Local University Supply and Distance: A Welfare Analysis with Centralized and Decentralized Tuition Fees

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Abstract We consider a two-city model in which two university systems may occur: a centralized system in which a social planner sets the tuition fee and a decentralized system in which universities are free to set their own fees. Within these two systems we also analyze two further scenarios, one with only one university and another with one university in each city. Individuals with heterogeneous innate ability decide whether to go to university according to the average ability (peer group effect henceforth), a tuition fee and mobility costs, if any. In the centralized system, the welfare is maximized by opening two free-of-fees universities, one in each city. This maximizes university participation and eliminates the impediment of mobility costs. In the decentralized system, whether a single-university or a two-university system is more welfare enhancing depends on the mobility costs. When mobility costs are sufficiently low, then having only one university is welfare maximizing. When, instead, mobility costs are high, two universities result to be welfare enhancing.

Keywords Peer group · Mobility cost · Tuition fees

JEL Classification L2 · L3

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1 Introduction

The welfare effect of a change in the number of universities has been widely investigated both theoretically and empirically. There exists strong empirical evidence of the necessity of widening higher education participation by means of an increasing number of universities.¹ Mobility costs and the peer group effect at university (as measured by the average ability of the students) have been found to be the main determinants of the individuals' sorting behavior and of the welfare effect resulting from a change in the number of universities.² Recently, Cesi and Paolini (2014) showed that the introduction of a new university induces a welfare improvement that is stronger when the university system is symmetric (that is, universities have the same average student ability).

As a matter of fact, mobility costs and the peer group effect are not the only determinants of individual behavior. Indeed, the choices of individuals and, consequently, the welfare implications of widening university participation through the change in the number of universities may crucially depend crucially on the tuition fees. Following Cesi and Paolini (2014) who use students' average ability as a proxy for the peer group effect, we study the welfare effect from introducing a new university in a system of endogenous tuition fees. We study two alternative systems. The main difference between the two is in the determination of the tuition fee. In a *centralized system*, a social planner determines the tuition fee that maximizes social welfare.³ In the *decentralized system*, each university sets its own tuition fee. In the decentralized system, the universities set the tuition fee that maximizes the total revenue from the collected fees: the optimal fee comes as result of a trade off between peer group and number of enrolments. Indeed, less able individuals refrain from enrolling in response to an increase of the fee. This will increase the peer group but it will result in a lower total number of students.

In the centralized system, we find that the welfare is maximized when the social planner sets zero fees. An increase of the fee, in fact, would have two different effects. Firstly, it will boost the average ability, as less able individuals abstain from enrolling. On the other hand, given that some individuals prefer to remain unskilled, university participation will be reduced. Consequently, we will have an ambiguous effect on the total amount of collected fees, since a higher per-student fee is paid by less individuals. We show that, passing from a positive to a zero fee, the welfare gains from more participation always offset the losses from lower peer group effect. Thus, the social planner maximizes welfare simply by maximizing university participation. A natural corollary of this result is that a two-university system induces a higher welfare

¹ See Cesi and Paolini (2014) for a recent survey.

² See, among others, Frenette (2004) for the role of mobility costs and Sacerdote (2001) for the peer group effects. Pignini and Staffolani (2015) offer a theoretical and empirical analysis of costs, geographical accessibility and quality of education with Italian data. Similar studies are provided by Gibbons and Vignoles (2012) and Drewe and Michael (2006) respectively on data from England and from ON (Canada).

³ Welfare is measured by the sum of students' utilities and the total amount of fees collected.

than a one-university system for any mobility cost.⁴ In other words, if a free-of-charge university is opened in each city and individuals do not pay a fee and save on the transportation cost, while enjoining the same average ability at the home university. This result is in line with the finding of [Cesi and Paolini \(2014\)](#) that widening participation through the introduction of a new university is welfare improving.

In the decentralized system, results become richer. With a one-university system, the optimal fee will be such that high-ability individuals from both cities go to university, provided that the mobility cost is sufficiently low. As the mobility cost gets higher, the monopolistic university can collect a higher amount of fee-revenue by setting a fee such that only local individuals (who face no mobility cost) find it convenient to go to university. In the duopoly case, each university attracts local individuals setting the fee that maximizes the fee-revenue. Which system between a two-university or a one-university decentralized system depends on the mobility cost. When the mobility cost is low, one university is socially desirable compared to the two-university system. This is because a monopolistic university sets a lower the fee in order to attract also non-local individuals, and this widens participation and increases both individuals welfare and total amount of fees collected. When, instead, the mobility cost gets higher, the monopolistic university only attracts local individuals, thus participation is higher (in our model double) in the two-university system.

Our results suggest that a centralized system with a free-of-charge university is preferred to the decentralized one, since when the choice of the fee is decentralized to universities, the latter maximize the total amount of fee without concerns on social welfare.

Our paper aims to contribute to the literature on students' sorting behavior at university ([Del Rey 2001](#); [De Fraja and Iossa 2002](#); [Del Rey and Wauthy 2006](#); [Gautier and Wauthy 2007](#); [Poyago-Theotoky and Tampieri 2014](#)). In particular, we study the role of peer group effect by integrating an endogenous tuition fee in [Cesi and Paolini \(2014\)](#). Unlike [Gautier and Wauthy \(2007\)](#), whose main focus is the study of the "tension between teaching and research", our focus is on the impact of the decentralization, the fees scheme and the peer group on students' choice and welfare.

The remainder of this paper is divided as follows. After having presented the main ingredients of the model in Sect. 2, we provide the analysis of the centralized system (Sect. 3) and of the decentralized system (Sect. 4). In Sect. 5, we present some final discussion and we draw the conclusions.

2 The model

We consider a spatial model of two cities indexed $j = A, B$, in which each city may host one university that "produces" graduates. In each city, individuals are uniformly and independently distributed according to their innate ability $\theta \in [0, 1]$, with the total population in each city normalized to 1. We model two systems according to whether the tuition fee f , paid by each student to attend university, is set by a social planner

⁴ We borrow the welfare analysis of [Cesi and Paolini \(2014\)](#), who show that, when the fee is zero, the introduction of a new university induces a welfare improvement.

or by each university.⁵ We define as *centralized* the system in which the fee is set by the social planner while we define *decentralized* the system in which each university sets its own fee. In the centralized system we assume that the social planner sets the fee equal across universities and across students. The utility of each individual born in city i attending university j is:⁶

$$U_i^j = \theta_i(1 + \bar{\theta}_j) - f, \quad (1)$$

where $\bar{\theta}_j$ measures the average ability at the university j that henceforth will also be called the peer group effect. The distance between universities (cities) is normalized to 1. A student located in i has no mobility cost of attending university i , but she faces a linear cost t if attending $j \neq i$.

When instead individual i does not attend university, she is defined as unskilled, u , and her utility is:

$$U_{i,u} = \theta_i. \quad (2)$$

3 Centralized System

In this section, we present a centralized system where the social planner decides the tuition fee charged to students enrolled at the university. We analyze two systems, one with only one university and the other with one university in each city. The two-university system may include two different cases, according to whether universities have the same (symmetric) or different (asymmetric) average ability. We will find the optimal fees in both situations.

The social planner sets the fee to maximizing social welfare, computed as the sum of individuals' utilities and the total amount of collected fees, as defined as it follows:

$$\begin{aligned} W = & \int_0^{\theta_-^A} U_{A,u} d\theta + \int_{\theta_-^A}^{\theta_+^A} U_A^A(\bar{\theta}^A) d\theta + \int_{\theta_+^A}^1 (U_A^B(\bar{\theta}^B) - t) d\theta \\ & + \int_0^{\theta_-^B} U_{B,u} d\theta + \int_{\theta_-^B}^{\theta_+^B} U_B^B(\bar{\theta}^B) d\theta + \int_{\theta_+^B}^1 (U_B^A(\bar{\theta}^A) - t) d\theta \\ & + \int_{\theta_+^A}^1 f d\theta + \int_{\theta_-^A}^{\theta_+^A} f d\theta + \int_{\theta_+^B}^1 f d\theta + \int_{\theta_-^B}^{\theta_+^B} f d\theta. \end{aligned} \quad (3)$$

The cutoff θ_-^j with $j \in \{A, B\}$ represents the lowest ability such that a student prefers the home university rather than remaining unskilled. The first line in Eq. (3) is the aggregate utility of individuals born in city A , the second one of B -born people and

⁵ In line with what we find in the paper, Jongbloed (2004, 2005) show how tuition fees charged by public universities are fixed or negligibly different in countries like Austria, Belgium, Denmark, Germany, Italy and Spain.

⁶ The model does not change if we introduce a family income that is heterogeneous among individuals. Being the tuition fee f fixed, it does not enter the individuals' sorting behavior. It is possible then to show that the model is robust to the introduction of an individual-specific income.

the third line represents the total amount of fees collected. Notice that in the symmetric case with no commuting we will have $\theta_+^A = \theta_+^B = 1$, whereas in the asymmetric case $\theta_+^A = 1 > \theta_+^B$, so that some of the integrals in Eq. (3) may disappear. In what follows we first find the optimal fee in each scenario, then we find which of these ensures the highest welfare.

One-University System. Let us assume only one university in city A and denote the average ability in university A by θ_M , it is easy to check that an individual living in A goes to the university if $U_A^A(\theta_M) \geq U_{A,u}$, that is, when her ability is sufficiently high, in particular $\theta \geq \frac{f}{\theta_M} = \theta_-^A$ and $\theta_+^A = 1$. Similarly, an individual living in B goes to university only if sufficient able so as to offset both the mobility costs and the tuition fees, i.e., she goes to university when her ability is such that $\theta \geq \frac{f+t}{\theta_M} = \theta_+^B$. Plugging these cutoffs into the welfare function we obtain:

$$\begin{aligned} W^M = & \int_0^{\frac{f}{\theta_M}} U_{A,u} d\theta + \int_0^{\frac{f+t}{\theta_M}} U_{B,u} d\theta + \int_{\frac{f}{\theta_M}}^1 U_A^A(\theta_M) d\theta \\ & + \int_{\frac{t+f}{\theta_M}}^1 (U_A^B(\theta_M) - t) d\theta + \int_{\frac{f}{\theta_M}}^1 f d\theta + \int_{\frac{t+f}{\theta_M}}^1 f d\theta. \end{aligned} \quad (4)$$

Before studying the welfare effect of a fee in such a scenario, firstly note that in the case of zero fee we have $\theta_-^A = 0$ and $\theta_+^A = t/\theta_M$, so that everybody goes to university A with only individuals from B facing the mobility cost, the welfare is:

$$W_0^M = \int_0^1 U_A^A(\theta_M) d\theta + \int_0^{t/\theta_M} U_{B,u} d\theta + \int_{t/\theta_M}^1 (U_B^A(\theta_M) - t) d\theta. \quad (5)$$

Making the difference between Eqs. (5) and (4) and after some simplifications it is easy to verify that $W_0^M - W^M = \frac{f^2}{\theta_M}$, letting us conclude that the no-fee solution is always preferred. We are then able to state the following Lemma:

Lemma 1 *The optimal fee in a centralized one-university system will be equal to zero.*

Two-University System. Let us assume now the scenario with one university in each city, university A and B respectively. The result in Cesi and Paolini (2014) also applies here and it is possible to check that there exist two different equilibria. The first one is symmetric, meaning that universities have the same average ability. In this case, no individual has incentives to switch city because of the mobility cost and then the only choice is between going to university and remaining unskilled in their own city. Welfare is then given by:

$$W^S = 2 \int_0^{\frac{f}{\theta_S}} U_{A,u} d\theta + 2 \int_{\frac{f}{\theta_S}}^1 U_A^A(\theta_S) d\theta + 2 \int_{\frac{f}{\theta_S}}^1 f d\theta \quad (6)$$

where θ_S is the average ability in both universities. Similarly to the one-university system, it is straightforward to verify that

$$W_0^S = 2 \int_0^1 U_A^A(\theta_M) d\theta + 2 \int_0^1 f d\theta > W^S \quad (7)$$

which let us conclude again that the zero fee solution induces a higher welfare.

We now consider the asymmetric equilibrium assuming $\bar{\theta}^A > \bar{\theta}^B$ wlog. In other words some individuals living in B prefer to enrol at the university A . With $t > 0$ the welfare is then:

$$\begin{aligned} W^A = & \int_0^{\frac{f}{\bar{\theta}^A}} U_{A,u} d\theta + \int_0^{\frac{f}{\bar{\theta}^B}} U_{B,u} d\theta + \int_{\frac{f}{\bar{\theta}^B}}^{\frac{t}{\bar{\theta}^A - \bar{\theta}^B}} U_B^B(\bar{\theta}^B) d\theta \\ & + \int_{\frac{t}{\bar{\theta}^A - \bar{\theta}^B}}^1 \left(U_B^A(\bar{\theta}^A) - t \right) d\theta + \int_{\frac{f}{\bar{\theta}^A}}^1 U_A^A(\bar{\theta}^A) d\theta + \int_{\frac{f}{\bar{\theta}^B}}^1 f d\theta + \int_{\frac{f}{\bar{\theta}^A}}^1 f d\theta. \end{aligned} \quad (8)$$

It is easy to see that the welfare with zero fee is:

$$\begin{aligned} W_0^A = & \int_0^{\frac{t}{\bar{\theta}^A - \bar{\theta}^B}} U_B^B(\bar{\theta}^B) d\theta + \int_{\frac{t}{\bar{\theta}^A - \bar{\theta}^B}}^1 \left(U_B^A(\bar{\theta}^A) - t \right) d\theta \\ & + \int_0^1 U_A^A(\bar{\theta}^A) d\theta + 2 \int_0^1 f d\theta. \end{aligned} \quad (9)$$

Again, simple algebra shows that $W_0^A > W^A$, thus we can conclude the following:

Lemma 2 *The optimal fee in a centralized two-university system will be equal to zero.*

Lemmas 1 and 2 state that when university cannot set their own tuition fee that, in turns, are set to maximize the sum of the individuals' utilities and the aggregate fee-revenue, a zero fee solution is always preferred. This result holds for both systems, with one and two universities. The intuition is the following. Let us assume to start from a zero fee. An increase in the tuition fee will have many different effects. On the one hand, since the lowest-ability individuals refrain from going to the university, the peer-group effect gets augmented at the benefit of enrolling individuals. On the other hand, it also unambiguously reduces the utility of the unskilled individuals that prefer not to pay an enrolment fee. Finally, even if the peer group effect gets stronger, the net utility of students is not always higher than in the case of a zero fee, as the increase in the peer group might be offset by the presence of the fee. Overall, it turns out that the negative effects on welfare are stronger than the gain that a positive fee would generate in terms of more aggregate fees and higher human capital.

Once having determined that the optimal fee would be zero both in a one and in a two-university system, we are able to state which is the most efficient number of universities thanks to Cesi and Paolini (2014). Indeed, they show that the two-university system is always welfare improving in comparison with one university when the fee is zero. This allows us to conclude the following:

Proposition 1 *In a centralized system, a two-university system induces a higher welfare than a monopolistic university.*

Proof We recall the results provided by Cesi and Paolini (2014), who showed how $W_0^S > W_0^A > W_0^M$ in the case of zero fees. $\square$

The main result behind Proposition 1 is that the highest possible welfare is obtained by maximizing participation. In a centralized system, the social planner has two instruments to enforce university participation, that are the tuition fees and the number of universities.

Setting fees equal to zero allows all individuals to get skilled. Clearly, the fee equal to zero is consistent with our hypothesis of zero cost of introducing a new university. Assuming positive university costs would have two effects. First, it would increase the optimal fee in both systems, the monopolistic and duopolistic university. Second, it might also change the welfare ranking between monopoly and duopoly. We would expect that monopoly would dominate for low mobility costs whereas duopoly does for high mobility costs.

A two-university system induces a reduction of the negative effects mobility costs have on the students' enrolment at the university. Mobility costs will be *de facto* completely offset in a symmetric two-university system. In such a scenario, all individuals go to the home university, so that participation is maximal and mobility costs do not play any role.

4 Decentralized System

In this section, we present a decentralized system where the tuition fee is set by the universities. As in the previous section we find the optimal fee in both scenarios of only one and two universities. We conclude the section by showing which scenario induces the highest welfare.

4.1 Decentralized One-University System

We maintain the assumption of one university located in the city A . In this scenario, each student can only choose between going to the university and being unskilled. The individuals who decide to attend university must pay the fee f and face the mobility cost t , if any. For individuals living in A , the only cost of university is given by the fee, whereas individuals living in B face both the fee and mobility costs. Once mobility costs have been faced and fees are paid, individuals can move freely between cities, so that the peer group effect is endogenous.

4.1.1 Individuals: Sorting Behavior

Let us define the peer group at the monopolistic university as θ_M . An individual with ability θ living in city A will go to the university if her ability offsets the payment of the fee, i.e. $\theta \geq \frac{f}{\theta_M}$. Hence, the average ability of individuals from city A who attends university is given by:

$$\theta_A^m = \frac{\int_{\frac{f}{\theta_M}}^1 \theta d\theta}{\int_{\frac{f}{\theta_M}}^1 d\theta} = \frac{f + \theta_M}{2\theta_M}. \quad (10)$$

Following the same argument, a student living in city B has ability such that $\theta \geq \frac{t+f}{\theta_M}$, so that the average ability of individuals born in city B who goes to university is:

$$\theta_B^m = \frac{\int_{\frac{f+t}{\theta_M}}^1 \theta d\theta}{\int_{\frac{f+t}{\theta_M}}^1 d\theta} = \frac{f + t + \theta_M}{2\theta_M}. \quad (11)$$

Computing the weighted average of θ_A^m and θ_B^m as determined in (10) and (11), θ_M is given by the following:

$$\theta_M = \frac{(1 - \frac{f}{\theta_M})\theta_A^m + (1 - \frac{f+t}{\theta_M})\theta_B^m}{(1 - \frac{f}{\theta_M}) + (1 - \frac{f+t}{\theta_M})} = \frac{2f^2 + 2ft - 2\theta_M^2 + t^2}{4f\theta_M - 4\theta_M^2 + 2\theta_M t}$$

Solving with respect to f gives:

$$f(\theta_M) = 2\theta_M^2 - t - \sqrt{4\theta_M^4 - 8\theta_M^3 + 4\theta_M^2 - t^2}. \quad (12)$$

Notice that $f(\theta_M)$ has to be non-negative, $f(\theta_M) + t < \theta_M$ and $\theta_M > 1/2$.⁷ For presentation purposes, these conditions are summarized in the following lemma:

Lemma 3 *For the fee to be positive, it is needed either (i) $\theta_M < 2 - \sqrt{2}$ and (i.1) $t \in [0, \theta_M^2 - \sqrt{\Delta}]$, or (i.2) $t \in (\theta_M^2 + \sqrt{\Delta}, \sqrt{3\theta_M^2 - 4\theta_M^3})$, where $\Delta \equiv \theta_M^4 - 4\theta_M^3 + 2\theta_M^2$, or (ii) $\theta_M \in (2 - \sqrt{2}, 3/4)$ and $t < \sqrt{3\theta_M^2 - 4\theta_M^3}$.*

The conditions stated in Lemma 3 are depicted in Fig. 1. Figure 1 has to be interpreted looking from low to high levels of θ_M . First, θ_M is never lower than $1/2$, which is the average ability that would result with neither mobility costs nor tuition fees. Moreover, θ_M must be sufficiently high, otherwise nobody is willing to pay a positive fee. Nevertheless, $f(\theta_M)$ is an increasing function in the region between the red and the blue curve, so that once θ_M reaches the level described by the blue curve, the fee turns out to be not worth it to be paid by agents that live in B , i.e., $\theta_M < t + f$.

4.2 University

In the decentralized system, the university sets the fee that maximizes the total fees collected. We will study the two possible scenarios according to whether university sets its own fee to attract only local or also non local individuals.

⁷ For the sake of completeness, there exists another solution, $f_2(\theta_M) = 2\theta_M^2 - t + \sqrt{4\theta_M^4 - 8\theta_M^3 + 4\theta_M^2 - t^2}$, that never satisfies the conditions.

Attracting local and non-local. Let us define the total fees collected by the university as TF_{L-N} with:

$$TF_{L-N} = \int_{\frac{f}{\theta_M}}^1 f d\theta + \int_{\frac{f+t}{\theta_M}}^1 f d\theta. \quad (13)$$

The two integrals represent the fees collected from individuals living in A and coming from B respectively. If the university attracts both local and non-local, it maximizes TF with respect to f subject to the constraint described in Eq. (12). The following Lemma gives the solution.

Lemma 4 *The optimal fee when attracting local and non-local students is:*

$$f_M^* = 12 - 8\sqrt{2} - t - \sqrt{-t^2 - 96\sqrt{2} + 136}. \quad (14)$$

Proof The maximization problem is:

$$\max_f TF = \int_{\frac{f}{\theta_M}}^1 f d\theta + \int_{\frac{f+t}{\theta_M}}^1 f d\theta. \quad (15)$$

After substituting for (12) the maximization problem (15) becomes:

$$\max_{\theta_M} \frac{(t - 2\theta_M) \left(t - 2\theta_M^2 + \sqrt{4(\theta_M - 1)^2 \theta_M^2 - t^2} \right)}{\theta_M}. \quad (16)$$

For any t , the function $f(\theta_M)$ in (12) is increasing in θ_M , so that we find a corner solution. According to Lemma 3, any θ_M higher than $2 - \sqrt{2}$ will lead to a situation where nobody can be attracted from city B , as the university has incentive to increase θ_M (and thus the fee f) up to the point where the blue curve in Fig. 1.⁸ Hence, the optimal θ_M^* will lie in the interval $[\frac{1}{2}, 2 - \sqrt{2}]$ and, given the monotonicity, this allows us to conclude that $\theta_M^* = 2 - \sqrt{2}$. Plugging this result into the function $f(\theta_M)$, we get (14). $\square$

Notice that f_M^* is decreasing in t , takes positive values and satisfies Lemma 3 only if $t < 6 - 4\sqrt{2}$, as depicted in Fig. 2.

Intuitively, once the university has incentives to induce the enrolment of some non-local individuals, it has to reduce the fee in order to make it worth for them to face the mobility cost. Once the mobility cost becomes sufficiently high, attracting non-locals becomes too costly in terms of fee reduction.

Attracting only local. Now, let us assume that the university attracts only local student. In such a case, the peer group is simply given by the θ_A^m in Eq. (10), that solved with respect to θ_A^m gives:

⁸ Clearly this is not optimal: we will solve the maximization problem where the university serves only local below.

Fig. 1 Decentralized one-university system: mobility cost and average ability compatible with mobility of individuals living in B

Fig. 2 Decentralized one-university system: optimal fee with mobility of individuals living in B

$$\theta_A^m = \frac{1}{4}(1 + \sqrt{1 + 8f}) \quad (17)$$

Now the total fee is simply:

$$TF_L = \int_{\frac{f}{\theta_A^m}}^1 f d\theta \quad (18)$$

That as above is maximized with respect to f . Notice that, for this to be an equilibrium, it is needed that nobody from city B is willing to enrol at university A paying the fee f_A^{m*} , i.e. $t + f_A^{m*} > \theta_A^m(f_A^{m*})$. Therefore, the optimal fee in the monopoly case will be given in the following Lemma.

Lemma 5 *In a decentralized one-university system:*

1. If $t < 6 - 4\sqrt{2}$, the optimal fee will be $f_M^* = 12 - 8\sqrt{2} - t - \sqrt{-t^2 - 96\sqrt{2} + 136}$ and able individuals from both cities go to university.
2. If $t \geq 6 - 4\sqrt{2}$, the optimal fee will be $f_A^{m*} = \frac{1+\sqrt{3}}{6}$ and only able individuals in A go to university.

Proof The maximization of TF_L with respect to f has an internal solution at $f_A^{m*} = \frac{1+\sqrt{3}}{6}$. The resulting average ability will be $\theta_A^{m*} = \frac{1}{2} + \frac{\sqrt{3}}{6}$. In order to have $t + f_A^{m*} > \theta_A^m(f_A^{m*})$, we need the mobility cost to be sufficiently high ($t > 1/3$).

Thus, when $t < 1/3$, only the equilibrium in point 1 is viable. Oppositely, when $t \geq 6 - 4\sqrt{2}$, only the equilibrium in point two is reachable. When $t \in [1/3, 6 - 4\sqrt{2}]$:

$$\begin{aligned} & \int_{\frac{f_M^*}{\theta_M}}^1 f_M^* d\theta + \int_{\frac{t+f_M^*}{\theta_M}}^1 f_M^* d\theta \\ &= \frac{1+\sqrt{2}}{\sqrt{2}} \left(\sqrt{136 - t^2 - 96\sqrt{2}} + 7\sqrt{2} - 10 \right) > \frac{1}{3\sqrt{3}} \\ &= \int_{\frac{f_A^{m*}}{\theta_A^{m*}}}^1 f_A^{m*} d\theta. \quad \square \end{aligned}$$

Lemma 5 shows how the optimal fee depends on the mobility costs. When mobility costs are relatively low, then the fee will be a decreasing function of the mobility cost because, as the latter increases, the university has to charge a lower fee to attract individuals from B (point 1 in Lemma 5). Once the mobility cost reaches a certain level, then the optimal fee will be such that only locals go to university. In this case, since none from city B goes to university, mobility costs do not play any role in the determination of the optimal fee (point 2).

4.3 Decentralized Two-University System

We now consider the case of one city in each university. We will focus only on symmetric equilibria where universities have the same average ability. The extant literature has shown how when mobility costs are sufficiently low an asymmetric university system may arise, in particular characterized by a top (high average ability) and a bottom (low average ability) university coexisting, with the top one attracting the ablest students. In what follows we borrow the result from [Cesi and Paolini \(2014\)](#), that is, only symmetric equilibria are strong Nash. Although we do not directly deal with the concept of strong Nash equilibria we only consider symmetric equilibria to ease the tractability of the results.

Let us assume university j with peer group θ^j to set a fee f^j .

Lemma 6 *In a decentralized two-university system, the optimal fee will be equal to $f_A^{m*} = \frac{1+\sqrt{3}}{6}$ and the ablest individuals in each city join the home university.*

Proof Assuming $\theta^A = \theta^B = \tilde{\theta}$, all agents in city $j \in \{A, B\}$ go to university if their ability is $\theta \geq \frac{f^j}{\theta^j}$, thus the average ability in both universities is

$$\theta^j = \frac{1}{4} \left(1 + \sqrt{1 + 8f^j} \right) \quad (19)$$

It turns out that universities act as local monopolies and they maximize the amount of fees collected simply by setting $f^{j*} = f^{j*} = f_A^{m*} = \frac{1+\sqrt{3}}{6}$. $\square$

The important point of Lemma 6 is that the optimal fee chosen by two symmetric universities will be the same as the one that would be chosen by a monopolistic university that serves only local. In fact, in both cases universities behave as local monopolies, maximizing the total amount of fee they can collect on local. After comparing the welfare in the two cases of monopolistic and duopolistic university system, we can state the main result for the decentralized scenario in the following proposition.

Proposition 2 *In a decentralized system: (i) if $t \leq 6 - 4\sqrt{2}$ one-university system induces a higher welfare than a two-university system, (ii) if $t > 6 - 4\sqrt{2}$ a two-university system induces a higher welfare than a one-university system.*

Proof If $t > 6 - 4\sqrt{2}$, the two alternative systems are a two-university system and a one-university system that serves only local individuals. Since the fee will be the same in both regimes, a two-university system will always give a higher welfare as it doubles participation. If $t \leq 6 - 4\sqrt{2}$, the one-university system gives the result of Lemma 14, that gives always a higher welfare than the two university system. Indeed:

$$\begin{aligned} W^d(f_A^{m*}) &= 2 \int_0^{\frac{f_A^{m*}}{\theta_A^{m*}}} U_{A,u} d\theta + 2 \int_{\frac{f_A^{m*}}{\theta_A^{m*}}}^1 U_A^A(\theta_A^{m*}) d\theta \\ &+ 2 \int_{\frac{f_A^{m*}}{\theta_A^{m*}}}^1 f d\theta = \frac{1}{9} (12 + \sqrt{3}) \end{aligned} \quad (20)$$

$$\begin{aligned} W_M(f_M^*) &= \int_0^{\frac{f_M^*}{\theta_M^*}} U_{A,u} d\theta + \int_0^{\frac{f_M^*+t}{\theta_M^*}} U_{B,u} d\theta + \int_{\frac{f_M^*}{\theta_M^*}}^1 U_A^A(\theta_M^*) d\theta \\ &+ \int_{\frac{t+f_M^*}{\theta_M^*}}^1 (U_B^A(\theta_M^*) - t) d\theta + \int_{\frac{f_M^*}{\theta_M^*}}^1 f d\theta + \int_{\frac{t+f_M^*}{\theta_M^*}}^1 f d\theta \end{aligned}$$

$$\begin{aligned}
&= \frac{t(4\gamma - t + 30\sqrt{2} - 44) + 32\sqrt{2}\gamma - 48\gamma - 566\sqrt{2} + 800}{2(\sqrt{2} - 2)} \\
&< \frac{1}{9}(12 + \sqrt{3})
\end{aligned} \tag{21}$$

where $\gamma = \sqrt{136 - t^2 - 96\sqrt{2}}$. $\square$

In the equilibrium described in Lemma (6), universities behave as local monopolists therefore they will set a fee that is the same as in the one-university system when the university attracts only locals (i.e., when t is high). Clearly, the two-university system is always welfare improving, since some people enrol in both cities rather than in only one. When, instead, the mobility cost is sufficiently low, a one-university system results in a wider university participation and a higher welfare because it charges a fee lower than the one in the two-university system. The main reason is that a monopolistic university finds it more profitable to attract non-local individuals by charging a low fee able to offset their mobility costs.

5 Conclusion

This paper contributes to the literature on the effect of peer group ability on the university choice when individuals pay a tuition fee and face a mobility cost in a two-city model. We study two different tuition fee schemes according to whether universities are free to charge their own fees. In a centralized system, in which tuition fee are set by a social planner, a two-university system induces a higher welfare than a one-university system. The main driver of the welfare improvement is university participation, achieved by both instruments of a zero tuition fee and one more local university.

In a decentralized system, in which universities are free to charge their own tuition fees, whether a one or two-university system induces a higher welfare depends on mobility costs. By focusing on symmetric equilibria (universities have the same average ability), we find that if mobility costs are sufficiently high, then a two-university system is preferred as it maximizes participation and completely offsets the effect of the mobility costs. In particular, the high-ability individuals in both cities go to the home university and none face mobility costs. When mobility costs are low, instead, a one-university system is preferred because it charges a lower fee to attract also non-local students. This has positive effects on university participation and university education achievement. Because of the symmetry each university behaves as a local monopolist in the two-university system, thus somehow reducing the level of welfare desirability of the two-university system compared to the one-university system.

In our model, universities act as local monopolies in the decentralized system. If universities were allowed to compete more fiercely, i.e., letting each of them poach ablest individuals from the other city, then the decentralized two-university system may induce competing universities to charge lower fees. If this was the case, we would expect the two-university system to be welfare enhancing compared to the one-

university scenario even for small mobility costs. In the limit case of no mobility costs, for example, duopolistic universities would compete *à la Bertrand*, thus resulting in a higher participation.

Nonetheless, there are additional welfare arguments in favor of a one-university decentralized system when mobility costs are sufficiently small. The present model assumes zero cost of introducing a new university. Assuming positive costs of university supply, which would be faced by the universities themselves in a decentralized regime, would have two effects. First, the optimal fees would adjust upwards in order to cover this cost. Second, it would change the welfare ranking between opting for a one-university and two-university system since one university rather than two would clearly avoid a cost duplication.

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