

Public funding of Higher Education: who gains, who loses?

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Abstract

This paper analyses the effects of public funding of higher education on individuals' welfare taking into account the hierarchical nature of the educational system and the fact that parents may complement basic public education with private tutoring. Although public funding financed by a proportional income tax increases the access to higher education, some of the agents who gain access lose in welfare terms. Moreover, it is shown that the marginal agent to access university would always prefer a pure private funding system in which she would not attend higher education but would also not pay tuitions or taxes.

Keywords: educational finance, welfare, higher education

JEL Classifications: I22 and I28

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1 Introduction

In 2013, public expenditure on higher education was 0.9% of GDP in Colombia, 1.2% in Ghana and 1.9% in Ethiopia (World Bank 2016). For OECD countries, the average value for public expenditure on higher education as a percentage of GDP was in 2013, 1.1%, with a minimum of 0.6% for Japan and a maximum of 1.9% for Estonia (OECD 2016). However, since the initial contribution of Hansen and Weisbrod (1969), a consensus was built in the economic literature that public funding of higher education implies a redistribution of income from poor to rich people, or at least from the ends (both poor and rich) to the middle.¹ This is mainly a consequence of the fact that students from high income families are more likely to attend higher education. On average, for OECD countries, higher education participation rates are fourfold higher for a young person with at least one parent who has a tertiary degree than for a young person whose parents have not attended secondary education. Thus, the large amounts governments all around the world spend on higher education seem to imply a regressive redistribution.

This paper aims to study the effects of the public funding of higher education on the individual welfare of the different agents, focusing on those agents whose decision of sending or not their child to the University depends on higher education funding policy.² To this end, I compare different levels of higher education subsidies taking into account the hierarchical nature of the educational system and also the fact that parents have the possibility to complement public education with private expenditures in individual tutoring. This possibility seems to be relevant in many countries. According to the PISA 2009 dataset, the percentage of 15 years old students who have out-of-school lessons is, for the case of Mathematics, 70% for Brazil, 86% for Tunisia, and 48% for the average of OECD countries. I establish the characteristics of those agents whose welfare increases and those agents whose welfare decreases with the public funding of higher education when public funding is financed by income taxes that apply to the whole population.

Several authors have followed a Political Economy approach to study how the public funding of higher education may be the result of the political process. Important examples are Creedy and François (1990) and Fernández and Rogerson (1995) or, more recently, Zhang (2008) and Gioacchino and Sabani (2009). Here, instead, I follow Glomm and Ravikumar (2003) approach; I take policy as given and look at its implications.

Other authors have studied the impact of financial incentives on the access to higher education. Dynarski (2003) and Kane (2003), using data for the US, obtained that decreasing the direct cost of college increases higher education enrollment rates. More recently, Steiner and Wrohlich (2012), using data for Germany, also obtained that increasing financial student aid in higher education would have a positive impact on access. The model in this paper is consistent

¹Zhang (2008) studies the role of public education on income inequality taking this assumption has her point of departure. See also Barr (2004).

²To simplify the exposition I don't distinguish between higher education and University.

with these results but its main focus is the effect of this policy on the welfare of the different individuals.

Closer to the questions addressed in this paper, Caucutt and Kumar (2003) study the effects of increasing higher education subsidies on inequality, welfare and efficiency. They solve their model numerically for the US case and obtain that, when present, the aggregate welfare gain is minimal. They also calculate the welfare gain for the two types of agents present in their model: poor (school educated) and rich (college educated). In any of the policy alternatives studied the rich lose and the poor gain. This would indicate that subsidizing higher education benefits the poor, implying a progressive redistribution. However, this is an aggregate measure for the whole class of poor parents, obtained as an expected gain from the policy and without discriminating between those who send their child to college and those who don't. In this paper, I calculate the welfare gain for each of a continuum of different parents distinguishing between those who decide to send their child to the University and those who decide not to send. I focus exactly on those whose decision depends on the subsidy level. The simplicity of the model allows to obtain general analytical results.

I take into account the hierarchical nature of the educational system. This aspect is very important for the study of higher education as it implies that only those that attain a minimum level in basic education are able to go to the University.³ The access to higher education is always limited and the importance of early investments to attain the educational prerequisites required to access University has been emphasized in the literature (Carneiro and Heckman (2003), Cunha et al. 2006, Caucutt and Lochner (2012)). For Australia, Cardak and Ryan (2009) obtained that what explains the socio-economic gap in participation in higher education is the gap in finishing secondary education or, for those students that complete secondary education, the dependence of the secondary education final grade on students socio-economic background. The secondary education final grade determines if the student is eligible to attend University. These empirical findings motivate a crucial assumption of the model presented in this paper, that there is a threshold level of human capital that must be attained for students to be able to advance to higher education.

Related to this issue, there is a literature on the relevance of credit constraints and its impact on the access to higher education. Carneiro and Heckman (2002) obtained that, for the US, at most 8 percent of the relevant population were constrained on their college decision. More recent analysis by Belley and Lochner (2007) and Winter (2014) have shown that the impact of credit constraints on the admission to higher education in the US have probably increased in the last decades. In any case, these authors do not question the relevance of earlier investments for the access to higher education.

Section 2 presents the model, section 3 compares different funding systems in what refers to access to higher education. Section 4 looks at individuals'

³Judson (1998), Su (2004) and Blankenau (2005) consider the hierarchical nature of education to study the allocation of public funds across different levels of education. In this paper expenditures in basic education are taken as given and I analyze the welfare implications of public expenditure on higher education.

welfare. Section 5 considers an alternative funding system that approximates a higher education tax. Section 6 concludes.

2 The model

Each agent has one offspring whose education he decides taking into account her ability. Agents are heterogeneous in what refers to the level of human capital they receive from their parents and also to the ability with which they are born.

There are two levels of education: basic (B) and University (U). The access to basic education is universal (and free) but only those who attain a predefined threshold are able to advance to University. So, the model takes into account the hierarchical nature of the educational system (see for instance Su, 2004 and Judson, 1998). In what refers to higher education I consider three alternatives: pure private funding, pure public funding and a mixed system where part of the cost is privately supported.

The utility of agent i depends on own consumption and on the level of human capital of his offspring (h_{+1}^i).

$$u^i = \ln c^i + \rho \ln h_{+1}^i \quad , \quad \rho > 0 \quad (1)$$

This follows de la Croix and Doepke (2004) and is equivalent to Glomm and Ravikumar (1992). Each individual income is given by his level of human capital.⁴ All decisions are made by adults.

The accumulation of human capital depends on the parent's level of human capital and on the offspring's ability (z). I assume that ability is known at the moment the decision is taken of advancing or not to higher education. This is in line with de Fraja (2002), who considers that there is uncertainty on ability but the realization is known before higher education choices are made. After basic education, the level of human capital is given by:

$$h_{+1}^B = zh^\delta, \quad 0 < \delta < 1 \quad (2)$$

where I omitted the index i to simplify notation.⁵ The level of human capital of the offspring depends on the parent's level of human capital (see for instance, Carneiro and Heckman, 2003).

If this level of human capital is higher than a predefined threshold \hat{h} , then the agent may decide to send the offspring into University. Otherwise, the offspring does not fill the needed prerequisites to advance to University and h^B , given in (2), is the final level of human capital that she takes to the next period unless, as explained below, parents invest on private tutoring. The existence of a minimum threshold is an important assumption of the model. This is a characteristic that distinguishes higher education from basic education.

⁴See for instance Glomm and Ravikumar (1992, 2003) or de la Croix and Doepke (2004). In what refers to the utility function, including the human capital of the offspring is equivalent to assuming that parents value the wealth they pass to their children. On this, see footnote 2 in Glomm and Ravikumar (1992).

⁵Considering diminishing returns to ability would not change the results of the model.

If the offspring goes into University, then the level of human capital she will have as an adult is h^U , given by:

$$h_{+1}^U = \gamma z h^\delta = \gamma h_{+1}^B, \quad \gamma > 1 \quad (3)$$

γ is the productivity parameter in higher education. It is larger than one as higher education builds on the outcome of basic education.

Parents have also the possibility of complementing public basic education with private tutoring, e , in order for the offspring to attain the threshold level \hat{h} that determines the possibility of attending University. The level of human capital attained by combining basic education with private tutoring (h^e) is given by,

$$h_{+1}^e = (1 + \varepsilon e) z h^\delta = (1 + \varepsilon e) h_{+1}^B \quad (4)$$

where ε is a productivity parameter for private tutoring. As is the case with higher education, tutoring builds on the outcome of basic education.

The only role of tutoring is to allow the access to the University but it does not change the return to education once the student sits in University classes.⁶ Thus, when the agent incurs this expenditure he chooses the exact amount that allows the attainment of the threshold, $h^e = \hat{h}$. So, from (2) and (4), tutoring is given by:

$$e = \frac{\hat{h} - h_{+1}^B}{\varepsilon h_{+1}^B} = \frac{\hat{h} - z h^\delta}{\varepsilon z h^\delta} \quad (5)$$

According to (5) the cost of the necessary private tutoring decreases with the student ability and with the parent human capital.

Thus, after all the decisions related to education, the offspring's human capital will be,

$$h_{+1} = \begin{cases} h_{+1}^B = z h^\delta & \text{if the offspring does not go into University} \\ h_{+1}^U = \gamma z h^\delta & \text{if the offspring goes into University} \end{cases} \quad (6)$$

Note that choices about the level of education are discrete, a student may do only basic school or she may go on to University, but if going to University she graduates.⁷

To study the agents' choices I now look at the costs of higher education. The following sections consider pure public, pure private and mixed funding of higher education and compare the results in what refers to access and welfare.

⁶I could assume instead that tutoring always increase the child final human capital or, alternatively that tutoring increase the final human capital of all students who go into the University. In the first case everyone would invest in tutoring, the amount of investment increasing with h and z . In the second case the same would happen but only for those agents who send their children to the University. In both cases, the model qualitative results would not change as the important point is that there are always some agents who make an extra investment as a means to gain access to the University.

⁷Galor and Zeira (1993) have shown that the characteristic of indivisibility of human capital investment in the presence of credit market imperfections implies that the initial distribution of wealth affects aggregate output and investment in the short and the long run. In this paper there are implicit credit market imperfections as agents may only spend current income.

3 Funding and Access to higher education

I begin this section by characterizing separately the different funding systems, then I compare these systems in terms of the access to higher education.

3.1 Pure public funding

When there is pure public funding, higher education is free for private agents and is paid by the government with the revenues of a proportional income tax at rate τ . Thus, in this case the budget constraint of any given agent is:

$$c = (1 - \tau)(h - e) \tag{7}$$

where education expenditures are taken to be tax deductible.⁸ All the decisions are taken by parents. Students accumulate human capital according to parents' decisions. Parents maximize utility (1) subject to (7) and the education technology defined by (6), the threshold \hat{h} and the possibility of private tutoring as described by (5). Agents take τ as given.⁹

There are three types of solutions. In the first one, which I label U , the student is able to go to the University without the need of private tutoring. A second type of solution, which I label UT , happens when after basic education the student does not attain the threshold \hat{h} but the parent pays private tutoring in order for the student to advance to University. Finally, the last type of solution, which I label B , happens when the student does not go to the University, so her final level of human capital is the one that results from basic education.

The next table characterizes the three types of solutions, where the subscript G stands for a solution in the context of pure public funding.

Table 1: solutions with pure public funding of higher education

	U^G	UT^G	B^G
c	$(1 - \tau)h$	$(1 - \tau)(h - e)$	$(1 - \tau)h$
h_{+1}	$h_{+1}^U = \gamma h_{+1}^B$	$h_{+1}^U = \gamma h_{+1}^B$	$h_{+1}^B = zh^\delta$

Any parent may be characterized by a value for his income, h , and a value for his offspring ability, z . Thus, we may define in the space (h, z) regions where the corresponding agents have optimal solutions of types U , UT or B .

When possible, U is the best solution. In this case it is always optimal to send the student to the University, as there are no additional costs.¹⁰ So, if $h_{+1}^B \geq \hat{h}$, that is, if after basic education the minimum threshold \hat{h} is attained,

⁸Note that the agent is not able to use the returns to investment on education as these belong to the offspring. So, there are implicit credit market imperfections in the model.

⁹In equilibrium τ must be such that tax revenues are equal to expenditure on higher education. I will come back to this point below.

¹⁰There might be opportunity costs if the student could be working instead of studying. I do not consider these opportunity costs. Maintenance costs may be included in the tuition, as long as they are independent of income and ability.

then U is possible and is the optimal choice. From (2) this implies that an agent sends his offspring to the University without paying any private tutoring if:

$$z \geq \frac{\hat{h}}{h^\delta} \quad (8)$$

When U is not possible, which solution - UT or B - maximizes utility depends on the characteristics of the agent, namely income and student's ability. So, those agents who don't satisfy the above condition, choose to pay for private tutoring if utility for solution UT is higher than utility for solution B . Taking into account the utility function (1) and the values for consumption and human capital as described in Table 1, we obtain that:

$$u(UT^G) > u(B^G) \iff (h - e) / h > \gamma^{-\rho} \quad (9)$$

Substituting with the value of tutoring as determined in (5), we obtain that the agent pays private tutoring, $e > 0$, and sends the offspring to University if (8) is not verified and:

$$z > \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1}{\gamma^\rho} h + 1 \right]^{-1} \quad (10)$$

Below this line agents don't send their offspring to the University. As the second term in the right side of (10) is a positive number smaller than one, this curve is always below the curve defined in (8). Figure 1a) shows the regions that correspond to each type of solution.

Even if there are no private costs attached to higher education, there is a set of agents who don't advance into it. Moreover, the poorer a family is, the more likely it is that this happens. This is in line with empirical observations, namely with the conclusions of Carneiro and Heckman (2002) and Cardak and Ryan (2009), that one important justification for the income gap in the access to higher education is the corresponding gap on earlier educational achievement. When higher education is free, the justification for the income gap on access is related to the minimum threshold, \hat{h} . This shows how relevant it is to take into account the fact that only those who attain this minimum threshold are able to advance to higher education.

3.2 Mixed and pure private funding

In the case of mixed funding the tuition covers part of the University cost, the remaining being supported by the public budget. In the case of pure private funding the tuition covers the whole University cost. All universities have the same cost x and imply the same return to education as defined in (3). So, I abstract from considerations related to the choice of quality in higher education. Let ϕ be the percentage of total University costs that is supported by the tuition, so that an agent that sends his offspring to the University pays ϕx_t .¹¹

¹¹If maintenance costs are included in the fixed University cost, x , then pure public funding includes grants that cover these maintenance costs and the case of no grants but zero tuition corresponds to a mixed funding case, with positive ϕ .

The next table characterizes the three types of solutions, where the subscript M stands for a solution in the context of mixed (private and public) funding.

Table 2: solutions with mixed funding of higher education

	U^M	UT^M	B^M
c	$(1 - \tau_\phi)(h - \phi x)$	$(1 - \tau_\phi)(h - e - \phi x)$	$(1 - \tau_\phi)h$
h_{+1}	$\hat{h}_{+1}^U = \gamma \hat{h}_{+1}^B$	$\hat{h}_{+1}^U = \gamma_U \hat{h}_{+1}^B$	\hat{h}_{+1}^B

τ_ϕ is the tax rate needed for the public budget to be able to support the part of University costs that are publicly funded. The subscript ϕ emphasizes the fact that the size of the tax rate depends on ϕ . Thus, $\tau_\phi = f(\phi)$ is the level of the tax rate for a mixed funding system characterized by ϕ that guarantees that in equilibrium tax revenues are equal to public expenditure on higher education. To be able to fully characterize the function $f(\phi)$, I would need to describe the distribution of h and z , as these characteristics determine which agents continue to higher education and so, determine the total amount of higher education costs. However, it is always the case that the larger the ϕ , the lower the tax rate ($\partial f / \partial \phi < 0$), as the percentage of total costs supported by public funds decrease and it will be shown that when ϕ increases less students go to higher education decreasing total costs with higher education. This property is enough to derive all the results presented below. Notice that for $\phi = 0$ we are back in the case of pure public funding, described in Table 1. So, $f(0) = \tau$ where τ is the tax rate referred in Table 1. For pure private funding $\phi = 1$ and $\tau = 0$, as in this case there is no need for public revenues to fund higher education.

I solve for the mixed funding of higher education and then the solution for private funding is obtained considering $\phi = 1$ (and $\tau = 0$). For both pure private funding and mixed funding of higher education, the comparison between solutions of types U and B implies that for agents who attain the threshold \hat{h} , there is still a decision to be taken. These agents don't need to pay private tutoring but they must decide if they want to pay the tuition.

Taking into account the utility function (1) and the values for consumption and human capital for solutions U and B , as described in Table 2, we obtain that an agent who verifies the threshold condition (8) decides to pay the tuition if:

$$u(U^M) > u(B^M) \iff (h - \phi x) / h > \gamma^{-\rho} \quad (11)$$

Which implies that,

$$h > \frac{\phi x \gamma^\rho}{\gamma^\rho - 1} \quad (12)$$

Thus, for those agents who are able to send their offspring to the University without paying for tutoring, the decision of sending or not their offspring to the University only depends on income, not on their ability.¹² Only those agents

¹²This is the result of assuming a fixed University cost ϕx_t and also a log utility combined with a Cobb-Douglas production function for h , as discussed by Glomm and Ravikumar (2003).

with high enough income find it optimal to pay the tuition. For lower values of h the optimal solution is of type B .

For those agents whose offspring do not attain \hat{h} the decision is to pay e and ϕx_t or not send their offspring to the University. As tutoring costs depend on the student's ability, z , for these agents the decision depends on both h and z . For (h, z) below the line defined in (8), the agent compares solutions UT and B . Taking into account the utility function (1) and the values for consumption and human capital for these solutions as described in Table 2, we obtain that,

$$u(UT^M) > u(B^M) \iff (h - \phi x - e) / h > \gamma^{-\rho} \quad (13)$$

Substituting with the value of e given in (5), this implies that the agent pays for tutoring, $e > 0$, and sends the offspring to University if (8) is not verified and :

$$z > \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1}{\gamma^\rho} h + 1 - \varepsilon \phi x \right]^{-1} \quad (14)$$

Below this line the optimal solution is B ; the student does not advance to higher education.

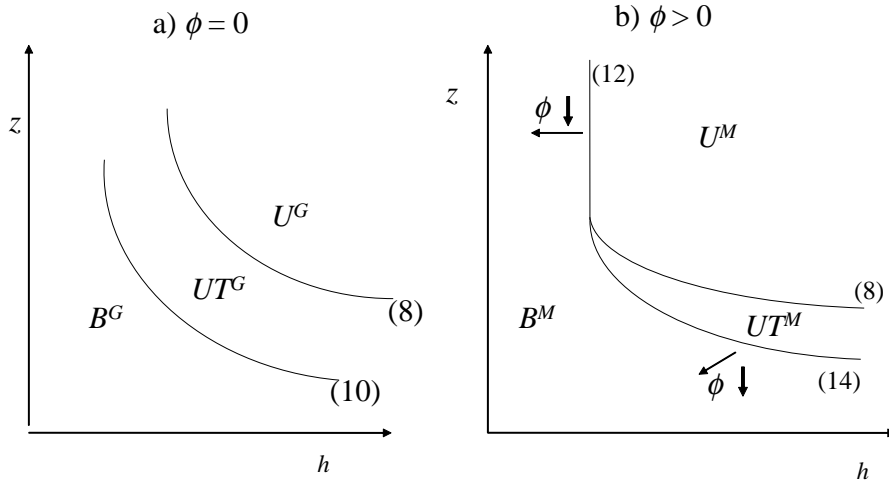


Figure 1: Agents's choices under pure public funding (panel a) or under mixed or pure private funding (panel b).

U refers to agents who send their offspring to the University without tutoring, UT refers to those who pay for tutoring and B refers to agents who don't send their offspring to the University. The superscript G refers to pure public funding, the superscript M refers to mixed funding. If ϕ decreases, the vertical line in panel b) moves to the left and curve (14) goes down and to the left.

Figure 1. b) combines the results obtained in conditions (12) and (14) and shows the regions that correspond to each type of solution for the mixed funding

case.¹³ As ϕ decreases, decreasing the private contribution to University costs, access to higher education increases.

Clearly the number of agents who go to University is maximized for $\phi = 0$, the case of pure public funding. Also, when agents have to pay tuitions they are less willing to pay for tutoring and so, the set of agents who chooses to pay for tutoring is smaller in this case. Moreover, the larger the tuition (larger ϕ), the smaller is the set of agents who chooses to pay for tutoring.

3.3 Access to higher education for different values of ϕ

The following Figure summarizes agents' decisions under each funding system. Region B in the figure corresponds to those agents who never send their offsprings to University. Regions U (U_1 and U_2) correspond to those agents who send their offsprings to University for any value of ϕ . U_1 corresponds to those agents who don't need to pay for tutoring, and region U_2 to those that do. Finally, regions A (A_1 and A_2) correspond to those agents for whom the decision of sending their offspring to University depends on the value of ϕ . These agents send their offspring to University if there is pure public funding of higher education but not if there is pure private funding. A_1 corresponds to those agents who don't need to pay for tutoring and region A_2 to those that do.

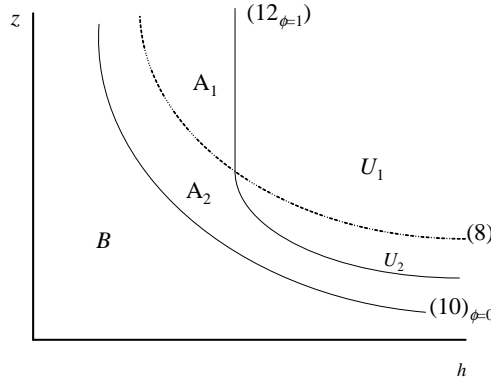


Figure 2: Access to higher education for different funding systems

Regions A_1 and A_2 refer to agents for whom the decision of sending their offspring to University depend on ϕ . Region B refers to agents who never send their offspring to University and regions U_1 and U_2 refer to agents who always do.

Access to the University increases when ϕ decreases. Thus, a government that wants to maximize access should choose $\phi = 0$. However, this analysis emphasizes that only for a set of median agents - in terms of ability and income - does the decision of sending their offspring to higher education depend on the

¹³In this section, in the main text I will focus on graphical analysis. In the appendix I present the justification for the positions of the curves in the figures.

existence and depth of public funding of higher education. For the extremes of the population the value of ϕ does not change this decision.

Moreover, even for those agents who gain access to University this does not necessarily imply that their welfare is higher under public funding of higher education as there are also costs associated with this funding system to be considered: taxes and, for those agents who need it, tutoring. So, now I compare the level of utility under each funding system for each type of agent.

4 Welfare: who gains, who loses?

This section answers the question asked in the title of the paper, using the framework developed in the previous sections and focusing on those agents for whom access to higher education depends on the funding system. First, for each value of ϕ , I look at the welfare of the marginal agent, where marginal refers to access. Then, I extend the analysis to all agents whose decision depends on the value of ϕ . Finally, I look at the agents in the extremes of the distribution. To summarize the results, I characterize the set of agents who have higher welfare under pure private funding than under a mixed system defined by a given value of ϕ .

Let marginal agents denote those agents who, for a given $\phi \geq 0$, are indifferent between sending or not sending their offspring to higher education. For these agents, given the value of ϕ , the utility from going into University is the same as the utility of not going. As they are obliged to pay taxes, they may be willing to pay the remaining cost of higher education ϕx , or $\phi x + e$, and advance to University. However, if they could choose, these agents would always prefer not to go to University and not to pay taxes nor tuition. This is why welfare will always increase for these agents if there is an increase on tuitions, determined by an increase on ϕ : they would not go into University if the tuition was marginally higher but they would also save on tuitions and pay lower taxes as the tax rate needed to support a system with higher ϕ is lower.

Moreover, changing to pure private funding, $\phi = 1$, would increase the welfare of these marginal agents even further as in that case they would not go the University but they would also pay no taxes nor tuition. The following Proposition extends this reasoning to a neighborhood of the set of marginal agents, showing that when ϕ increases to $\phi = 1$, there is always a set of combinations of h and z corresponding to agents who lose access to the University but whose welfare increases.

Proposition 1 *For $\phi = \bar{\phi}$, such that $1 > \bar{\phi} \geq 0$, consider the set of agents who send their offspring to higher education for $\phi = \bar{\phi}$ but not for $\phi = 1$, that is,*

these agents characterized by a pair (h, z) such that,¹⁴

$$h > \frac{\bar{\phi}x\gamma^\rho}{\gamma^\rho - 1} \wedge z > \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1}{\gamma^\rho} h + 1 - \varepsilon \bar{\phi}x \right]^{-1} \wedge \quad (15)$$

$$\wedge \left(h < \frac{x\gamma^\rho}{\gamma^\rho - 1} \vee z < \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1}{\gamma^\rho} h + 1 - \varepsilon x \right]^{-1} \right)$$

Let $\tau_{\bar{\phi}} < (\gamma^\rho - 1) / \gamma^\rho$.¹⁵ There is a non-empty subset of this set of pairs (h, z) characterized by,

$$\begin{cases} h < \frac{\bar{\phi}x\gamma^\rho}{\gamma^\rho - 1 / (1 - \tau_{\bar{\phi}})} \vee z < \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1 / (1 - \tau_{\bar{\phi}})}{\gamma^\rho} h + 1 - \varepsilon \bar{\phi}x \right]^{-1} & \text{for } \bar{\phi} > 0 \\ z < \frac{\hat{h}_t}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1 / (1 - \tau)}{\gamma^\rho} h + 1 \right]^{-1} & \text{for } \bar{\phi} = 0 \end{cases} \quad (16)$$

corresponding to agents who have higher welfare for $\phi = 1$ than for $\bar{\phi}$.

Proof.

- i) Consider first those agents who satisfy conditions (15) and (8): these agents choose the solution of type U for $\phi = \bar{\phi}$ and the solution of type B under pure private funding. Thus, for these agents to have higher welfare for $\phi = 1$ than for $\bar{\phi}$, it must be that,

$$u(B^R) > u(U^M; \phi = \bar{\phi})$$

Taking into account the solutions described in Table 2, this implies that

$$\ln(h) + \rho \ln h_{+1}^B > \ln(1 - \tau_{\bar{\phi}}) (h - \bar{\phi}x) + \rho \ln \gamma h_{+1}^B$$

which implies the first inequality in condition (16), for $\bar{\phi} > 0$. For $\bar{\phi} = 0$, none of these agents have higher utility for $\phi = 1$ than for $\bar{\phi}$.

- ii) Consider now those agents who satisfy condition (15) but don't satisfy condition (8): these agents choose the solution of type UT for $\phi = \bar{\phi}$ and the solution of type B under pure private funding. Thus, for these agents to have higher welfare for $\phi = 1$ than for $\bar{\phi}$, it must be that,

$$u(B^R) > u(UT^M; \phi = \bar{\phi})$$

Taking into account the solutions described in Table 2, this implies that

$$\ln(h) + \rho \ln h_{+1}^B > \ln(1 - \tau_{\bar{\phi}}) (h - e - \bar{\phi}x) + \rho \ln \gamma h_{+1}^B$$

¹⁴ \wedge and \vee are the mathematical signs of conjunction and disjunction.

¹⁵ If this condition is not verified then all agents defined in (15) have higher welfare for $\phi = 1$ than for $\bar{\phi}$. I don't consider this case as this would mean that the costs of higher education are too high relative to its productivity, as measured by γ .

Next, take into account the value of e as determined in (5) and obtain,

$$h > (1 - \tau_{\bar{\phi}})\gamma^{\rho} \left(h - \frac{\hat{h}}{\varepsilon z h^{\delta}} + 1 - \bar{\phi}x \right)$$

which, after some calculations, implies the second inequality in (16).

- iii) To see that this set of pairs (h, z) is non-empty compare the expressions in the right side of both inequalities in (16) with the corresponding expressions in the first line of (15). The curve defined in (16) is above the line defined by the first two inequalities in (15), for any $\tau > 0$ and $\bar{\phi} > 0$. For $\bar{\phi} = 0$, the condition in (16) is above the corresponding expression in the first line of (15), for any $\tau > 0$.

■

Moving from a pure private funding system to a mixed funding system always implies that there is a non-empty set of pairs (h, z) characterizing agents who gain access to higher education but whose welfare decreases. For these agents the increase in (their offspring's) income obtained from going to the University is not enough to compensate their current consumption loss implied by taxes. For these people no taxes and no higher education would imply higher welfare. This is more probably the case for those agents who benefit less from going to University because of lower ability and/or lower parents' human capital. Figure 3 shows the set of pairs (h, z) corresponding to agents who gain access to the University when the economy changes from a pure private funding system to a public funding system but that however, see their welfare decreased.

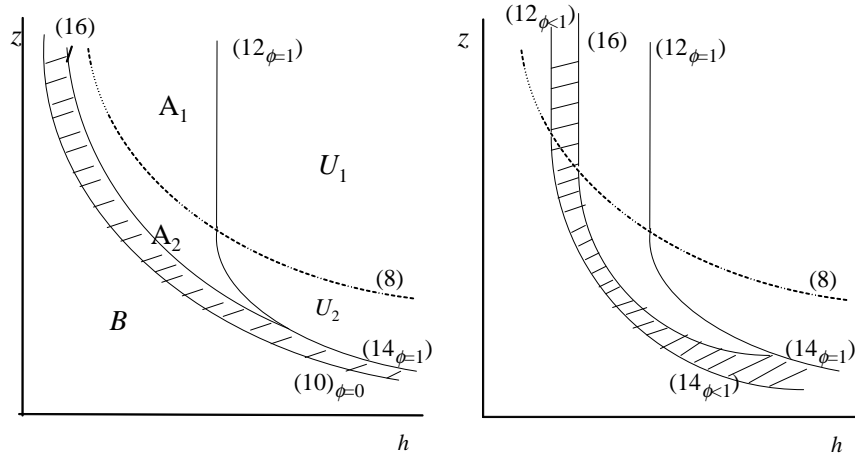


Figure 3: Agents who gain access to higher education but lose in welfare terms. The shaded areas refer to agents who gain access but whose welfare decreases. The left panel compares $\phi = 1$ and $\phi = 0$. The right one compares $\phi = 1$ and $0 < \bar{\phi} < 1$.

The number of individuals in the shaded areas of Figure 3 that actually exists in a given country depends on the joint distribution of (h, z) . It could even happen that this joint distribution is such that there are no individuals characterized by these pairs (h, z) , for instance because all individuals are characterized by pairs (h, z) to the right of curve (16), meaning that for that value of ϕ they would all send their offspring to higher education and would have higher welfare than under pure private funding.

The positive correlation between h and z observed in the data implies that the extremes of the shaded areas in Figure 3 are probably empty, as we do not expect to observe individuals with very high h and very low z nor with very low h and very high z . However, the positive correlation between h and z also implies that we may expect a concentration of individuals in the central region of the shaded areas. Moreover, notice that these shaded areas correspond to individuals for whom the decision of sending or not their offspring to the University depends on the value of tuitions, which is determined by ϕ . The literature suggests that in many countries there are a relevant number of individuals in this situation.¹⁶

Next, I look at welfare for the extremes of the distribution. Consider first those agents who don't send their offspring to University in any case (region B in Figure 2): for these agents welfare is clearly higher under pure private funding of higher education. This happens because with public funding they have to pay taxes although they never use the higher education system. So, their preferred value of ϕ is 1. This is just a consequence of the fact, already recognized in the literature, that public funding of higher education implies a redistribution from those that don't attend higher education to those that do. As students from high income families are more likely to attend higher education, this implies a redistribution of income from poor to rich people.

Next, consider those agents who send their offspring to University in any funding system - regions U_1 and U_2 in Figure 2 - and compare their welfare for pure private funding ($\phi = 1$) and a mixed funding system characterized by $\phi = \bar{\phi}$. The following Lemma establishes the results for this case.

Lemma Those agents in Region U of Figure 2 send their offspring to the University for any value of ϕ . These agents have higher welfare with $\phi = 1$ than with $\phi = \bar{\phi}$, such that $1 > \bar{\phi} \geq 0$ if,

$$h > \frac{x}{\tau_{\bar{\phi}}} \left[1 - \bar{\phi}(1 - \tau_{\bar{\phi}}) \right] \wedge z > \frac{\hat{h}}{h^{\delta}} \left[\varepsilon h + 1 - \frac{\varepsilon x}{\tau_{\bar{\phi}}} \left[1 - \bar{\phi}(1 - \tau_{\bar{\phi}}) \right] \right]^{-1} \quad (17)$$

Proof.

- i) Consider first those agents Region U_1 of Figure 2 who satisfy condition (8): these agents choose the solution of type U for any ϕ . Thus, for these

¹⁶See, for example, Belley and Lochner (2007) for the US and Steiner and Wrohlich (2012) for Germany.

agents to have higher welfare for $\phi = 1$ than for $\bar{\phi}$, it must be that,

$$u(U^R) > u(U^M; \phi = \bar{\phi})$$

Taking into account the solutions described in Table 2, this implies that

$$\ln(h - x) + \rho \ln h_{+1}^U > \ln(1 - \tau_{\bar{\phi}}) (h - \bar{\phi}x) + \rho \ln h_{+1}^U$$

which implies the first inequality in condition (17).

- ii) Consider now those agents who don't satisfy condition (8): these agents choose the solution of type UT for any ϕ . Thus, for these agents to have higher welfare for $\phi = 1$ than for $\bar{\phi}$, it must be that,

$$u(UT^R) > u(UT^M; \phi = \bar{\phi})$$

Taking into account the solutions described in Table 2, this implies that

$$\ln(h - x) + \rho \ln h_{+1}^U > \ln(1 - \tau_{\bar{\phi}}) (h - e - \bar{\phi}x) + \rho \ln h_{+1}^U$$

Next, take into account the value of e as determined in (5) and obtain, after some calculations, the second inequality in condition (17).

■

For those agents who always send their offspring to the University without the need to pay tutoring welfare may be higher under pure private funding than under a partial public funding of higher education depending on their level of income. This happens because with public funding (partial or total) they have to pay taxes, which are proportional to income, but they only pay for part of the fixed University tuition while under private funding the opposite happens. As taxes are proportional to income, the richest agents prefer to pay the tuition. So, the richer agents are, the more likely they are to prefer pure private funding.

Those agents who always send their offspring to University but that need to pay private tutoring spend the same amount with tutoring in both funding systems. However, these expenditures are tax deductible and this must be taken into account when comparing taxes and University tuition. Tax deductions are higher for those agents whose offspring are further away from the threshold value, \hat{h} . Thus, for those agents who pay for tutoring, the higher their level of human capital, and the higher the ability of their offspring, the more they prefer private funding because, as they spend a smaller amount in tutoring, their tax deductions are also smaller.

The following Proposition summarizes the results obtained and Figure 4 shows the set of agents who have higher welfare under pure private funding than under pure public funding, as implied by the Proposition for $\bar{\phi} = 0$.

Proposition 2 Let $\tau_{\bar{\phi}} < (\gamma^\rho - 1)/\gamma^\rho$. Those agents characterized by a pair (h, z) such that,

$$\left(h > \frac{x}{\tau_{\bar{\phi}}} [1 - \bar{\phi}(1 - \tau_{\bar{\phi}})] \wedge z > \frac{\hat{h}}{h^\delta} \left[\varepsilon h + 1 - \frac{\varepsilon x}{\tau_{\bar{\phi}}} [1 - \bar{\phi}(1 - \tau_{\bar{\phi}})] \right]^{-1} \right) \vee$$

$$\begin{cases} h_t < \frac{\bar{\phi} x \gamma^\rho}{\gamma^\rho - 1 / (1 - \tau_{\bar{\phi}})} \vee z < \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1 / (1 - \tau_{\bar{\phi}})}{\gamma^\rho} h + 1 - \varepsilon \bar{\phi} x \right]^{-1} & \text{for } \bar{\phi} > 0 \\ z < \frac{\hat{h}_t}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1 / (1 - \tau)}{\gamma^\rho} h + 1 \right]^{-1} & \text{for } \bar{\phi} = 0 \end{cases}$$

have higher welfare for $\phi = 1$ than for $\phi = \bar{\phi}$.

Proof.

- i) The conditions in the first line were obtained in the previous Lemma and correspond to condition (17). The conditions in the second line were obtained in Proposition 1 and correspond to condition (16).
- ii) All agents characterized by pairs (h, z) below the line defined in condition (16) fulfill the conditions defined in Proposition 1 or are below the line defined in condition (10).
- iii) It was already established that all agents characterized by pairs (h, z) below the line determined in condition (10), that is, those agents that never go to the University have higher welfare for $\phi = 1$.
- iv) Taking together the previous Lemma, Proposition 1 and point iii), the result is obtained.

■

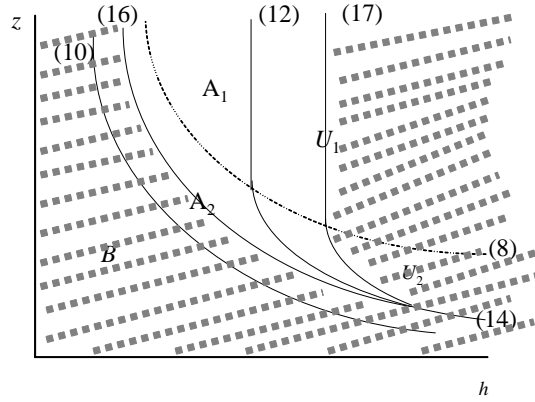


Figure 4: higher welfare with private than with public funding

The shaded area corresponds to agents who have higher welfare with pure private funding than with pure public funding. The white area in the middle corresponds to agents who prefer pure public funding.

Although a change from a pure private funding system to a pure public funding system, or more generally to a mixed funding system, always implies an increase in access to higher education, the richer and the poorer prefer private funding and the middle income agents prefer public funding. Moreover, gaining access to University doesn't necessarily imply an increase in welfare. This happens because on one hand, access to higher education directly increases welfare but on the other hand the fact that there is public funding of higher education implies that all agents have to pay higher taxes, which decreases welfare. For the agents identified in the Proposition the last effect is stronger than the first one.

An interesting result is that, among those who gain access to the University with public funding, the poorer among them prefer pure private funding. Thus, when we compare public funding with pure private funding, once we take into account the possibility of complementing public funding of basic education with paid tutoring, there are agents among those who gain access to the University that would have higher welfare without going to the University and without paying taxes and tutoring. Note that paying for tutoring is an optimal choice for these agents only because they have to pay taxes to fund higher education in any case.

5 A Different Funding System: higher education tax

The previous Section showed that with public funding of higher education the marginal agent to access higher education would have higher welfare with a pure private funding system. He would prefer not to send his offspring to University and not to pay taxes. Also, all those who don't send their offspring to higher education in any system prefer pure private funding as when there is public funding of higher education they pay for the higher education of the others. To avoid these problems I now consider a funding system for higher education where agents only contribute for higher education funding if they send their offspring to University. So, agents may choose if they want to be part of the higher education funding system. I consider a mixed system similar to the previous one, where ϕ measures the private contribution for higher education costs but where only those who send their offspring to University pay the taxes that finance higher education.¹⁷ This is a "higher education tax" as it is only paid by those who "use" the higher education system.

In this environment there are the same three types of solutions: U when the student goes into University without the need of private tutoring, UT when the student goes to University but needs private tutoring and B when the student doesn't go to University. Table 3 characterizes these solutions, where the subscript O stands for a solution in this context where the agent may opt for University and paying taxes or not going to University and not paying taxes.

¹⁷All taxes are used to fund higher education, I abstract from other uses of public revenues.

τ_{ϕ_O} is the tax rate associated to a private contribution ϕx in this funding system.

Table 3: solutions with a "higher education" tax

	U^O	UT^O	B^O
c	$(1 - \tau_{\phi_O})(h - \phi x)$	$(1 - \tau_{\phi_O})(h - e - \phi x)$	h
h_{+1}	$h_{+1}^U = \gamma h_{+1}^B$	$h_{+1}^U = \gamma h_{+1}^B$	h_{+1}^B

In this context, if condition (8) is satisfied, that is, if the agent doesn't need to pay private tutoring, the agent chooses between solutions U and B . The choice is not obvious even if $\phi = 0$, as he only pays taxes if his offspring goes to University. Comparing U^O and B^O , we obtain that agents for whom condition (8) is verified send their offspring to University if:

$$u(U^O) > u(B^O) \iff h > \phi x \frac{\gamma^\rho}{\gamma^\rho - 1/(1 - \tau_{\phi_O})} \quad (18)$$

where I assume that $\tau_{\phi_O} < (\gamma^\rho - 1)/\gamma^\rho$.

For those agents for whom condition (8) is not satisfied, that is, for those agents who need to pay private tutoring, we compare solutions UT^O and B^O . Taking into account the value of tutoring as defined in (5) we obtain that these agents send their offspring to University if,

$$u(UT^O) > u(B^O) \iff z > \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1/(1 - \tau_{\phi_O})}{\gamma^\rho} h + 1 - \varepsilon \phi x \right]^{-1} \quad (19)$$

Figure 5 shows the regions that correspond to each type of solution.¹⁸ Condition (19) defines a line that crosses (8) at the level of h defined in (18).

There are more students continuing to higher education when all taxpayers contribute to the funding system than when only those with offspring in higher education contribute to the funding system.¹⁹ As we would expect, if going to University implies paying taxes, then, for the same value of tuition, some agents that would go to University in the previous funding system now choose not to go. This is shown in Figure 6. For $\phi = 1$, there is pure private funding exactly as before: no taxes and those agents who send their offspring to higher education pay the whole cost x . Thus, for $\phi = 1$, all the results are exactly as in Sections 3 and 4.

¹⁸Here it is not clear what happens to access when ϕ changes, as the implied change on τ_{ϕ_O} has opposite effects on access. See conditions (18) and (19).

¹⁹Formally, this is implied by the fact that, for $\phi = 0$, condition (19) is always above condition (10) and, for $0 < \phi < 1$, condition (19) is always above condition (14) and condition (18) is always to the right of condition (13).

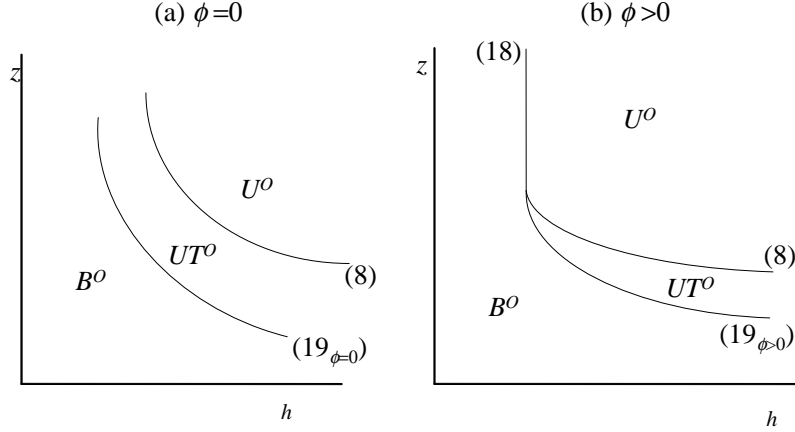


Figure 5: Agents' choices under a higher education tax

U^o refers to agents who send their offspring to the University without tutoring, UT^o refers to agents who pay for tutoring and B^o refers to agents who don't send their offspring to the University.

The following Proposition looks at the welfare of those agents for whom access to higher education depends on the value of ϕ , for the case of a higher education tax.

Proposition 3 *If taxes are paid only by those agents who send their offspring to higher education, then, for any $\phi = \bar{\phi}$, such that $1 > \bar{\phi} \geq 0$, all those agents who send their offspring to higher education for $\phi = \bar{\phi}$ but not for $\phi = 1$ have higher welfare for $\phi = \bar{\phi}$ than for $\phi = 1$.*

Proof.

- i) Consider first those agents who satisfy condition (8): if send their offspring to higher education for $\phi = \bar{\phi}$ but not for $\phi = 1$, then they choose the solution of type U for $\phi = \bar{\phi}$ and the solution of type B under pure private funding. Thus, for these agents, it must be that,

$$u(B^R) > u(U^R) \quad \text{and} \quad u(U^O; \phi = \bar{\phi}) > u(B^O; \phi = \bar{\phi})$$

From Table 2, solutions B^R and B^O coincide. Thus $u(B^O; \phi = \bar{\phi}) = u(B^R)$. So, we obtain that $u(U^O; \phi = \bar{\phi}) > u(B^R)$, implying that these agents have higher welfare for $\phi = \bar{\phi}$ than for $\phi = 1$.

- ii) Consider now those agents who don't satisfy condition (8): these agents choose the solution of type UT for $\phi = \bar{\phi}$ and the solution of type B under pure private funding. Thus, it must be that, for these agents,

$$u(B^R) > u(UT^R) \quad \text{and} \quad u(UT^O; \phi = \bar{\phi}) > u(B^O; \phi = \bar{\phi})$$

We saw that $u(B^O; \phi = \bar{\phi}) = u(B^R)$. Thus, $u(UT^O; \phi = \bar{\phi}) > u(B^R)$, implying that these agents have higher welfare for $\phi = \bar{\phi}$ than for $\phi = 1$.

■

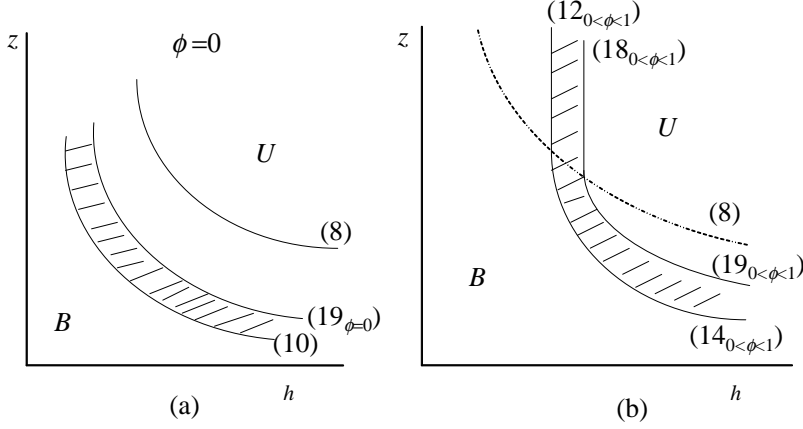


Figure 6: Access to higher education under a higher education tax and with a generic income tax

The shaded area corresponds to agents who send their offspring to University when all taxpayers contribute to the public funding of higher education but not when only those who benefit from the system contribute to it, considering the same value for ϕ .

Panel (a) is for $\phi = 0$, panel (b) is for $0 < \phi < 1$.

The main advantage of having taxes paid only by those agents who send their offspring to higher education is that with this system there is no longer a redistribution of income from the poorer to the richer. Moreover, in this case, welfare increases for all those agents who gain access to higher education.

6 Conclusion

This paper studies the effect of public funding of higher education on the welfare of different agents, focusing on those agents whose decision of sending or not their children to the University depends on higher education funding policy. I do not look at aggregate welfare but instead I identify the characteristics of those individuals who gain or lose with the public funding of higher education. The model considers that all decisions are made by parents and takes into account the hierarchical nature of the educational system and also the fact that parents have the possibility to complement basic public education with private expenditures in individual tutoring.

Assuming that public expenditure on higher education is financed through a general proportional income tax, I consider three funding systems for higher education: pure public funding, pure private funding and a mixed funding system,

where only a percentage ϕ of the higher education cost is privately supported with the remaining being publicly supported. I obtain that although pure public funding maximizes access to University, moving from pure private funding, to pure public funding or to a mixed funding system, always decreases the welfare of the poorer agents. Moreover, I show that, for any value of ϕ , the welfare of the marginal agents to access University is always lower than under a pure private funding system. This happens because in the pure private funding system these parents would not send their offspring to University but they would also not pay tuitions nor taxes. Thus, gaining access to higher education doesn't necessarily imply an increase in welfare. The equality of opportunity in access to higher education is the main argument in favor of public funding of higher education. However, it is shown that if all taxpayers contribute to the public funding of higher education then the system is harming those agents who it was supposed to help.

Finally, I consider financing higher education through a higher education tax, meaning that only those who send their children to University contribute to the public funding of higher education. With this funding system, although access decreases relative to the case where all agents contribute to the system, it is shown that all agents who gain access to higher education due to public funding have higher welfare under public funding than with pure private funding. In this case, there is a progressive income redistribution and the system increases the welfare of those agents it is supposed to help.

I did not consider any specific distribution of human capital and ability. This implies that the results obtained are valid for any possible distribution of human capital and ability and thus, for any economy.

An important policy implication that results from the analysis in this paper is that funding higher education with a general tax income reduces the welfare of those people who don't use the higher education system and also of those that gain access to higher education but for whom the benefit in terms of income change is small. And these tend to be the students with poor earlier educational achievements.

7 Appendix: proofs relative to the figures

7.1 Figure 1.b):

Notice that the curve defined in condition (14) crosses the line that determines the possibility of going to the University without tutoring, defined in (8), for $h = \phi x \gamma^\rho / (\gamma^\rho - 1)$, the threshold level obtained in (12). Thus, the lines defined in (12) and (14) cross the curve defined in (8) at the same point. When ϕ decreases the vertical line moves to the left and the curve that separates UT from B goes down.

Also, the curve that determines who is willing to pay for tutoring, given in (14), is - for any $\phi > 0$ - above the curve that determines who is willing to pay for tutoring in the case of pure public funding of higher education, given in (10).

7.2 Figure 2:

Access to higher education for different values of ϕ

- i) Those agents characterized by a pair (h, z) such that

$$z < \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1}{\gamma^\rho} h + 1 \right]^{-1}$$

don't send their offspring to the University for any value of ϕ .

- ii) Those agents characterized by a pair (h, z) such that

$$h > \frac{x\gamma^\rho}{\gamma^\rho - 1} \wedge z > \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1}{\gamma^\rho} h + 1 - \varepsilon x \right]^{-1}$$

send their offspring to the University for any value of ϕ .

- iii) For all the other agents the decision depends on the value of ϕ . For any ϕ , such that $0 \leq \phi \leq 1$, those agents characterized by a pair (h, z) such that the conditions in i) and ii) are not verified and,

$$h > \frac{\phi x \gamma^\rho}{\gamma^\rho - 1} \wedge z > \frac{\hat{h}}{h^\delta} \left[\varepsilon \frac{\gamma^\rho - 1}{\gamma^\rho} h + 1 - \varepsilon \phi x \right]^{-1}$$

send their offspring to University.

Proof. The inequality in part i) is the same condition as in equation (10) but with the opposite sign and separates the sets UT^G and B^G in Figure 1a). For $\phi = 0$, this is the condition that determines which agents don't send their offspring to the University. For $\phi > 0$, the relevant conditions are (14) and (12). As the set determined by these two conditions is above (10) for any $\phi > 0$, those pairs (h, z) that are below the line defined in (10) are also below the line defined by (14) and (12), shown in Figure 1b). Thus, below this line agents don't send their offspring to the University in either system. This proves part i).

In part ii) the first inequality is given in (12) for $\phi = 1$ and the second in (14), also for $\phi = 1$. (12) results from imposing $u(U^M) > u(B^M)$ for agents who satisfy (8), and (14) results from imposing $u(UT^M) > u(B^M)$ for agents who don't satisfy (8). If a pair (h, z) is above these lines for $\phi = 1$, it also above these lines for any $\phi < 1$. Thus, if the agent is in the region above (14) and to the right of (12) he sends his offspring to the University for $\phi = 1$ and also for any $\phi < 1$.

For $\phi = 0$, condition (10) determines which agents send their offspring to the University. The line defined by (10) is below the line defined by (14), for any $\phi > 0$. This proves part ii).

Part iii) considers the pairs (h, z) that don't satisfy the condition in part i) nor the conditions in part ii). The first inequality is given in (12) and results from imposing $u(U^M) > u(B^M)$, for agents who satisfy (8), and the second inequality is given in condition (14) and results from imposing $u(UT^M) > u(B^M)$, for agents who don't satisfy condition (8). ■

7.3 Figure 3:

The lines defined by conditions (14) and (16) intersect for $h = x(1-\phi)\gamma^\rho(1-\tau)/\tau$, but both curves are always above condition (10) that defines the set of agents who never go to University.

7.4 Figure 4:

For $\phi = 0$, the lines defined by conditions (14), (17) and (16) intersect for $h = x\gamma^\rho(1-\tau)/\tau$, but the three curves are always above condition (10) that defines the set of agents who never go to University.

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