The expansion in the higher education sector: A tale of two regions[*][†]

Marisa Hidalgo-Hidalgo   Guadalupe Valera
Universidad Pablo de Olavide, Seville

June 1, 2012

Abstract

In a world of global competition for talent and knowledge-related investment, universities are being encouraged to form mergers by means of funding incentives. This policy is based on the idea that mergers create synergy gains that enhance universities´ prestige increasing the international visibility of regional higher education systems. However, this process reduces competition for both teaching and research funds. In this paper we analyze whether or not the expansion in the number of universities is optimal from an aggregate excellence point of view, taking into account that universities act strategically when competing. Our findings suggest that the relationship between cost differentials of universities competing within the same area, the amount of research funds and universities´ strategic quality choice plays a key role in achieving higher levels of excellence through mergers.

Keywords: Higher Education, University Competition, Mergers, University Funding System

JEL Classification: H52, I22, D78, I23

[*]Very preliminar, please do not quote.

[†]We are grateful for the comments and suggestions of Iñigo Iturbe-Ormaetxe, Moshe Justman and Darío Maldonado. We would like to thank seminar participants at Málaga and VI Workshop on Public Policy Design in Girona. Financial support from Spanish Ministry of Education and Science (SEJ2007-67734/ECON), Instituto Valenciano de Investigaciones Económicas and Junta de Andalucia (SEJ01252 and SEJ-426) is gratefully acknowledged. **Address for correspondence:** Marisa Hidalgo, Departamento de Economía, Métodos Cuantitativos e Historia Económica, Universidad Pablo de Olavide, Ctra de Utrera Km.1, E-41013, Sevilla, Spain. E-mail: mhidalgo@upo.es

1 Introduction

The importance of universities and higher education providers to the national economy is becoming increasingly well recognized across Europe.[1] Higher education now provides the skill and the knowledge transfer that enables regions to grow and to attract new investment. At the same time, globalization and increased international competition has come with increasing scrutiny of the differences in the performance of countries' universities and therefore highlighting the importance of making higher education institutions attractive to the world. This issue is of special interest due to the recent evidence regarding the poor performance of the European Higher Education System and its comparison with the US one (which seems to be better placed to compete with the new academic producers in Asia).[2]

Recent years have seen an increasing interest in political focus on research and education.[3] Policy makers view the Higher Education sector from the perspective of globalisation, in which the education of highly qualified workers and the production of new knoledge and innovation takes a central role for the country competitiveness. This wisdom is particularly relevant when we consider the above mencioned poor performance of the European universities and the lower growth rates experienced in Europe that has triggered different higher education reform proposals across Europe. Although the practical implementation of these proposed reforms varies greatly from country to country, there is a trend towards similar proposals in a series of European countries. In fact, all these programs share the same objectives: reinforce national universities making them more competitive, visible and reputable in an international context and attract better professors, researchers and students. To fullfill these objectives, and among the main course of action present in the different reform initiatives we find the promotion of "strategic alliances" between universities as a target. In

[1] There is a large literature on education and growth (see, among others Acemoglu (2009)). However note that this literature tends to use aggregate measures of education (e.g. average years attained) and does not differentiate education investments by type or expenditure, and certainly does not differentiate them by governance of schools.

[2] In 2003, the Institute of Higher Education of the Shanghai Jao University released the first "Shanghai ranking" where most European universities ranked low -or did not rank at all. See also Aghion et al. (2009) for details on the comparison between European and US universities according to international rankings.

[3] The increasing interest in this issue is reflected in various articles published in international press. See, for example, the one entitled "Leader: Together, they are stronger" published in The Times Higher Education in December 2011.

particular, universities, research centers and firms are being encouraged to form associations in order to receive public funds.[4] In principle, the mergers have strategic aims and do not consider definitive clousure of institutions. Some examples of mergers can be found in Sweden, Demmark, UK, France and USA (see Skodvin (1999)).

An analysis of US universities may lead us to conclude that more autonomous universities that need to compete more for resources are more productive. Nevertheless, we should have in mind that the success of the American Higher Education System is a result of its own organization and funding system. In the European context, this could be seen as an argument against the aggregation of universities and for the expansion of higher education market (that is, an increasing number of universities) as the mergers would likely reduce competition in the market for Higher Education. In any case, the debate is open and hightens the need to investigate the impact of these reforms on the Higher Education sector. To do this, it is important to take into account the relationship between the prevailing funding policies for higher education institutions in Europe and their institutional behavior since this relationship is going to determine their performance in terms of excellence and thus it is crucial to check whether the reforms that are being implemented are in the right direction.

This paper contributes to this debate by addressing the following question: to what extent the aggregation of higher education institutions, implemented by these reforms, is a valid instrument to alter the reputation of existing institutions? In other words, is it always true that the assumed synergy gains caused by the meeger induces higher excellence when there is competition for resources and faculty candidates?

We construct a simple model where universities act as non-profit institutions with the goal of maximizing prestige or excellence subject to a budget constraint in a framework where universities act strategically when competing for both teaching and research funds. They do so by choosing the quality of their faculty members, which in turn determine their income and prestige. Hence, in our model universities compete for both faculty candidates and resources. We analyze university performance within two areas: in one of them there is just one university while in the other there are two universities competing for candidates and/or resources. Finally, we also assume that acquiring quality is costly and interpret different costs as different reputation levels.

[4] For example, in 2006 Germany launched the "Initiative for Excellence" (2006-2012) program. At the same time, France launched the program "Pôles de Recherche et Enseignement Supérieur" (PRES 2006). Lately, Spain has just developed the initiative "Campus de Excelencia Internacional" in 2009.

The industrial organization of the higher education sector remains difficult to model, and in particular, the various forms of price and non-price competition among universities are still very much unexplored (De Fraja and Iossa (2002) and Brewer (2002)). Among recent contributions, Winston (1999) remarkably summarizes the intuitions, and provides a non-technical description, of university economics. The modelling of university behavior is generally also considered as difficult, and any choice of an objective function is open to criticism.[5]

Our paper draws upon the literature on university governance. De Fraja and Iossa (2002) point out that increased student mobility favors the emergence of elite institutions and explore how strategic admission setting can lead to quality stratification of higher education institutions. Del Rey (2001) investigates the strategic choice of universities between teaching and research activities, focussing on how the financial allocation between both can be controlled by a proper choice of the government's parameters. However, in her model research is treated as a residual item and no attention is paid to its quality. Beath et al. (2005) develop a model that incorporates research quality directly into a university's budget constraint and provide a rather general setting that allows universities to actively choose the quality of their teaching and research when facing different funding systems. Nevertheless, they do not consider inter-university competition. Recently, Gautier and Wauthy (2007) analyze the possible implications of incentive schemes as a tool to promote efficiency in the management of universities. They analyze a multitasking agency problem where there is competition for resources between departments within the same university and the objectives of academics and authorities are different. Finally, Aghion et al. (2009) investigate how university governance affects research output and show that university autonomy and competition are positively correlated with university output, both among European and US public universities.

This paper provides a framework to study the impact of promoting or not the creation of a new university on the level of aggregate excellence achieved by a regional Higher Education System. This decision can be interpreted in two different ways: on the one hand, the new university can be the aggregation of two established separate universities in an area (Region M in the paper) as a reaction to educational policy and driven by the possibility of getting resources. On the other hand, education authorities might consider the possibility to launch a new university in an area (Region C) where there is already one university that will compete with the new one for resources

[5] See e.g. Borooah (1994).

and/or faculty candidates in a context where universities act strategically. That is, we analyze the impact of the creation of new universities on aggregate excellence or prestige.

Our main finding is that, university aggregation is not necessarily good or, reversibly, university duplication is not necessarily bad. We also show that the relationship between cost differentials of universities competing within the same area, the amount of research funds and universities´ strategic quality choice plays a key role in determining the success or failure of the mergers as an strategy of educational policy to improve the position of their universities in the global market for higher education. In particular, we show that the lower the differential cost between the two competing universities, the lower the amount of resources needed for the merged institution to produce higher aggregate excellence than the competing one. That seems to support the idea that the larger the differences between the involved institutions, the greater the probability that the merger will be successful. We feel that these results provide some input to policy makers in order to fullfill their objectives when implementing this educational policy.

The paper is organized as follows. Section 2 introduces the model. Section 3 analyzes the region where there are two universities competing. Section 4 analyzes the region where there is only one university -the merged institution- operating. Section 5 compares both regions according to aggregate excellence. Finally, Section 6 concludes. Cumbersome proofs are relegated to the Appendix.

2 The Model

In this section we describe the behavior of the agents comprised in the higher education market: universities and faculty candidates. First we assume that the universities's aim is to maximize their prestige or excellence. In addition we consider that universities are non-profit organizations. Observe that the term "non-profit" here means they are allowed to make profits but that there is no outsider to whom the firm can legally distribute those profits as a normal firm does to their owners.[6]

[6] Among the different aspects of interest the industry of Higher Education offers to those who perform economic analysis, the university objective function is undeniably important not only in the mind of both faculty members and college students (as consumers of educational services) but also for policy makers. The pursuit of excellence is widely used as the universities' objetive (see, among others, James (1990) and Clotfelter (1999)). In addition, see Winston (1999) for a detailed analysis

To achieve their objective universities hire the most able faculty members, admit the brightest students and pursue the highest-quality academic and cultural environment. To sharpen the analysis we consider that the excellence of university i, E_i, depends positively on two factors. First, excellence depends on human capital H_i, which is captured by the quality-weighted number of faculty members, i.e., $H_i = n_i x_i$, where $x_i \in [0, 1]$ denotes the admission standard or minimum productivity that university i requires to faculty candidates and n_i denotes the number of candidates hired. And second, excellence depends on physical capital, K_i that we assume depends on the expenditure on maintaining and improving the universities' facilities.[7] To further simplify, we propose the following objective function:[8]

$$E_i = H_i + \delta K_i, \tag{1}$$

where $\delta > 0$ measures the weight of the physical capital on excellence.

Financing is provided by some funding agency. In particular, the total funds that each university i receives come from two sources. The first one is related to the number of faculty members, $t_r n_i$, where t_r can be interpreted as the students/lecturer ratio, thus $t_r > 1$. Therefore, teaching funds are increasing in the number of candidates hired (or reversibly, increasing in the total number of students for some fixed number of faculty members).[9] In addition, universities obtain extra funds through research grants. We denote by G the total grant available to the funding agency to finance research that will be allocated competitively among universities operating in the market. Thus, each university i gets a proportion p_i of G.

of the university objetive function.

[7] It may include to offer small class size, enhancing extracurricular activities, tuition discounts and other financial aid considerations to students. It may also include research facilities: labs, research assistants, sabbatical, etc.

[8] Assuming perfect substitutability between human and physical capital could be perceived as a restrictive assumption. Thus, in this sense solutions of the university's optimization problem below must be interpreted as extreme ones. Nevertheless we think that even by modelling in this way this analysis can provide interesting insights.

[9] We consider here that t_r is fixed or, equivalently, the number of admitted students adjusts (ex. through rationing) to hold t_r fixed. Observe that we abstract from analysing students' behavior here and instead, we are implicitly assuming that by hiring the best lecturers and providing the best campus facilities, universities can attract more students and this fact allows them to select the best students (Winston (1999) and Epple, Romano and Sieg (2007) use a similar argument in their models).

Finally, we assume that setting any admission standard is costly. We also assume that universities differ in their cost of acquiring quality, that is, different universities have different reputations for the quality of the services they provide. This means that seeking for faculty candidates and research funds is less costly for a university with a higher reputation level. In particular, the total cost of setting an admission standard x_i is $\alpha_i x_i$, where $\alpha_i \in (0,1)$ is the cost of acquiring one extra unit of quality.[10] To sum up, the total amount of resources R_i, that each university i can get is:

$$R_i = t_r n_i + p_i G - \alpha_i x_i, \tag{2}$$

We assume there is a continuum of faculty candidates that differ according to their productivity, θ. For convenience we assume that candidates are uniformly distributed in the interval [0,1]. Only those candidates with productivity above x_i (the admission standard set by university i) are offered a position at university i. Note that we do not exclude the possibility that universities become so selective that they do not hire any new candidate ($x_i = 1$). In other words, they can decide whether or not to expand along the next period. We also assume here that candidates' utility is increasing with salaries. The candidates' salary scheme is equal to $t_s + x_i$. That is, each candidate receives a minimum wage equal to t_s plus some variable amount which depends on the university quality or admission standard. The key idea is that the willingness to accept a position is positively related to the quality of the university.[11] Thus, the total salary bill paid by university i, S_i, is equal to $(t_s + x_i)n_i$. Finally, we denote by t the fixed component of the university's net profit per candidate hired, i.e. $t = t_r - t_s$.

Finally, each university spends its resources R_i on paying salaries S_i, and maintaining facilities K_i. Thus, university i budget constraint is:

$$K_i + S_i = R_i. \tag{3}$$

[10] This initial reputation differential is best understood as resulting from established quality inherited from the past. As Graves et al. (1982) point out, universities' reputation serves several related functions. Faculty candidates can use such reputation as a proxy for the quality of the research/teaching environment at particular universities. For students, such reputation is suggestive of the faculty skills and knowledge. Finally, reputation serves as a signal of trustworthiness to the funding agency.

[11] This assumption on salary scheme is commoly accepted in related literature (see, for example, Del Rey and Wauthy (2007)). Graves et al. (1982) find that departments that have a high number of published works per faculty member are departments that pay higher salaries. In addition, the best research teams are more likely to be given research contracts.

Universities set their admission standard x_i by solving the following maximization problem:[12]

$$\begin{aligned} \underset{\{x_i\}}{Max} \quad & E_i = H_i + \delta K_i \\ s.t. \quad & K_i + S_i = R_i. \end{aligned} \tag{UP}$$

In what follows, α_i the cost of acquiring one extra unit of quality is assumed to be low enough such that the maximum excellence level will not be achieved for $x_i^* = 0$. Otherwise, corner solutions would arise with universities providing no quality at all or hiring the whole population of faculty candidates (even those with the least productivity levels). In order to rule out this possibility we establish the following assumption.

Assumption 1(A.1): $\alpha_i < G - t$.

Now we consider two regions with different higher education market structures. In one of them, called M, universities are induced to merge. In the other one, called C, there are two universities competing for resources. We compute the Nash-equilibrium for this particular university market structure. We analyze here the interplay between this asymmetric geographic regulation and university behavior. We simplify matters by considering the limit case where transportation costs approach infinity.[13]

2.1 Region C: two competing universities

In region C there are two universities, labeled 1 and 2. We analyze a game where both universities simultaneously choose their admission standard, x_1 and x_2, taking the admission standard of the competitor as given.[14]

First, the research grant is shared as follows. The proportion of total research grant that university i can get, $p_i(x_i, x_j)$ (for $i = 1, 2$) depends on the relative admission standard set by both universities. This reward structure can be interpreted

[12] The behavior of a non-profit firm must respect the fact that its total cost cannot exceed its total revenues, so the firm may appear to be profit-motivated in its attempts to raise revenue, when its behavior is driven by a budget constrained situation (see Winston (1999) for a detailed discussion).

[13] Thus faculty candidates only work at the universities in their regions (either one of the competing or the merged university). By doing so we focus on the comparison of aggregate excellence in the competing versus the merged regulation setting.

[14] We think this approach is more appropriate than considering sequential decisions as our focus is on universities' behavior while operating in the higher education market rather than on universities' decision on whether or not entering into the higher education market.

as a particular tournament where there is a rank-order payment scheme.[15] Thus, we assume that universities always receive a proportion of the award G as long as they set a positive admission standard. Note that, the funding agency always fully allocates G except for the case when both universities choose the lowest admission standard. If this is the case, no award is provided. Thus, $p_i(x_i, x_j)$ is as follows:

$$p_i(x_i, x_j) = \begin{cases} \dfrac{x_i}{x_i + x_j} & if \quad x_i + x_j > 0 \\ 0 & if \quad x_i + x_j = 0. \end{cases} \tag{4}$$

Given the salary scheme, a faculty candidate when being admitted to both universities, chooses to work at the one with the highest admission standard as there she gets the highest salary. Thus, the partition of candidates between both universities is:

$$n_i(x_i, x_j) = \begin{cases} x_j - x_i & if \quad x_i < x_j \\ \frac{1-x_i}{2} & if \quad x_i = x_j \\ 1 - x_i & if \quad x_i > x_j. \end{cases} \tag{5}$$

Hence, the university i maximization problem is:

$$\begin{array}{lccc} \underset{\{x_i\}}{Max} & E_i(x_i, x_j) = H_i(x_i, x_j) + \delta K_i & & \\ s.t. & K_i + S_i & = & R_i(x_i, x_j). \end{array} \tag{6}$$

Now we proceed to analyze the optimal admission decision of both universities. Each university solves the maximization problem described in (6) where $n_i(x_i, x_j)$ is given by Equation (5). We start by analyzing the case where university 1 and 2 differ in their reputation cost. In particular, we consider that university 1 is more reputable than university 2, that is, $\alpha_1 < \alpha_2$. Observe that we do not consider here the case where one or the two universities get out of the market. That would be the case if their equilibrium excellence value were non-positive. However, this will never happen as each university will always receive some funds (that is, $E_i(x_i = 0, x_j) = \delta t n_i > 0$ or $E_i(x_i = 1, x_j) = \delta(p_i G - \alpha_i)$).

Let first x_i^* denote the equilibrium admission standard set by university i. We show that, regardless of the amount of the research grant and the cost of acquiring quality

[15] Tournaments are extensively used as allocation mechanisms, see Lazear and Rosen (1981). Indeed, Gautier and Wauthy (2007) find that the optimal allocation of resources among departments should be based on the relative performance of their research projects. However, in contrast with the usual tournament set up, in our model there is no uncertainty with respect to the admission standard chosen by the university.

for the universities, there is no symmetric equilibrium in which both universities admit, at least, some candidates but not all of them, i.e., there is no equilibrium where $x_i^* = x_j^* = x$ and $x \in (0,1)$. Suppose that there is an equilibrium in which $x_i = x_j = x$. If $x_j = x > 0$, then from Equations (6) and (5) the excellence function of university i is as follows:[16]

$$E_i(x_i, x) = \begin{cases} (x_i(1+\delta)+t)(x-x_i) + \delta(\left(\frac{x_i}{x_i+x}\right) G - \alpha_i x_i) & if \quad x_i < x \\ (x(1+\delta)+t)\left(\frac{1-x}{2}\right) + \delta(\frac{G}{2} - \alpha_i x) & if \quad x_i = x \\ (x_i(1+\delta)+t)(1-x_i) + \delta(\left(\frac{x_i}{x_i+x}\right) G - \alpha_i x_i) & if \quad x_i > x. \end{cases} \tag{7}$$

It is clear that evaluating $E_i(x_i, x)$ at $x_i = x$ we get:

$$\delta(\frac{G}{2} - \alpha_i x) < (x(1+\delta)+t)\left(\frac{1-x}{2}\right) + \delta(\frac{G}{2} - \alpha_i x) < (x(1+\delta)+t)(1-x) + \delta(\frac{G}{2} - \alpha_i x). \tag{8}$$

Then, (x, x) can never be an equilibrium as a small deviation to the right always increases the excellence of university i. Now, if $x_j = 0$ then from (A.1) it is clear that the best reply of university i is to set some $x_i > 0$.

The following proposition characterizes the optimal admission standard set by both universities in equilibrium. To obtain tractable analytical solutions we impose here $\delta = 1$. We need to set a minimum value for the amount of the research grant to guarantee equilibrium existence. If G is above this value then university 1, the most reputable university, is has incentives to set an admission standard high enough to dissuade university 2, the least reputable university, from setting an admission standard just above its own standard, i.e., $x_2 = x_1 + \varepsilon$. Instead, university 2 sets an admission standard below x_1. By doing so, university 2 is not competing with university 1 for hiring the best faculty candidates but hiring the highest amount of them.

Assumption 2 (A.2): $G > \underline{\underline{G}}(\alpha_1, \alpha_2, t) = \frac{(\alpha_1+\alpha_2+2t)^2 2t}{(\alpha_2+t)2t+(\alpha_1-\alpha_2)^2}$.

Observe that if $t = 0$ then there is always an equilibrium for any $G > 0$. In this case, the teaching funds received by universities, $t_r n_i$ just cover the minimum wage paid to the candidates hired $t_s n_i$. Thus, setting a low admission standard to hire more faculty candidates is not anymore the right strategy to maximize excellence.

[16] Notice that, as we mentioned above, the university objective function can be alternatively understood as maximizing "income or rents", i.e., its revenue.

As a result, any amount of resources guarantees that the most reputable university is setting an admission standard higher or equal to the least reputable university.[17]

Proposition 1 shows that the most reputable university always sets the highest admission standard. We find that there is an upper bound for the research grant G above which both universities set an admission standard equal to one. We denote this value by $\overline{G}$ which stands for $\overline{G} = 4(\alpha_2 + t)$. We also find that there is a lower bound for the research grant such that below that value both universities set an admission standard below one. We denote it by $\underline{G}$ which stands for $\underline{G} = \frac{(\alpha_1+\alpha_2+2t)^2}{\alpha_2+t}$.

Proposition 1 *Let $\alpha_1 < \alpha_2$ and $\delta = 1$. The equilibrium admission standards (x_1^*, x_2^*) depend on the total research grant:*

(i) If $G < \underline{G}$ then $x_2^* < x_1^* < 1$.

(ii) If $G \in (\underline{G}, \overline{G})$ then $x_2^* < x_1^* = 1$.

(iii) If $G > \overline{G}$ then $x_2^* = x_1^* = 1$.

Proof. See the Appendix. ■

Proposition 1 shows that, as expected, the equilibrium admission standard set by each university is increasing in the amount of the research grant, G. We do not ignore that the assumption $\delta = 1$ may lead to extreme solutions. Thus, in that sense we should interpret the results as magnified tendencies. Nevertheless we think that the qualitative results would not dramatically change. Figures 1 and 5 in the Appendix illustrate the results in Proposition 1. Figure 1 below depicts the excellence function of both universities, for some (equilibrium) value of the admission standard set by the other university. Figure 5 depicts the best reply functions of both universities in the three possible scenarios.

Here Figure 1 (Excellence and equilibrium admission standards)

Remark 1 below shows how both universities share the total research resources in equilibrium. It provides us with several insights about the design of a competitive research system based on relative quality.

Remark 1 *The research grant is shared as follows:*

(i) $p_1(G) \geq p_2(G)$ for any G,

(ii)$p_1(G)$ is decreasing with G, whereas $p_2(G)$ is increasing with G.

[17] If (A.2) does not hold we would just need to impose additional conditions on α_1 and α_2 to ensure the existence of the equilibrium. However, under these additional conditions no new equilibria emerge. Thus, we discard them and propose this assumption in order to avoid unnecesary complexity.

Proof. From Proposition 1 and Equation (4) we get that if $G < \underline{G}$, $p_1 = \frac{\alpha_2+t}{\alpha_1+\alpha_2+2t} > p_2 = \frac{\alpha_1+t}{\alpha_1+\alpha_2+2t}$. If $G \in (\underline{G}, \overline{G})$ then $p_1 = \sqrt{\frac{\alpha_2+t}{G}} > 1 - \sqrt{\frac{\alpha_2+t}{G}} = p_2$. Finally, if $G > \overline{G}$ then $p_1 = p_2 = 1/2$. (ii) Hence, it is easy to check that regarding p_1 we have that $1/2 < \sqrt{\frac{\alpha_2+t}{G}} < \frac{\alpha_2+t}{\alpha_1+\alpha_2+2t}$. Regarding p_2 we have that $1/2 > 1 - \sqrt{\frac{\alpha_2+t}{G}} > \frac{\alpha_1+t}{\alpha_1+\alpha_2+2t}$. ■

First, the proportion of resources received by the less reputable university can not be higher than the proportion received by the most reputable one. Furthermore, the lower the amount of research funds, the higher the difference in the proportion of resources received by each university. Second, we find that raising the level of funding allocated by merit-based competition increases the excellence of the least reputable university. The reasoning behind this result could be that whenever the amount of funds associated with winning the research tournament is small (i.e., lower than $\underline{G}$ here) university 2 may find that raising teaching funds (by setting a low x_2 and thus increasing its size) is an easier way to increase excellence than hiring the most promising and qualified faculty candidates. As research funds increase, then university 2 changes its strategic choice due to the fact that now research quality effort is better rewarded and thus it is motivated to make strategic choices that improve its performance in terms of quality. This result is in line with Aghion et al. (2009). Although in a different context, they find that if research funding depends more on their performance, they make strategic choices that improve the percentage that they get from grants for which they must compete.

Finally, notice that the proportion of research funds received by the most reputable university, that is, the university with the lower cost of acquiring quality decreases as the total amount devoted to research funding increases. The idea behind this result is the following: if the amount of research funds is small, university 1 takes advantage of having the lower cost of acquiring quality. This implies that this university is better rewarded in terms of research without making the effort to attract top faculty candidates. As the research funds increase, university 1 is motivated to choose the highest admission standard in order to achieve the maximum level of excellence. However, as admission standards are constrained to be lower or equal to one, when university 1 reaches that limit it is not possible it to increase research funds. It can not longer take advantage of its reputation to reinforce prestige. In particular, if the amount of research funds is very high (namely, higher than the upper bound $\overline{G}$) observe that there is only room for university 2 to increase its excellence level by capturing more research funds. At this point, the amount of research funds at stake is so high that offsets the difference in the cost of acquiring quality to choose the admission standard. Figure 2 shows the proportion of research funds received by both universities as a function of the total amount of research grant.

Here Figure 2 (Universities' research funds sharing)

We consider in turn each possible equilibrium configuration, where we distinguish three alternative scenarios depending on the amount of funds devoted to finance research. We denote by E_i^* the excellence level achieved by university i at equilibrium, i.e., $E_i^* = E_i(x_i^*, x_j^*)$ for $E_i(x_i, x_j)$ in Equation (7) and $\delta = 1$. Table 1 reports the excellence values in the three possible scenarios.

Table 1: The excellence in equilibrium

	E_1^*	E_2^*
$G > \overline{G}$	$\frac{G}{2} - \alpha_1$	$\frac{G}{2} - \alpha_2$
$G \in (\underline{G}, \overline{G})$	$\sqrt{(\alpha_2 + t)G} - \alpha_1$	$G + \alpha_2 - 2(\sqrt{(\alpha_2 + t)G} - t$
$G < \underline{G}$	$t + \left(\dfrac{\alpha_2 + t}{\alpha_1 + \alpha_2 + 2t}\right)^2 G$	$\dfrac{(\alpha_2 + 2t)(\alpha_1 + t)}{(\alpha_1 + \alpha_2 + 2t)^2} G$

From Table 1 we can also conclude that the excellence level achieved in equilibrium is higher for university 1 (the most reputable) than for university 2 regardless of the amount devoted to finance research. That is, $E_1^* > E_2^*$ for any G. First, if the research grant is such that $G < \underline{G}$, that is, they are scarce, university 1 does not need to set the highest admission standard. Only by setting a higher admission standard than its competitor, university 1 can maximize excellence. This is so because as the research is poorly rewarded, it is better for university 2 to choose to expand its size in order to maximize prestige. Even if the research grant is not that low, university 1 sets a higher admission standard than university 2. In this case, the excellence value of university 1 remains higher than that of university 2. In particular, if $G \in (\underline{G}, \overline{G})$ university 1 needs to set the highest admission standard to reach the highest excellence level. The idea behind this result is that the amount of the research grant is high enough to incentive university 2 to find profitable, in terms of research reward, increasing quality. Thus, this university does not need to set the admission standard to the most to maximize excellence. As such, university 1 best choice is to set $x_1^* = 1$ in order to get the higher proportion of the research put into competition to maximize prestige. Finally, if the research grant is sufficiently high, i.e., $G > \overline{G}$, then this induces an increase in competition among universities in such a way that admission standards are increased to the utmost. As a consequence, the research grant G is equally split between the two universities no matter the cost of acquiring quality. In this case, it is straightforward to see that university 1 achieves a higher excellence level as it benefits from its advantage in reputation. Nevertheless, an inefficiency in allocating research funds may emerge as long as differences in cost are sufficiently large. We will discuss this issue in the next section.

Next, we consider the case where both universities are symmetric, that is, they face the same cost of acquiring quality. Region C in this case might represent regions with a system where is possible to find universities nearby offering very similar degrees and with similar reputations. The Spanish and French university systems are good examples here.[18] The following proposition summarizes the equilibrium result when both universities face the same cost of acquiring quality.

Proposition 2 *Let* $\alpha_1 = \alpha_2 = \alpha$ *and* $\delta = 1$. *Then there is a unique equilibrium where* $x_1^* = x_2^* = 1$ *for* $G \geq \overline{G}$.

Proof. See the Appendix. ■

That is, if both universities face the same cost of acquiring quality α, then there is a unique and symmetric equilibrium, i.e., $x_1^* = x_2^* = 1$ only if $G \geq \overline{G}$. The reason is the reward scheme designed by the funding agency. Note that universities, while competing for research funds, just have one device to get the maximum amount of the research grant -and hence maximizing excellence-. This is its quality or admission standard. In other words, each university can only take advantage by setting a higher admission standard than its competitor. In this setting, universities fully devote their efforts to attract as many faculty candidates as possible unless the research is highly rewarded. Hence the unique equilibrium emerge when the amount devoted to finance research is very high, that is, if $G \geq \overline{G}$. Observe that then, the excellence value of both universities in equilibrium coincide:

$$E_1^* = E_2^* = \frac{G}{2} - \alpha. \tag{9}$$

[18] We should mention here that in both European countries are being implemented similar reforms although the practical implementation of these changes varies greatly from country to country.

2.2 Region M: two merged universities

Consider now region M where there is just one university. This university can also be interpreted as the salient one after a process of aggregation of two (or more) universities with joint proposals.[19] Alternatively, this university can be thought as it is endowed with some form of market power. This could represent some university with a substantial market share or a leadership position, or a dominant network of public universities.

Next we analyze this university's optimal decision. Let x_m denote the admission standard set by university M. Note that, the number of candidates hired by this university is equal to $n_m(x_m) = 1 - x_m$. We assume here that this university can get a proportion of the total research grant G equal to its admission standard. That is, we assume that $p_m(x_m) = x_m$.[20] It is easy to check that under (A.1) the university A's excellence function, E_m, is concave on x_m. Hence, university M optimal admission standard is $x_m^* = \frac{(1-\delta)+\delta(G-\alpha_m-t)}{2(1-\delta)}$. Note that this optimal admission standard is decreasing in the cost of acquiring quality α_m and increasing in the weight of facilities on excellence, δ. That is, the higher the weight of facilities on excellence the lower the number of candidates hired but the higher its quality. The equilibrium excellence achieved by university M is:

$$E_m = t + (G - \alpha_m - t)\left(\frac{(1-\delta) + \delta(G - \alpha_m - t)^2}{2(1-\delta)}\right). \tag{10}$$

It can be checked from above that the excellence achieved by the merged university is increasing in the weight of facilities on excellence, δ and decreasing in α_m, that is, the higher the cost of acquiring quality, the lower the level of excellence achieved. Finally observe from (A.1) that if $\delta = 1$ then $x_m^* = 1$ and $E_m^* = G - \alpha_m$.

3 Competition versus merge

In the following section we compare aggregate excellence in both regions where there are competing universities (region C) and merged ones (region M). In the sequel we

[19] Good illustrations of this case might be the recent cases of Germany, France and Spain commented above.

[20] Observe that even though it may happen that the total amount of resources G might not be fully allocated (i.e., $x_m \in (0,1)$), in the equilibrium, as we will see below, the funding agency always fully allocates G. Thus, as we will see in Section 3 the amount of research resources spent in the "merged" and the "competing" markets coincide. Therefore, in this sense, the scheme payment where $p_m = 1$ coincide with the one above.

assume that $\delta = 1$. We denote by E_c the equilibrium aggregate excellence achieved in the competing region:

$$E_c = E_1^* + E_2^*, \tag{11}$$

where E_1^* and E_2^* are defined as in Table 1. Next, we introduce a situation that may characterize the competing region. At the competing region the two universities are characterized by a cost of acquiring quality, α_1 and α_2. Let denote the average cost of acquiring quality in region C by α_c. Now, when comparing the cost of acquiring quality in region C and region M it might happen that $\alpha_m = \alpha_c$. We call this phenomenon *synergy neutral* universities. As we show below, the role of potential synergy gains ($\alpha_c > \alpha_m$) is important to compare the aggregate excellence in the competing and the merged regions. We also comment on how the results might change as α_c varies. In particular we will consider the extreme cases where the merger creates zero synergy gains, that is, $\alpha_m = \alpha_2$ and where the merger fully exploits the potential synergy gains, that is, $\alpha_m = \alpha_1$. The former case represents a situation where the salient university after the merging process is perceived as a copy of the least reputable university among the mergers. On the contrary, the latter case captures a situation where the most reputable university leads the merging process and impose its reputation level to the salient university.

We start by analyzing the case where both universities operating in region C are symmetric, that is, they face the same cost of acquiring quality, $\alpha_1 = \alpha_2 = \alpha$. Thus, $\alpha_c = \alpha$. From Proposition 3 we have that an equilibrium exists if G is above $\overline{G}$. If it is the case then from Equation (9) it is immediate that $E_c = G - 2\alpha$. Therefore, from Equation (10) it can be checked that $E_m > E_c$ if $\alpha_m < 2\alpha_c$.

Observe that, in the region with the two universities competing for research funds, having a lower cost of acquiring quality than the merged university in the other region is a sufficient condition to achieve a higher aggregate excellence. In other words, whenever there are synergy gains among the competing institutions, then this process of association among established universities does result in a new institution with a higher aggregate excellence. This may simply be the result of exploiting the efficiency gains that arise by making a better use of joint resources and the elimination of duplication. See Figure 3:

This situation where both universities in region C are symmetric and question whether or not merging could be better for them than competing to improve their aggregate excellence. As they are symmetric this merging process can also be inter-

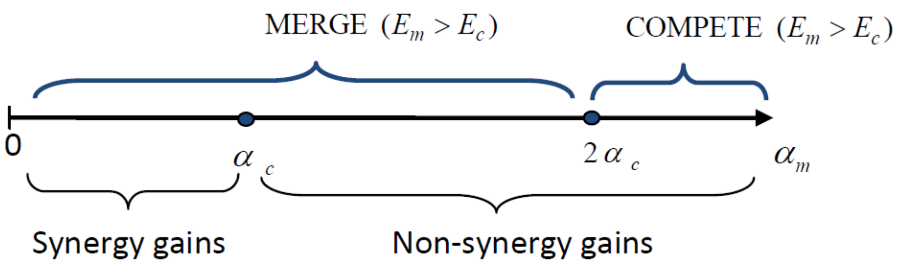

Figure 1: Symmetric universities: competition vs. merge

preted as a kind of reorganization procedure to improve their position in the higher education system hierarchy by raising the reputation of the new institution above the aggregate reputation of the previous single institutions. An illustration of this result might be the merging process by the University of Provence-Aix Marseille I, University of Mediterranean-Aix Marseille II and Paul Cezanne University-Aix Marseille III in France. Under the Excellence Program implemented in France, the three universities have merged under the name of University Aix-Marseille.[21]

Now we turn to analyze the case where both universities in the competing region face different reputation costs. We assume first that the universities are synergy neutral, $\alpha_m = \alpha_c$. Proposition 3 shows that whether or not the competing universities produce higher aggregate excellence than the merged institution depends both on the amount of research grants and the cost differential between them. We denote by $G^m(\alpha_1, \alpha_2, t)$ the threshold value for research resources above which merged universities produce higher aggregate excellence than competing ones. In addition we denote by α_2^m threshold value of the cost of acquiring quality for university 2 below which merged universities produce aggregate excellence than competing ones.

Proposition 3 *Let $\alpha_m = \alpha_c$ and $\delta = 1$. Then, the following conditions hold:*

(i) If $\alpha_2 > \alpha_2^m$ then $E_m > (<) E_c$ if and only if $G > G^m(\alpha_1, \alpha_2, t)$.

(ii) If $\alpha_2 < \alpha_2^m$ then $E_m > E_c$ regardless of G.

Proof. See the Appendix. ■

[21] These three universities had very similar positions in international rankings before the merging process (there were either very low ranked or did not appear at all among the first 500 universities, see Shanghai Ranking 2006).

Several comments can be made here. First, it can be check that $G^m(\alpha_1, \alpha_2, t)$ is decreasing in α_1 and increasing with α_2. As $\alpha_1 < \alpha_2$ this implies that the higher the differential cost between the two competing universities, the higher the amount of resources needed for the merged institution to produce higher aggregate excellence than the competing ones. In other words, if the differential cost between the competing universities is very high, unless the amount of research resources is very large, then aggregate excellence in the competing region is higher than in the merged one. Second, and as expected $G^m(\alpha_1, \alpha_2, t)$ is increasing with t. This means that the higher the university's net profit per candidate hired the higher the amount of resources needed for the merged university to produce higher aggregate excellence than the competing universities. Recall that the equilibrium excellence of the merged institution does not depend on t.

Figure 4 below illustrates Proposition 3. It represents combinations (α_2, α_1) giving rise to the same value of $G^m(\alpha_1, \alpha_2, t)$.

Here Figure 4 (Asymmetric universities: competition vs. merge)

4 Concluding Remarks

In this paper we analyze whether higher education providers, while pursuing maximum aggregate excellence, should foster competition by launching new universities or should encourage the existing ones to form associations. We compare aggregate excellence in these two different situations and focus on the role of the amount of research funds and the differential reputation cost among universities.

Our main result is that the higher the differential cost between the two competing universities, the higher the amount of resources needed for the merged institution to produce higher aggregate excellence than the competing one.

There are several extensions that can be considered here. The first one refers to study the role of the type of higher education institution, research versus teaching oriented, in the comparison between competing and merged universities. Second, it could also be analyzed the case where the public agency finances universities both inside and outside its own region. It could be interesting to check which would be the universities' optimal strategy in this situation: to compete or merge between them?

Finally we think that the results presented here are relevant to several recent debates in the literature on the university governance. In particular it is specially relevant for Europe where some governments are implementing policies, and creating incentives for joint proposals among different universities, with the aim of changing the position of their higher education institutions in the current international hierarchy. Our results therefore provide support for policies that promote greater competition among universities whenever research expenditures are sufficiently high. In addition our theoretical results yield two hypothesis to be tested empirically: the impact of the ex-ante reputation differences between universities and the amount of research resources in the succeed of some eventual merging process

5 Appendix

Proof. of Proposition 1: From Equations (6) to (5) we can check first that $E_i(x_i, x_j)$ is concave in each of the different intervals. In addition, from (A.1): $\lim_{x_i \to 0} \frac{\partial E_i}{\partial x_i} \mid_{x_i < x_j} > 0$. Note that $\lim_{x_i \to 1} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j} < 0$ if either $x_j < \widehat{x}_j(\alpha_i, G, t)$, where $\widehat{x}_j(\alpha_i, G, t)$ is such that $\frac{(1+\widehat{x}_j)^2}{\widehat{x}_j} = \frac{G}{\alpha_i + t}$, or $\frac{G}{4(\alpha_i+t)} < 1$. The sign of $\lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i < x_j}$ and $\lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j}$ also depends on the value of x_j. In particular, $\lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i < x_j} = \lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j} > 0$ if and only if $x_j < \frac{G}{4(\alpha_i+t)}$. Consider two cases: (a) $\frac{G}{4(\alpha_i+t)} < 1$ which implies that $\lim_{x_i \to 1} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j} < 0$. If $x_j < \frac{G}{4(\alpha_i+t)}$ then $\lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i < x_j} = \lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j} > 0$ and thus from Equations (4) to (6) the best reply of university i, $b_i(x_j) = -x_j + \sqrt{x_j \frac{G}{\alpha_i + t}}$ which is higher than x_j. If $x_j > \frac{G}{4(\alpha_i+t)}$ then $\lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i < x_j} = \lim_{x_i \to x_j} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j} < 0$ and thus, from Equations (4) to (6) we have that the best reply of university i depends on the value of x_j. In particular if $x_j < \widetilde{x}_j(\alpha_i, G, t)$, where $\widetilde{x}_j(\alpha_i, G, t)$ is such that $E_i(-\widetilde{x}_j + \sqrt{\widetilde{x}_j \frac{G}{\alpha_i + t}}, \widetilde{x}_j) \mid_{x_i < x_j} = \lim_{x_i \to \widetilde{x}_j} E_i(x_i, \widetilde{x}_j) \mid_{x_i > \widetilde{x}_j}$, then $b_i(x_j) = x_j + \epsilon$ and if $x_j > \widetilde{x}_j(\alpha_i, G, t)$ then $b_i(x_j) = -x_j + \sqrt{x_j \frac{G}{\alpha_i + t}}$ which now is lower than x_j. To sum up, if $\frac{G}{4(\alpha_i+t)} < 1$ then the best reply of university i is:

$$b_i(x_j) = \begin{cases} -x_j + \sqrt{x_j \frac{G}{(\alpha_i+t)}} & if \quad x_j < \frac{G}{4(\alpha_i+t)} \\ x_j + \epsilon & if \quad \frac{G}{4(\alpha_i+t)} \le x_j < \widetilde{x}_j(\alpha_i, G, t) \\ -x_j + \sqrt{x_j \frac{G}{(\alpha_i+t)}} & if \quad x_j \ge \widetilde{x}_j(\alpha_i, G, t). \end{cases} \tag{12}$$

(b) $\frac{G}{4(\alpha_i+t)} > 1$. If $x_j < \widehat{x}_j$ then $\lim_{x_i \to 1} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j} < 0$ thus from Equations (4) to (6) we have that the best reply of university i is $b_i(x_j) = -x_j + \sqrt{x_j \frac{G}{\alpha_i}}$ which is higher than x_j. If $x_j \ge \widehat{x}_j$ then $\lim_{x_i \to 1} \frac{\partial E_i}{\partial x_i} \mid_{x_i > x_j} \ge 0$ and thus from Equations (4) to (6) the best reply of university i, $b_i(x_j) = 1$. Thus, if $\frac{G}{4(\alpha_i+t)} > 1$ then the best reply of university i for any x_j is:

$$b_i(x_j) = \begin{cases} -x_j + \sqrt{x_j \frac{G}{(\alpha_i+t)}} & if \quad x_j < \widehat{x}_j(\alpha_i, G, t) \\ 1 & if \quad x_j \ge \widehat{x}_j(\alpha_i, G, t). \end{cases} \tag{13}$$

Figure 4 depicts the best reply functions of both universities in each possible scenario.

Here Figure 4 (Best reply functions and equilibrium)

Now, (i) Let $G < \underline{G}$ and now we can distinguish two cases: a) if $G > 4(\alpha_1 + t)$ then an equilibrium exists if the following two conditions holds: a.1) $b_2(x_1 = 1) < \widehat{x}_2$, which holds if and only if $G < \underline{G}$ and a.2) $\widetilde{x}_1(\alpha_2, G, t) < x_1^*$, which holds if and only if $G > \underline{\underline{G}}(\alpha_1, \alpha_2)$ and thus from A.2 this condition holds. b) if $G < 4(\alpha_1 + t)$ then an equilibrium exists if the following two conditions holds: b.1) $b_1(x_2 = \frac{G}{4(\alpha_1+t)}) > \widetilde{x}_1$ and b.2) $\widetilde{x}_1(\alpha_2, G, t) < x_1^*$. However, it can be checked that $b_1(x_2 = \frac{G}{4(\alpha_1+t)}) > x_1^*$ for any α_1, α_2 and G. Thus, b.2) is a sufficient condition to ensure the existence of equilibrium in this case. Thus, from A.2 then this equilibrium always exists. The equilibrium is $x_i^* = \dfrac{\alpha_j + t}{(\alpha_j + \alpha_i + 2t)^2}G$ for $i = 1, 2$.(ii) Let $G \in (\underline{G}, \overline{G})$ where $\underline{G} = \frac{(\alpha_1+\alpha_2+2t)^2}{\alpha_2+t}$. Then, from (13) for university 1 and (12) for university 2, we can check that an equilibrium will always exist if $b_2(x_1 = 1) > \widehat{x}_2$ which holds if and only if $G > \underline{G}$. This equilibrium is $x_1^* = 1$ and $x_2^* = -1 + \sqrt{\frac{G}{\alpha_2+t}}$. (iii) and finally, let $G > \overline{G}$ where $\overline{G} = 4(\alpha_2 + t)$. Then, from (13) for $i = 1, 2$ the unique equilibrium is $x_1^* = x_2^* = 1$. ■

Proof. of Proposition 2: Observe that if $\alpha_1 = \alpha_2 = \alpha$ then $\underline{G} = \overline{G} = 4(\alpha + t)$. Now, let $G < \underline{G}$ and then, from (12) for $i = 1, 2$ there is no equilibrium. Finally, let $G > \overline{G} = 4(\alpha + t)$. Then, from (13) for $i = 1, 2$ the unique equilibrium arises and consists of $x_1^* = x_2^* = 1$. ■

Proof. of Proposition 3: From Equation (10) we have that $E_m = G - \alpha_m$ for any G. Now let $\alpha_m = \alpha_c$ and $G^m(\alpha_1, \alpha_2, t) = \begin{cases} \frac{(\alpha_1+\alpha_2+2t)^3}{2(\alpha_2+t)(2\alpha_1+t)} & if \quad \alpha_2 \leq 3\alpha_1 \\ \frac{(\alpha_1-3\alpha_2-4t)^2}{4(\alpha_2+t)} & if \quad \alpha_2 \geq 3\alpha_1 \end{cases}$. (i) First let α_2^m be such that $\underline{\underline{G}}(\alpha_1, \alpha_2^m, t) = G^m(\alpha_1, \alpha_2^m, t)$ and let $\alpha_2 > \alpha_2^m$. Now we can distinguish the following two cases: (i.1) Let $\alpha_2 < 3\alpha_1$. If $G > \overline{G}$ then from Table 1 we have that $E_C = G - \alpha_1 - \alpha_2$ and thus it is clear that $E_m > E_c$ always hold. Now let $G \in (\underline{G}, \overline{G})$. From Table 1 we have that $E_c = G - \alpha_1 + \alpha_2 + 2t - \sqrt{(\alpha_2 + 2t)G}$. Then it can be checked that $E_m > E_c$ always hold. Finally let $G < \underline{G}$. Then, from Table 1 we have that $E_c = t + \frac{((\alpha_1+t)^2+(\alpha_2+t)^2+t(\alpha_2+t))}{(\alpha_1+\alpha_2+2t)^2}G$. It can be checked that $E_m > E_c$ if and only if $G > G^m(\alpha_1, \alpha_2, t)$. (i.2) Let $\alpha_2 > 3\alpha_1$. If $G > \overline{G}$ then from Table 1 we have that $E_C = G - \alpha_1 - \alpha_2$ and thus it is clear that $E_m > E_c$ always hold. Now let $G \in (\underline{G}, \overline{G})$. From Table 1 we have that $E_c = G - \alpha_1 + \alpha_2 + 2t - \sqrt{(\alpha_2 + 2t)G}$. Then it can be checked that $E_m > E_c$ if and only if $G > G^m(\alpha_1, \alpha_2, t)$. Finally let $G < \underline{G}$. Then, from Table 1 we have that $E_c = t + \frac{((\alpha_1+t)^2+(\alpha_2+t)^2+t(\alpha_2+t))}{(\alpha_1+\alpha_2+2t)^2}G$. It can be checked that $E_m < E_c$ always hold. (ii) Let $\alpha_2 < \alpha_2^m$. If $G > \overline{G}$ then, from Table 1 we have that $E_C = G - \alpha_1 - \alpha_2$ and thus it is clear that $E_m > E_c$ always hold. Now let $G \in (\underline{G}, \overline{G})$. From Table 1 we have that $E_c = G - \alpha_1 + \alpha_2 + 2t - \sqrt{(\alpha_2 + 2t)G}$. It can be checked that $E_m > E_c$ always hold in this case as $\alpha_2 < \alpha_2^m$. Finally, assume that $G < \underline{G}$. Then, from Table 1 we have that $E_c = t + \frac{((\alpha_1+t)^2+(\alpha_2+t)^2+t(\alpha_2+t))}{(\alpha_1+\alpha_2+2t)^2}G$.

Again it can be checked that $E_m > E_c$ always hold in this case as $\alpha_2 < \alpha_2^m$. ■

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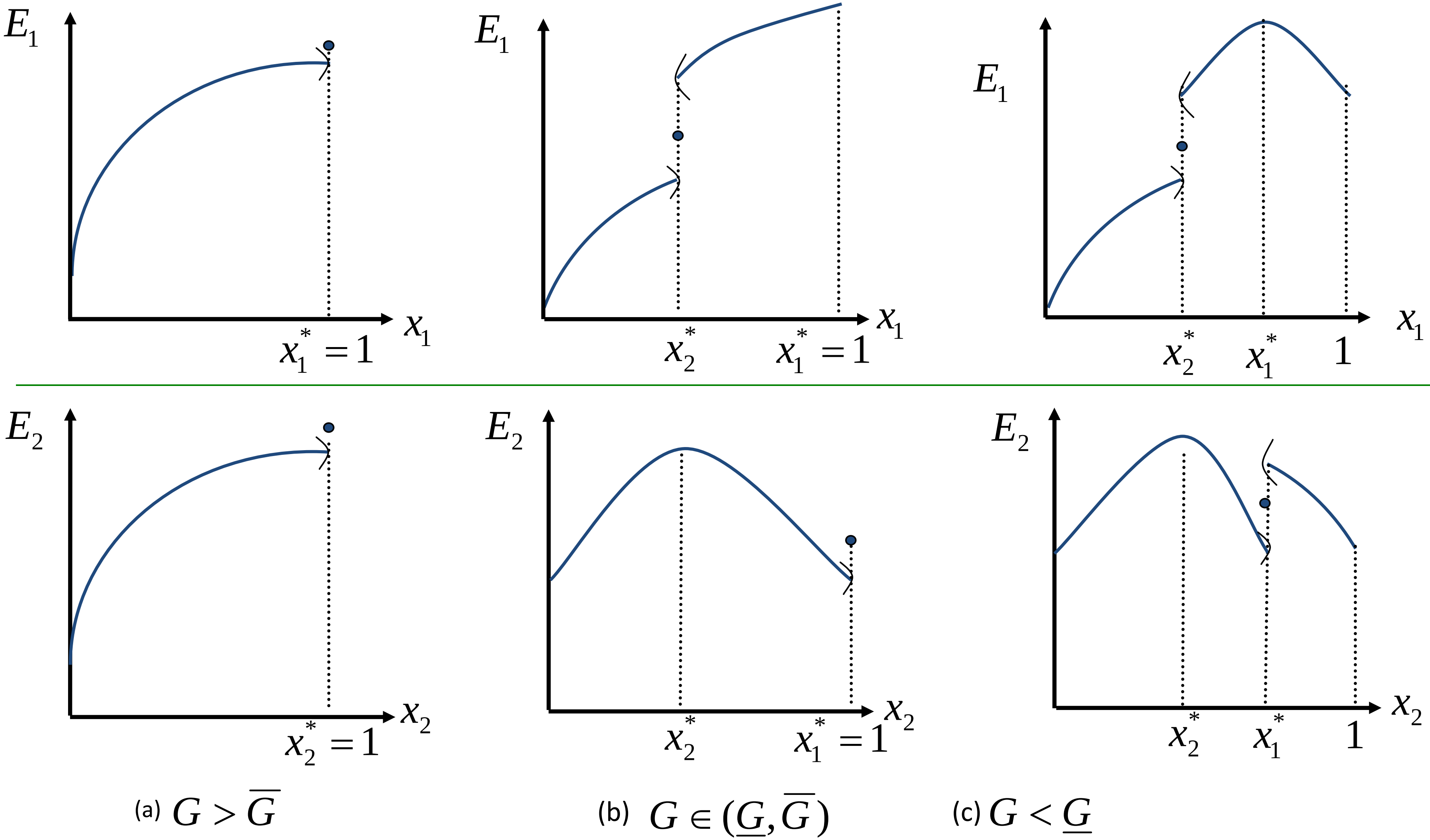


Figure 1: Excellence and optimal admission standards

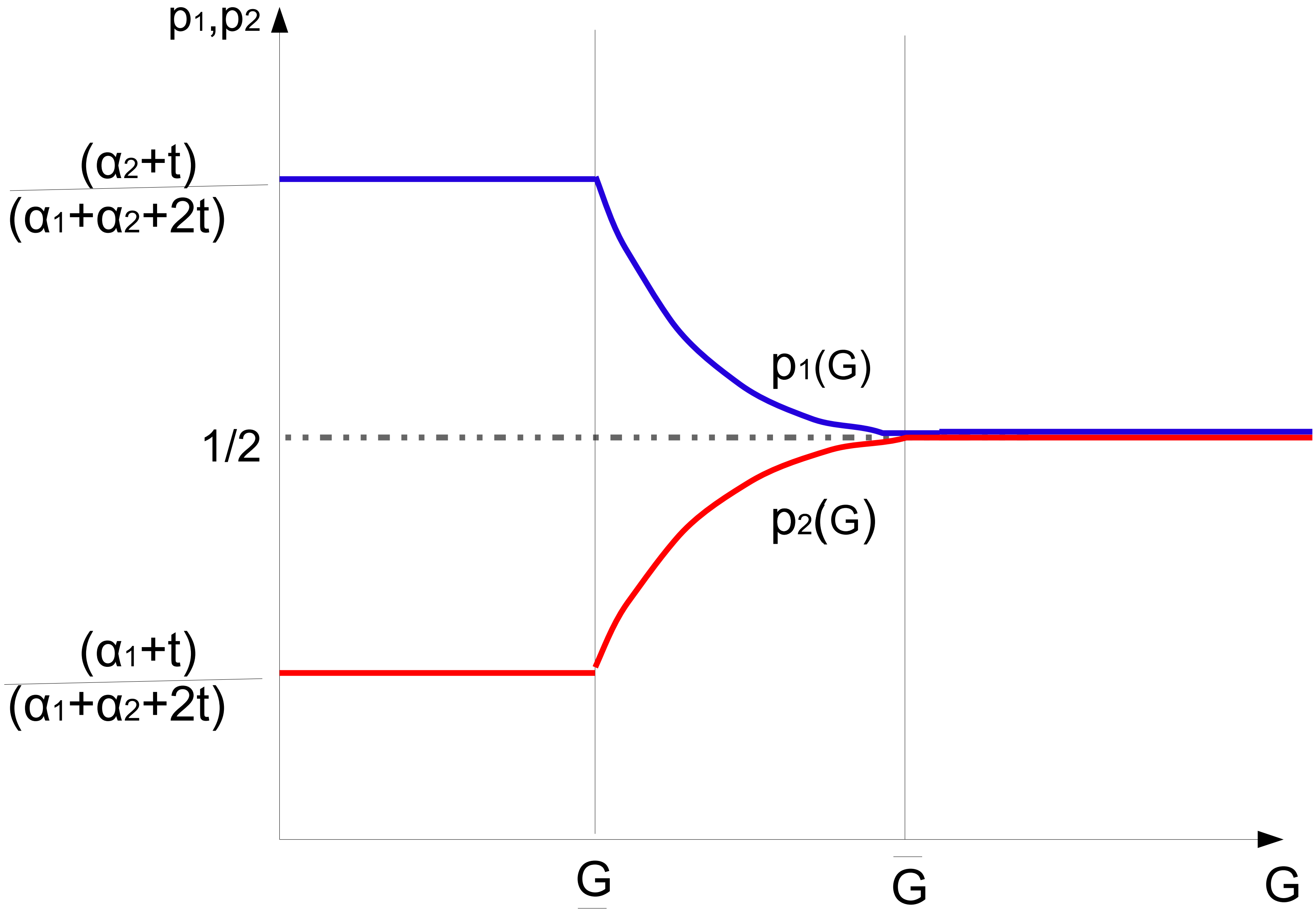
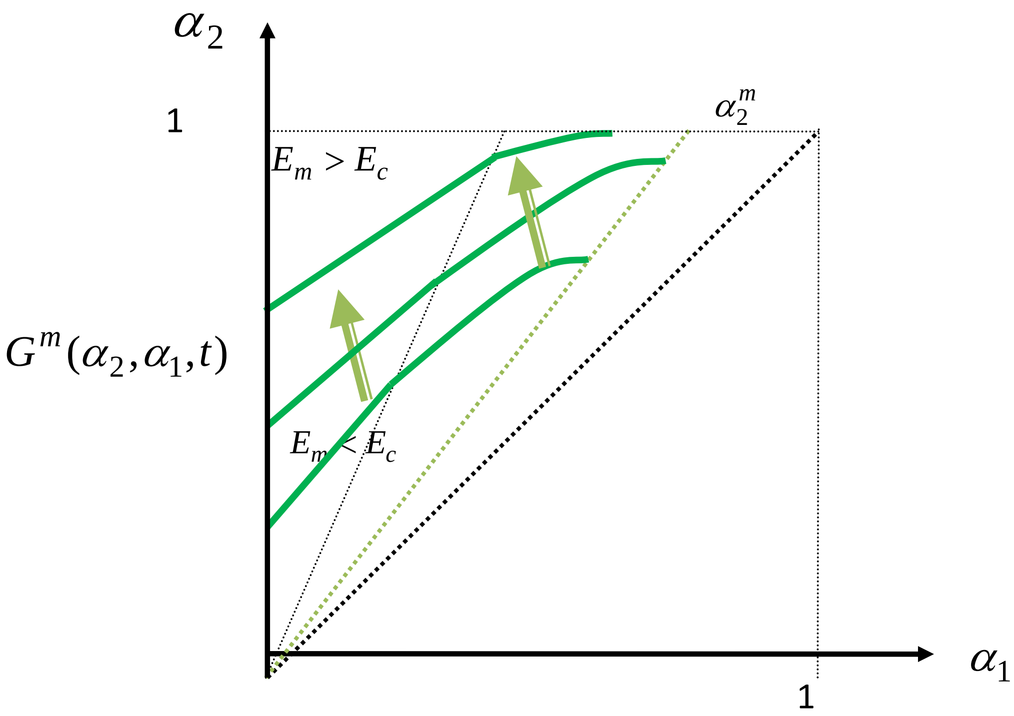


Figure 2: Universities´ proportion of resources



$$\alpha_m = \alpha_c$$

Figure 4: Competing versus merged

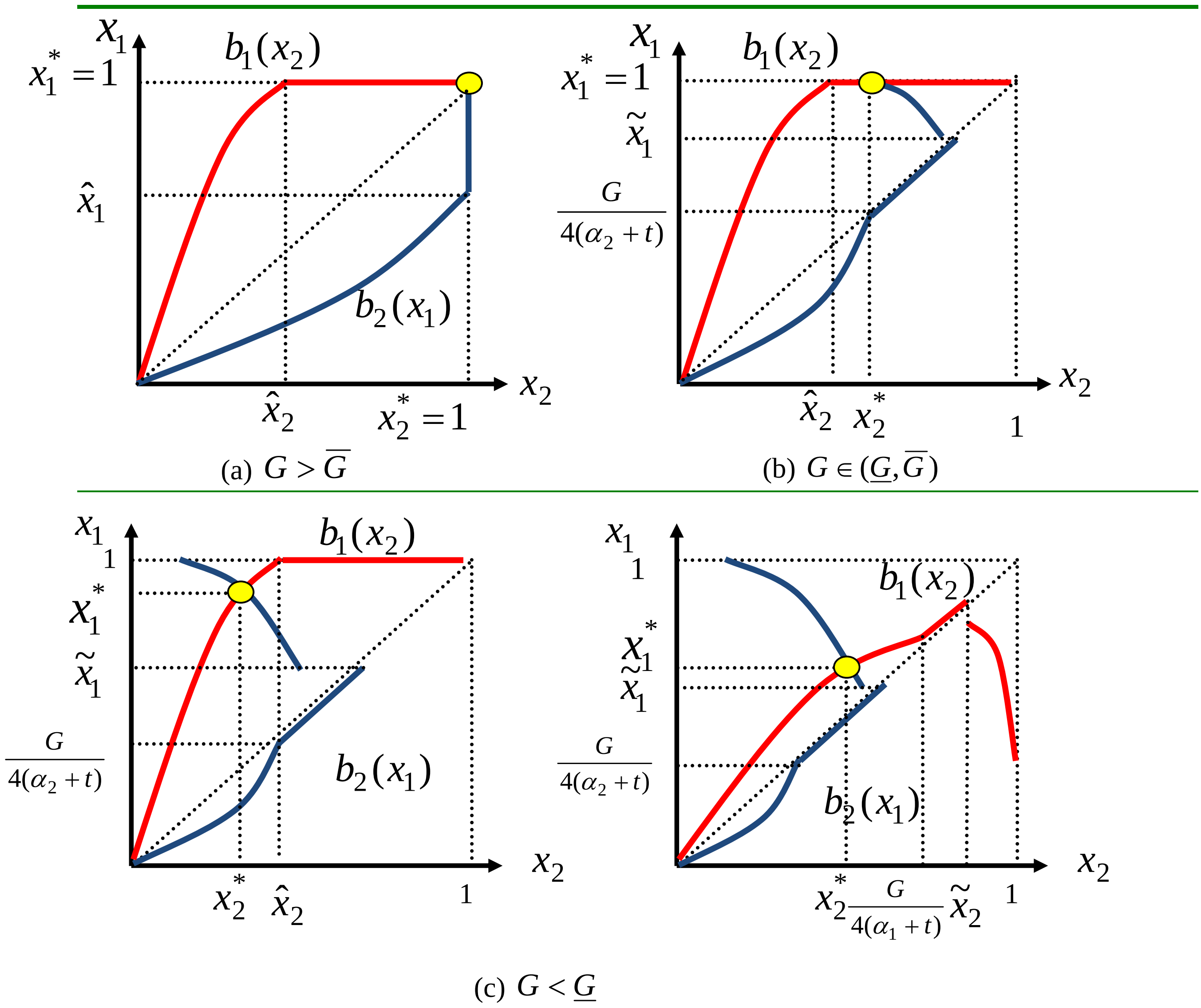


Figure 5: Best reply functions and equilibrium