \alpha) \rho_k}. \quad (6)$$

Equation (6) together with the budget constraint in (5) yields the average talent of the professors who would be hired by the university:

$$\bar{\mu}_k^d = [(T + ts)M - w_k N_k] \left( \frac{1 - \alpha}{w N_k \eta_k} \right), \quad (7)$$

which denotes that the larger the university's income the better the talent of the professors 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 depending on the income ( $T + ts$ ) that it will receive and on the professors' costs follows:

$$[T + ts]^s = \frac{H_k (w N_k)^{1-\alpha}}{A_k M} \left( \frac{\rho_k}{\alpha} \right)^\alpha \left( \frac{\eta_k}{1 - \alpha} \right)^{1-\alpha} + \frac{N_k w}{M}. \quad (8)$$

*Figure 2*

As we can observe in equation (8), the larger the professors' ( $w, N_k, \eta_k$ ) and students' costs ( $\rho_k$ ) the larger the tuition that the university should receive 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 lower tuition.

Although the supply curves can take many shapes, if there were only two universities we can represent them in the following figures (3) and (4)<sup>4</sup>.

*Figures 3, 4*

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<sup>4</sup>Alternatively, both supply curves could be parallel.

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:

$$H_k^*(tx) = [txM - wN_k] \left(\frac{\alpha}{\rho_k}\right)^\alpha \left(\frac{1-\alpha}{\eta_k}\right)^{1-\alpha} A_k \left(\frac{1}{wN_k}\right)^{1-\alpha}. \quad (9)$$

In figure (5) we see that the per-student income received by universities ( $tx$ ) determines the maximum and the minimum level of quality that can be supplied by universities ( $H_l^s(tx) = H_{min}^s$ ,  $H_k^s(tx) = H_{max}^s$ ). Thus, we see that  $H_k^s(tx) > H_l^s(tx)$ . We should also point out that the larger the tuition charged, the higher the quality both universities can offer

### *Figure 5*

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

However, in order to analyze the final distribution of students across universities and the quality of education that will be offered at any of the universities we must take into consideration that this is not a standard problem in which the firm can select both inputs. In our framework universities do not select students directly. Students apply to universities and they are assigned by the government to one university or another depending on their preferences, on their 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 crucial issue as far as the professors hired by the university is concerned because their quality will finally determine student's decision.

In the following section we will analyze the decision made by students and universities assuming that the government fixes uniform tuition and fees<sup>5</sup> and that no subsidies are implemented. We will then analyze government's decision allowing for subsidies.

## **3.2 University competition under uniform tuition and no subsidies.**

In this section we analyze the results obtained in the case that there were no subsidies to universities and in case that the government might fix the tuition that universities are allowed to charge to their students. We work within a framework where the government decides that all students pay the same tuition

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<sup>5</sup>This policy is rather common in Spanish public universities.

and fees regardless of the universities they attend<sup>6</sup>. We focus our analysis on the case of two universities and we assume that  $A_l < A_k$ .

We will show that in spite of public intervention, stratification of universities and sorting of students by their talent can occur. These results are consistent with those found in models of competition among private universities.

In order to analyze which university will offer the highest quality 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 (they know  $A_j, N_j, \bar{\mu}_j \forall j = k, l$ ).

Due to peer-effects students might be interested in attending the university that selected the best students. If the most  $M$  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  $\bar{\phi}_{\max} > \bar{\phi}$ . The  $M$  most talented students will prefer to gather in any of the two universities if

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

The other students will also prefer to be admitted in the university where the most talented students chose to register. Therefore, peer-effects motivate that students rank first the university where the best students gather.

However, which university would those students rank first? They would rank first university  $k$  instead of  $l$  if

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

This condition requires that

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

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

Once the government knew the rank of universities and the student's abilities it would assign the best  $M$  students to university  $k$  such that  $\bar{\phi}_k > \bar{\phi}_l$

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 fees and tuition in order to be accepted.

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<sup>6</sup>This analysis would also be valid if we considered that there were uniform fees and tuition and that the government transferred uniform per-student subsidies to any of the given universities.

If the previous condition is not satisfied and instead

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

then apparently, students should show no preference for any of the two universities given. However, they would still prefer the university where most talented students were accepted.

**Universities' decision.**

If university  $k$  wanted to be ranked first and be assigned the best  $M$  students, it should hire professors with an average talent that satisfied condition (12). This depends on the quality of the professors selected by university  $l$  and the structural differences between universities ( $A_k, A_l$ ). It is interesting to note that university  $k$  could be selected first event if it hired professors that were less talented than those hired by university  $l$ . This would be possible if  $A_k$  were high enough.

What kind of professors would be hired by each of the two universities? We should take into account that the basic salary is fixed and decided by the government though universities can offer additional income to its professors depending on their talent. Therefore, the decision by the professor depends on the incentives she can receive at each university. These incentives are associated to the average talent of her fellows.

However, incentives are subject to the budget constraint of each university. Any of the universities that wanted to be ranked first by the  $M$  most talented students could afford the following incentives:

$$\bar{\mu}_k \eta_k w N_k = [T M - N_k w - \rho_k \bar{\phi}_{\max}], \quad (14)$$

$$\bar{\mu}_l \eta_l w N_l = [T M - N_l w - \rho_l \bar{\phi}_{\max}], \quad (15)$$

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. If universities  $k$  and  $l$  could hire the best  $N_k$  and  $N_l$  professors, they could be able to pay them  $\eta_k, \eta_l$ , respectively.

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

$$\bar{\mu}_{k(N_k)} \eta_k = \frac{[T M - N_k w - \rho_k \bar{\phi}_{\max}]}{N_k} > \bar{\mu}_{l(N_l)} \eta_l = \frac{[T M - N_l w - \rho_l \bar{\phi}_{\max}]}{N_l}, \quad (16)$$

therefore university  $k$  could afford paying higher incentives to its professors.

$\bar{\mu}_{k(N_k)}$  and  $\bar{\mu}_{l(N_l)}$  represent the average quality of the most  $N_k$  and  $N_l$  talented professors were they hired by university  $k$  or  $l$ , respectively. As a consequence if

condition (16) was satisfied, all professors would prefer to be hired by university  $k$ , which would be able to select the best professors, so that

$$\bar{\mu}_k > \bar{\mu}_l. \quad (17)$$

If the previous inequality (17) holds, so does condition (12). Thus, university  $k$  might be able to offer the highest quality at the same tuition and fees.

This result shows that even in the case that the Administration fixed uniform tuition and fees (or alternatively that universities received the same per-student income), stratification of universities by their quality 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: the number of universities, the resources available to finance higher education, the desired number of students enrolled, etc.

In this paper, since the number of students is fixed and that 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 the attend. This means that the aim of this policy is to avoid stratification between universities. 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 and public subsidies.

As shown in figure (6) when the government decides the tuition ( $T$ ) that will be charged by all universities, it also determines the quality of education supplied by the best university, university  $k$ . If university  $l$  received this tuition ( $T$ ), it would not be able to supply the same quality of education. If this university  $l$  was to compete with  $k$ , segregation and stratification would occur.

*Figure 6*

Apparently, in order to avoid stratification to occur, the government might offer a per-student subsidy  $ts_l$  to university  $l$ . If this were the case per-student income for university  $l$  would be  $(T+ts_l)$ . This income should be large enough in order to allow university  $l$  to supply the same quality that is offered at university  $k$ :

$$H_l(ts_l + T) = H_k(T). \quad (18)$$

In this section we analyze whether this policy 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 ( $M$ )

$$G = ts_l M.$$

In order to decide on  $T$  and  $ts_l$ , the government should know students' and universities' decision first. Some questions arise if the government policy is aimed at guaranteeing that all universities offered the same quality: i) how would students rank universities?, would they care whether to attend university  $k$  or  $l$ ?, ii) how would universities decide the talent of their professors? or, iii) how would the government choose  $T$  and  $ts$ ?

If there were uniform tuition and fees and if students knew ex-ante that they would have access to the same quality of education regardless of the university they might attend, 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.

At this stage we should remark that we assume that the government cannot allocate students and professors as a social planner so as to guarantee that condition (18) is satisfied. It is obvious that, in case they could, there would be no need for subsidies. We assumed that students choose the university and the government allocates students according to their preferences and grades.

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

$$H_k = \bar{\phi}_k^\alpha \bar{\mu}_k^{1-\alpha} A_k = H_l = \bar{\phi}_l^\alpha \bar{\mu}_l^{1-\alpha} A_l, \quad (19)$$

which means that the government should subsidize university  $l$  until it is able to hire professors such that their average talent satisfies:

$$\frac{\bar{\mu}_k}{\bar{\mu}_l} = \left(\frac{A_l}{A_k}\right)^{\frac{1}{1-\alpha}} \left(\frac{\bar{\phi}_l}{\bar{\phi}_k}\right)^{\frac{\alpha}{1-\alpha}}. \quad (20)$$

The main problem faced by the government is how it is going to decide on  $ts_l$  such that universities hire professors with an average talent that satisfies exactly the previous condition? Since the distribution of students is such that  $\bar{\phi}_k^\alpha A_k > \bar{\phi}_l^\alpha A_l$ , in order for students to be indifferent between universities  $k$  and  $l$ , university  $l$  should be able to hire professors that were more talented than those that were hired by university  $k$ ,  $\bar{\mu}_l > \bar{\mu}_k$ . 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 (20). It may occur otherwise that ex-post  $H_l > H_k$ . If this were the case the university  $k$  might have to be subsidized instead.

The question that arises is how can the government guarantee a distribution of professors that satisfied condition (19) in a framework where professors apply to universities according to the income they are going to receive?

Two alternative policies could be implemented.

A) First, the government may decide to subsidize university  $l$  such that it was able to offer the same incentives to their professors as those that might be offered to them by university  $k$ . That is, the government may decide that

$$\frac{\bar{\mu}_k \eta_k}{\bar{\mu}_l \eta_l} = \frac{N_l}{N_k} \frac{[T M - N_k w - \rho_k \bar{\phi}_k]}{[(ts_l + T) M - N_l w - \rho_l \bar{\phi}_l]} = 1. \quad (21)$$

In this case, professors would be indifferent as whether to work at universities  $k$  or  $l$  because income in both universities would be the same. In this case none of the universities could offer additional income to attract the most talented professors.

The problem is that in this set up the government cannot guarantee that the final distribution of professors satisfies condition (20). If this distribution would not satisfy condition (20) what could the government do in order to correct this situation?

B) Second, the government could decide that university  $l$  received additional income so that they could hire professors who are better talented than those hired by the other university. The government might implement a per-student subsidy  $ts_l$  such that

$$\frac{\bar{\mu}_k \eta_k}{\bar{\mu}_l \eta_l} = \frac{N_l}{N_k} \frac{[T M - N_k w - \rho_k \bar{\phi}_k]}{[(ts_l + T) M - N_l w - \rho_l \bar{\phi}_l]} < 1. \quad (22)$$

In this case, university  $l$  would be able to pay larger incentives to its professors and all of them would be interested in being hired by that university, regardless of their talent. 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 (20). 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 (20) 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.

The government, though, has an additional problem to face. Even in the case that the government could avoid stratification by implementing policies A) and B), the government should decide the level of tuition and fees that students should pay ( $T$ ). This decision depends on the existing differences between universities (represented in  $A_j, \bar{\phi}_j, N_j, \rho_j, \eta_j, \forall j = k, l$ ) as well as on the amount of resources devoted to subsidize universities ( $G$ ).

Let us assume that stratification was avoided by implementing a subsidy to university  $l$  such that

$$\frac{\bar{\mu}_k \eta_k}{\bar{\mu}_l \eta_l} = \frac{N_l}{N_k} \frac{[T M - N_k w - \rho_k \bar{\phi}_k]}{[(ts_l + T) M - N_l w - \rho_l \bar{\phi}_l]} \leq 1. \quad (23)$$

Given that  $ts_l = \frac{G}{M}$  and using expression (23) the government would find the level of fees and tuition ( $T^*$ ) that allows condition (20) to be satisfied

$$T^* \leq \frac{1}{M} \left( \frac{N_k}{N_l - N_k} \right) [G + \rho_k \bar{\phi}_k - \rho_l \bar{\phi}_l],$$

where we see that  $T^*$ , which determines the quality of education that would be offered by both universities, depends on the amount of resources ( $G$ ) devoted to reduce differences between universities.

To sum up, in this section we tried to show that it is very unlikely that the policy of subsidizing some universities might prevent from stratification. There are still two remarks to make, though. 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. Second, non-stratification would be accomplished at the cost of fixing an upper-bound to the level of quality that even the best universities could offer.

If the government were not subject to a budget constraint any level of quality could be financed and any result obtained in the private sector could also be replicated. However, due to the budget constraint and the limits on tuition and fees that universities can charge there is a restriction on the quality of education that can be provided even at the best public universities. 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 tried to show that stratification of public universities and segregation of students by talent can also occur in a public university system. Uniform tuition and fees at public universities does not prevent stratification and segregation.

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, this policy does not prevent the segregation of students, who would be indifferent between attending one university or the other. In addition to that we showed that it is very unlikely that stratification could be prevented by subsidizing inefficient universities because the government cannot decide either the allocation of professors or that of students across universities. We also showed that even if stratification could be prevented through subsidies, 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, should make use of different alternatives than fixing low and uniform tuition. As a matter of fact, this policy represents implicit subsidies to rich and poorly talented students and limits the quality of higher education due to the government's budget constraint.

A natural extension of the model would consist in allowing different jurisdictions, therefore introducing competition among regional governments because they decide on the tuition and the subsidies to the universities in their jurisdictions. Stratification may also occur in favour of those universities that received higher subsidies and fixed lower tuition because their administration provided more resources. Strategic competition among governments has been partially analyzed in Fethke (2005). However, he does not analyze issues on segmentation or stratification.

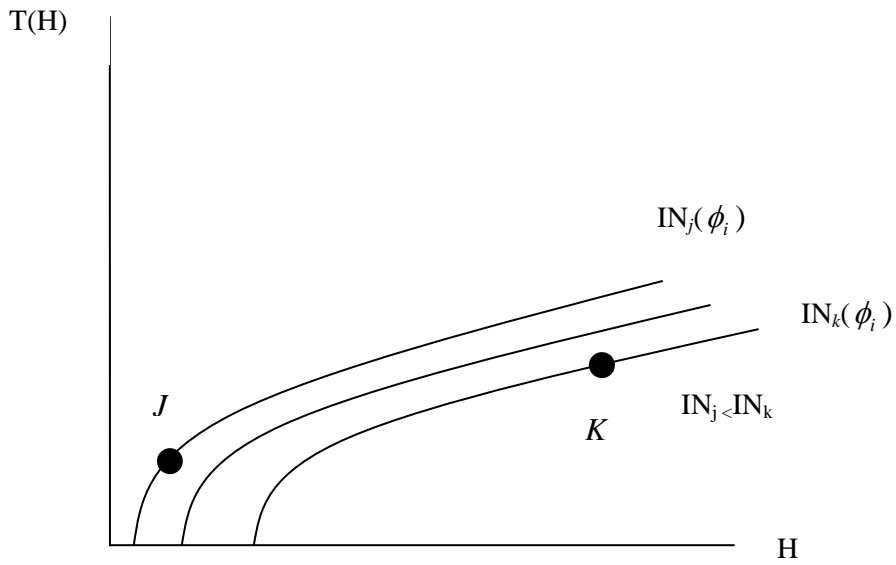
Another extension of the model is for universities to change the selection process of students. If we allowed universities to select their students, results might change. The difficulty, from a theoretical point of view, is to define the algorithm according to which stable matching would occur.

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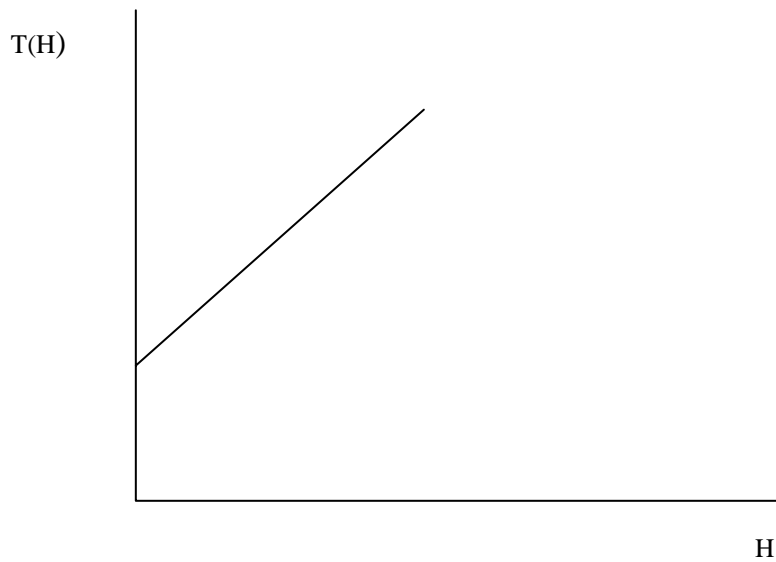
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$$T = \bar{w}[1 + H^\varepsilon \phi_i] - IN$$

Indifference curve (with respect to net income)

Figure 1



$$T(H)^s = w \frac{N_k}{M} \left[ H_k \left( \frac{1}{wN_k} \right)^\alpha \frac{1}{A_k} \left( \frac{\rho_k}{\alpha} \right)^\alpha \left( \frac{\eta_k}{1-\alpha} \right)^{1-\alpha} + 1 \right]$$

Quality of supply function.

Figure 2

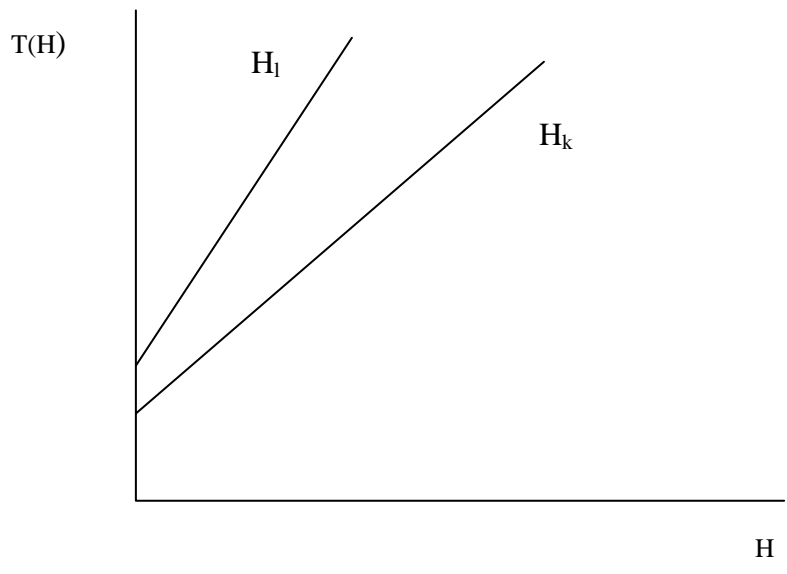


Figure 3

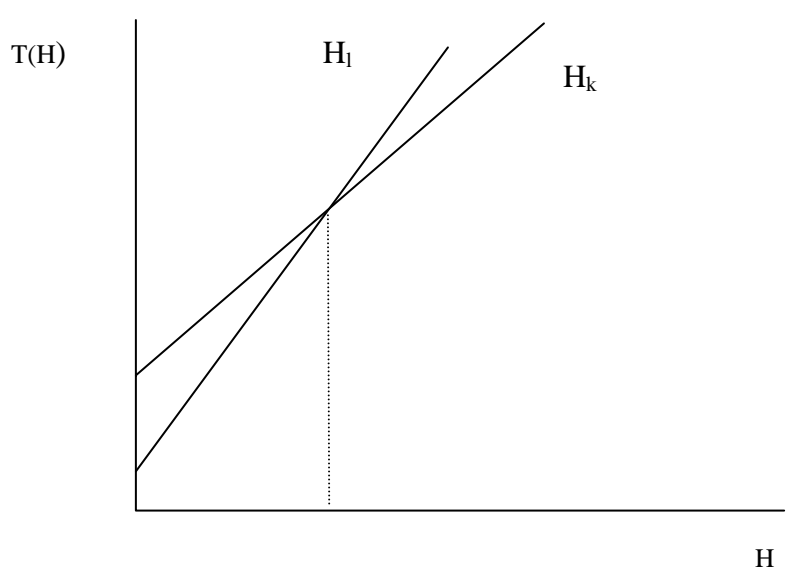


Figure 4

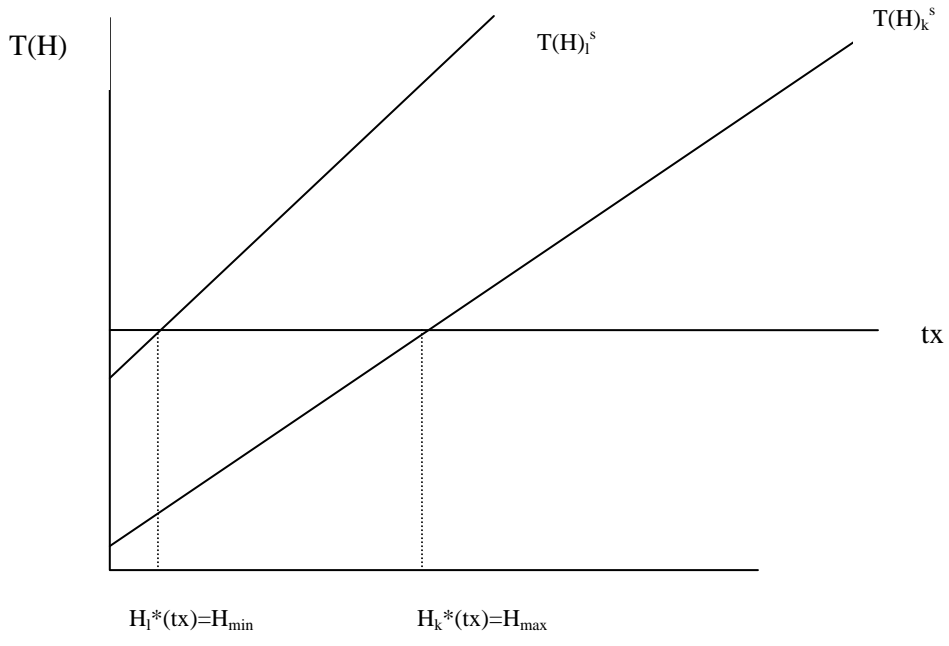


Figure 5

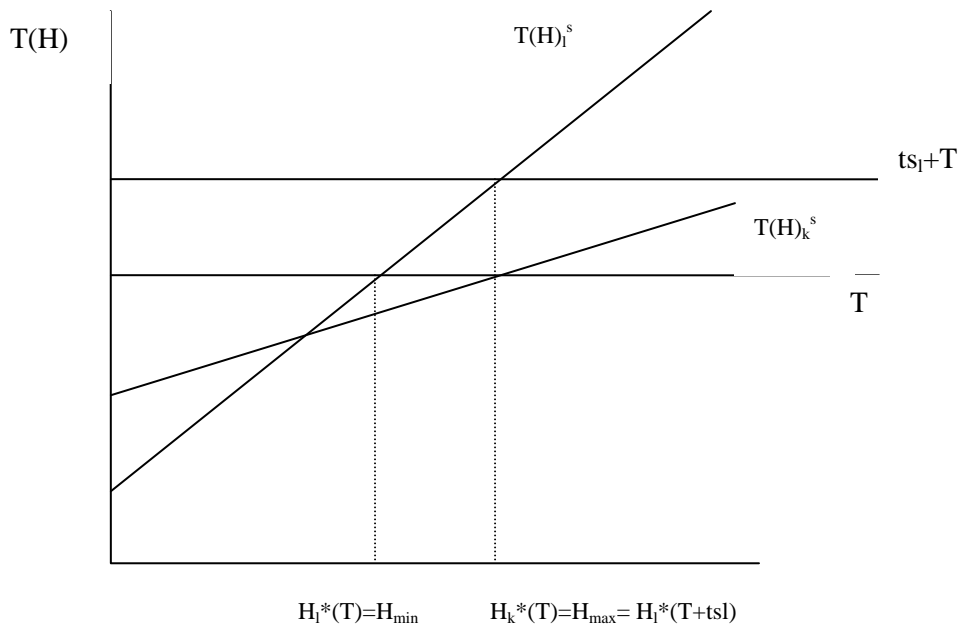


Figure 6