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Student Loans in a Tiebout Model of Higher Education

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Abstract:

A model is presented where universities competitively supply education to mobile students. Students are subject to a liquidity constraint so that tuition must be paid out of pre-university income. It is shown that student loans provided by home jurisdictions will ensure an efficient quality of higher education if loans do not contain any subsidy. If there is income-related debt relief, however, the equilibrium quality of education is inefficiently low. This is because students reduce their expected future income by attending a university offering low quality, and thereby reduce the amount of debt to be repaid.

Keywords: education, university, mobility, liquidity constraint, debt relief.

JEL classification: H75, I23.

1 Introduction

Promoting the mobility of students is an acknowledged goal of the European Union, which, remarkably, has already been attained to a large extent. Although student mobility between member states is still substantially smaller than inside nations, there is a non-negligible number of immigrant students in many countries. While desirable, such mobility is also suspected to conflict with efficiency since it may create fiscal externalities. When higher education is publicly financed by autonomous local jurisdictions, such externalities may arise from mobility of

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students and from mobility of graduates. With mobile students, a local jurisdiction which acts in the interest of native citizens will not take the benefit of immigrant students into account when determining size and quality of its universities (see for example Büttner and Schwager, 2004; Mechtenberg and Strausz, 2008). When graduates are mobile, taxes or other non-private returns to education such as agglomeration benefits will not accrue to the region which has paid for the education (see for example Wildasin, 2000; Poutvaara and Kanniainen, 2000; Egger, Falkinger, and Grossmann, 2012). In both cases, an underprovision result obtains: There are too few places at universities, or universities are of insufficient quality.

Such an inefficiency does not occur if university funding is purely private (Wildasin, 2000), or if tuition fees are levied which are determined competitively by the authorities running the universities (Schwager, 2008). Indeed, a university is nothing but a club or a local jurisdiction in the tradition of Buchanan (1965) and Tiebout (1956). In a decentralised setting such entities provide congestible local public goods efficiently if they can impose user fees which internalise marginal crowing costs, possibly complemented by a tax on immobile factors. In spite of their clear allocative benefits, however, tuition fees are rarely observed in European countries, and where they exist, they do not nearly cover cost. The reason for this policy choice, beyond simple electoral opportunism, is the fear that potential students from lower income families will be deterred from taking up a university education if fees are too high. This fear is based on an imperfection of the capital market which makes it impossible to obtain a loan to finance studies. If this is the case, prospective students who cannot pay tuition fees upfront out of their own or their parents' wealth will not be able to study, even if attending university were the efficient choice.

In order to overcome this market failure, several countries have introduced a system of student loans. When the government provides credit to all prospective students, then all those for whom studying is worthwhile will be able to do so. Still, concerns remain about the social impact of such loans, since they will burden graduates with a substantial amount of debt. This concern is particularly acute in cases where the student does not earn the income usually associated with a university education. This can occur, for example, if demand for academic

labour suddenly slumps, if the graduate cannot work full time because of illness or obligations such as caring for children or elderly relatives, or simply if the student fails to graduate at all. As a consequence, student loans usually come with some clause stipulating that repayment is conditional on sufficient income. For example, the U.S. Department of Education runs an 'Income-Based Repayment Program' which offers graduates in 'partial financial hardship' the opportunity to cap the monthly amount repaid. Moreover, under certain conditions, interest payments are covered by the program, and part of the debt may be canceled (see U.S. Department of Education, 2012). In Australia (see Australian Government, 2012) and Germany (see KfW Bankengruppe, 2012), contractual repayments of federal student loans can be deferred or suspended as long as debtors earn insufficient income. Also such postponements are likely to involve a partial debt relief since they typically reduce the present value of the amount due, say because deferment is granted without charging a market interest rate, or because repayments are never taken up again.

The present paper analyses the effect of student loans which provide for this kind of socially motivated debt relief. The model features decentralised decisions by universities which competitively supply education at varying qualities and set tuition fees accordingly. Mobile students are free to choose a university but face a liquidity constraint requiring to pay tuition out of an initial endowment. Home jurisdictions provide loans so as to allow credit constrained students to choose a university of high quality. It is shown that in equilibrium, such loans induce an efficient quality of higher education if they do not entail any subsidy element. If repayment of student loans, however, is partly or fully conditional on earning sufficient income, the equilibrium quality of education is inefficiently low. This result obtains because the socially motivated debt relief acts like a tax on success, which is more likely if the university provides a high-quality education. Therefore, students have an incentive to attend a university of lower quality so as to reduce the expected repayment of the loan. Politically, this implies that in order to induce an efficient quality of higher education one has to eliminate needs-related elements from the student loan scheme, centralise decisions on higher education, or suppress student mobility.

In the economics of education, student loans and income dependent repayment

schemes have been the object of a number of studies. In this literature, specific attention is granted to quantifying the implicit subsidies involved and the repayment burdens induced by loan schemes employed in various countries. For example, such computations are provided for Australia (Chapman, 1997), Thailand (Chapman and Lounkaewa, 2010), Germany (Chapman and Sinning, 2011), and in an international comparison (Shen and Ziderman, 2008). On the theoretical side, an income contingent repayment of the loan smoothes consumption and provides insurance against income risks (Jacobs, 2002; Chapman and Sinning, 2011). Ionescu (2011) shows in a life cycle model that the possibility to discharge, by way of default, the debt incurred with a student loan provides such insurance and thus raises human capital investment by low-income students. Also empirically, student loans have been shown to affect student behaviour. Tangkitvanich and Manasboonphempool (2010) find that the introduction of a student loan scheme in Thailand raised enrolment of students from poor backgrounds. More specifically, Rothstein and Rouse (2011) consider a highly selective college in the U.S. which replaced student loans by full grants. This shift induced students to more often choose 'non-remunerative' majors such as humanities or sociology, and led them to accept first employments with lower salaries. To this strand of literature, the present paper contributes by presenting a general equilibrium analysis of the effects of student loans and income dependent debt relief on the supply and demand of educational quality. By so doing, it highlights the trade-off between equity or insurance objectives, which call for debt relief, and the aim of raising the quality of universities, which requires full repayment of loans.

As mentioned above, income contingent debt relief can be seen as a tax on the returns to education. In this general sense, the present paper analyses an incentive effect which is also central to the theory of human capital taxation. In this literature, it has been shown that progressive income taxes reduce the accumulation of human capital and growth (Caucutt, Imrohoroglu, and Kumar, 2006; Erosa and Koreshkova, 2007). Moreover, extending the classical insights of optimal tax theory, human capital taxation has been analysed in the presence of redistributive objectives (Bovenberg and Jacobs, 2005; Jacobs and Bovenberg, 2010), and second best rules describing the optimal mix of taxes on human capital, education subsidies, and capital income taxes have been derived (Richter,

2009, 2011; Peterman, 2012). In contrast to this literature, which considers unitary governments, the present paper is focussed upon the separation of powers between jurisdictions which hand out loans and grant debt relief, and independent, competing institutions which supply education. Thus, the contribution of the present paper consists in emphasising the welfare effects of fiscal decentralisation of education policy and education subsidies in the presence of liquidity constraints for students.

In the following Section 2, the model is introduced. Section 3 then discusses, as a benchmark, the allocation which obtains under centralised policy decisions and without student mobility. This is compared, in Section 4, with the allocation obtained in a Tiebout model with decentralised decisions and student mobility. The final Section 5 summarises the findings.

2 The Model

In the model economy, there are a large number of identical jurisdictions. In each of these jurisdictions there are immobile agents whose number is normalised to one, and $\ell > 0$ mobile students. Every immobile agent (student) has an initial endowment of $e > 0$ ($y > 0$) units of a numéraire good. It is assumed that policy of a jurisdiction is decided so as to maximise the aggregate utility of immobile residents and students originating from this jurisdiction.

Universities are described by a function $c(q, m)$ which gives the cost of providing an education of quality $q \in [0, 1)$ to $m \geq 0$ students. The quality q measures the probability that a student studying in this university is successful, in which case after graduating she earns a wage $w + w_o > 0$ determined in an integrated labour market. With the remaining probability $1 - q$, the student is unsuccessful and earns the wage $w_o \geq 0$ paid to non-graduates. The cost function satisfies $c(0, m) = 0$ and $c(q, m) \to \infty$ as $q \to 1$ for all $m \geq 0$. Thus, the useless education $q = 0$ is obtained for free, and it is impossible to provide an education where success is guaranteed. The cost function has positive partial derivatives $c_q(q, m) > 0$ and $c_m(q, m) > 0$ for all $q > 0, m > 0$ expressing the marginal cost of improving quality and extending enrolment.

The tuition fee per student is denoted by $t \geq 0$. There is free entry into and free exit from the market of higher education, which means that universities can be founded and closed without set-up or demolition cost. Universities can be purely private institutions, or may be run by some public entity, for example by the home jurisdictions of the students. In both cases, it is assumed that universities have to break even by charging sufficiently high tuition fees. While a state subsidy for universities is obviously an empirically relevant case, this is ruled out both for simplicity and in view of the objective function of local policy makers. When students are mobile, subsidising the local university is not a suitable instrument to foster the utility of students originating from the subsidy-paying jurisdiction, since home grown students may emigrate and immigrant students may benefit from the subsidy. Therefore, the present paper focusses on a transfer paid to students, not to universities.

Key to the present analysis is a liquidity constraint on the financing of tuition fees. That is, the cost of studying must be paid upfront either out of the endowment y or from a loan $b \geq 0$ granted to the student by her home jurisdiction. Thus, studying at a university that charges tuition t is only feasible if $b + y \geq t$. The loan is to be paid back in full if the student is successful, whereas only the fraction $\mu \in [0, 1]$ is to be repaid if the student is unsuccessful. This rule formalises, in a stylised way, socially motivated regulations which make repayment of student loans conditional on income, as mentioned in the introduction. From a theoretic point of view, it is in line with the basic idea of a liquidity constraint since a student who fails to graduate will add only the wage w_o to her initial endowment and so might not be able to repay the loan in full. Assuming, for simplicity, an interest rate of zero, a loan of b therefore implies a net transfer of $b - \big[qb + (1 - q)\mu b\big] = b(1 - \mu)(1 - q)$ from taxpayers to the student.

3 Benchmarks

As a first benchmark case, the efficient allocation is characterised. Since all jurisdictions are identical, the criterion employed is the aggregate utility per jurisdiction. When quality q is chosen, the expected gain in wages procured by the university system is $q\ell w$ per jurisdiction. With enrolment m per university,

there have to be ℓ/m universities per jurisdiction, so that the cost of education is $(\ell/m)c(q,m)$ per jurisdiction. Adding total endowments $e+\ell y$ and basic wages ℓw_o, one sees that the efficient education policy is given by the solution (q^*, m^*) to the programme

$$\max_{q,m} \quad e + \ell y + \ell w_o + \ell q w - \frac{\ell}{m} c(q,m) \tag{1}$$

with the necessary conditions

$$c_q(q^*, m^*) = m^* w \,, \tag{2}$$

$$c_m(q^*, m^*) = \frac{c(q^*, m^*)}{m^*} \,. \tag{3}$$

Efficiency requires that the marginal cost of an increase in quality is equated to the aggregate gain in expected wages procured by better education (2), and that the marginal and average cost of a student are equal, so that the cost per student is minimised (3).

Equations (2) and (3) are the usual first-order conditions in models with congestible public goods and free entry of providers of public goods. Correspondingly, this solution shares the caveats usually encountered in such models. First, a standard convexity assumption on the cost function is not sufficient to make problem (1) concave (see Starrett, 1988, 77-83). However, in the model at hand,

Assumption 1 $\quad c_{qq} > 0, \quad c_{mm} > 0, \quad c_{qq}c_{mm} - \left(\frac{c_q}{m} - c_{qm}\right)^2 > 0$

ensures that the first order conditions (2) and (3) are sufficient for a local welfare maximum. The first two inequalities in Assumption 1 stipulate increasing marginal cost of quality and enrolment. The third inequality requires that, starting from a solution to the first order conditions, a change in quality does not drive marginal and average cost of students too far away from each other. This is required for an interior solution to obtain since otherwise, an increase in quality might call for a large increase in enrolment which in turn might make another increase in quality worthwhile, shifting the optimum towards the maximal quality and an infinite number of students.

As a second caveat, notice that partitioning the total number of students into entities of m^* each may require to create a non-integer number of universities.

It is assumed that there are so many jurisdictions, and that the optimal size of a university is so small, that ignoring this integer problem leads to negligible mistakes.

For the following, it is convenient to define, for any combination of quality q and tuition t, the profit maximising enrolment $m(q,t) = \text{argmax}_m\{tm - c(q,m)\}$ characterised by $t = c_m(q,m)$. That is, enrolment is adjusted so that, for given quality, tuition covers the marginal cost of educating an additional student. Inserting $m(q,t)$ back into profits yields $tm(q,t) - c\big(q, m(q,t)\big) = 0$. This equation implicitly defines a relationship $t = \tau(q)$ which gives the tuition necessary to cover the cost to provide education quality q, assuming that enrolment is optimally adjusted. From $c(0,m) = 0$, this function satisfies $\tau(0) = 0$, and the envelope theorem implies $\tau'(q) = c_q/m > 0$, so that improving the quality of education requires a higher tuition. Moreover, since $d\,m/d\,q = [(c_q/m) - c_{mq}]/c_{mm}$, one has

$$\tau''(q) = \frac{1}{m}\left[c_{qq} + \frac{d\,m}{d\,q}\left(c_{qm} - \frac{c_q}{m}\right)\right] = \frac{1}{mc_{mm}}\left[c_{qq}c_{mm} - \left(\frac{c_q}{m} - c_{qm}\right)^2\right].$$

Therefore, Assumption 1 implies $\tau''(q) > 0$. Thus, the marginal increase in tuition necessary to finance an increase in quality rises as quality increases. Figure 1 illustrates this relationship. This figure is drawn such that $\tau(q^*) > y$ holds. This is the interesting case where students cannot finance the efficient education quality out of their endowment, so that the liquidity constraint is relevant.

In the second benchmark considered, a policy decision is analysed where students are immobile; that is, students stay in their home jurisdiction and study at a university provided by this jurisdiction. In order to make this benchmark as comparable as possible to the Tiebout equilibrium, which is the focus of the paper, it is assumed that also in this benchmark, universities have to break even, and that the credit constraint has to be observed. The government decides on the quality of education, the tuition, and the student loan. As mentioned above, the objective used is the aggregate utility of taxpayers and students. In the absence of any deadweight loss of taxation, the effective transfer implicit in the loan, $\ell b(1-\mu)(1-q)$, cancels out in this aggregation. Hence, the local government

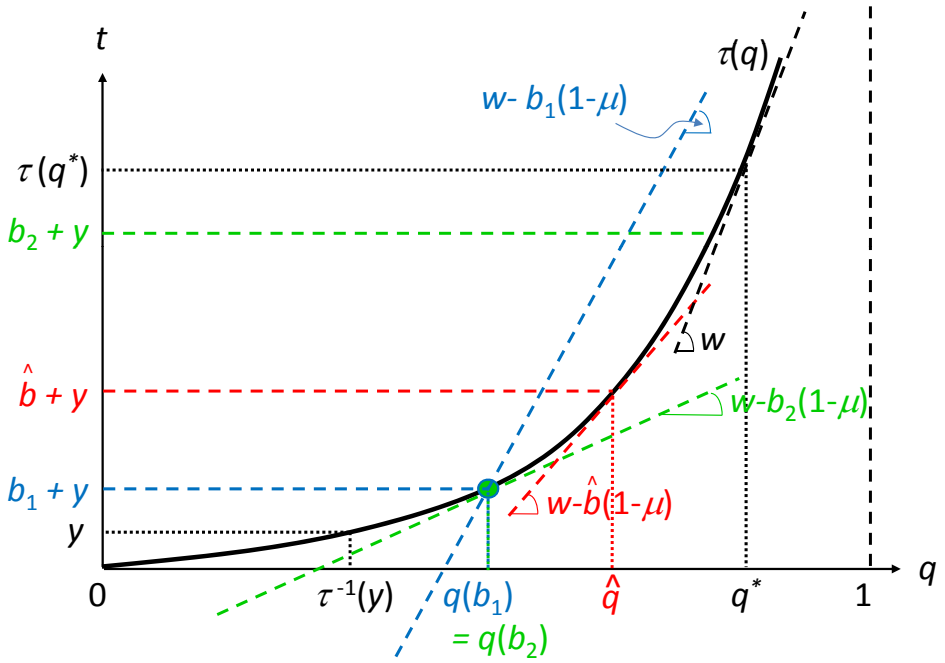

Figure 1: **The inverse supply of education** $\tau(q)$**.** At the efficient quality q^*, one has $\tau'(q^*) = w = c_q/m$. The slopes of the increasing straight lines illustrate the marginal benefit of quality for varying amounts of the loan. With the critical loan $\hat{b} = \tau(\hat{q}) - y$, this slope equals the marginal cost $\tau'(\hat{q})$. The loans $b_1 < \hat{b} < b_2$ are chosen such that they induce the same quality $q(b_1) = q(b_2)$. With b_1, the liquidity constraint binds, and marginal benefit exceeds marginal cost of education. With b_2, marginal benefit equals marginal cost, and the liquidity constraint is slack.

solves the programme

$$\begin{aligned} \max_{q,t,b} \quad & \ell(y + w_o + qw - t) + e \\ \text{s.t.} \quad & t \geq \tau(q)\,,\ b + y \geq t\,. \end{aligned} \tag{4}$$

The solution to this programme is given by the efficient quality q^* together with the tuition fee that just covers cost, $t^* = \tau(q^*)$, and any loan large enough to overcome the liquidity constraint, $b \geq \tau(q^*) - y$.

Notice that programme (4) also describes the decision of a central government which maximises the average aggregate utility per jurisdiction. Consequently, the same solution obtains, and efficiency is also reached in the case of a centralised decision. Thus, if students have to study in their home state, or if a central state

imposes a uniform quality on all universities, the efficient allocation is provided. Key to this result is that in these two arrangements, students cannot choose the university but have to pay for the quality decided by the respective government.

4 Tiebout Equilibrium

In this section, a Tiebout equilibrium in the market for education is analysed. This means that students from every jurisdiction freely choose a university where to study. Universities maximise profits, which implies that a university which offers quality q at tuition t will enrol $m(q,t)$ students. Moreover, since entry to the market of higher education is free, profits must be zero. Therefore, only combinations of quality and tuition will be offered which satisfy $t = \tau(q)$. Conversely, since all such combinations allow the university to break even, any such combination will be offered if demanded by students. Thus, with free entry, the function $\tau(q)$ is the inverse supply function of the university sector, where enrolment adjusts such that $m = m(q, \tau(q))$.

A student chooses education of quality q so as to maximise her expected life time income consisting of endowment y, expected wage $w_o + qw$ net of tuition cost t, and the transfer $b(1-q)(1-\mu)$ implicit in the loan obtained by her home jurisdiction. In this choice, she is restricted, firstly, by the supply of universities so that $t = \tau(q)$. Secondly, the student must be able to finance tuition out of her endowment y and the loan b. This leads to the decision problem of a student:

$$\begin{aligned} \max_{q} \quad & y + w_o + qw - \tau(q) + b(1-q)(1-\mu) \\ \text{s.t.} \quad & b + y \geq \tau(q)\,. \end{aligned} \tag{5}$$

By differentiating (5) one finds $w - b(1-\mu) - \tau'(q)$, the net marginal benefit of an increase in the quality of education. Here, w is the increase in expected wage procured be an improved education, and $\tau'(q)$ is the rise in tuition caused by attending a slightly better university. The term $-b(1-\mu)$ stems from the fact that part of the loan does not have to be paid back in case of failure. Since a better education reduces the probability of failure, the possibility of discharge reduces the marginal benefit of educational quality.

Now define a critical level of the loan $\hat{b}$ by the solution to the equation

$$w - \hat{b}(1-\mu) = \tau'(\tau^{-1}(\hat{b}+y))\,. \tag{6}$$

This is the loan which, together with the endowment y, is just sufficient to finance an education of quality $\hat{q} = \tau^{-1}(\hat{b}+y)$ where marginal benefit and marginal cost are equalised (see figure 1). Next, restrict attention to the interesting case with $\tau(q^*) > y$ and $\mu < 1$. Then, as $\hat{b}$ increases from 0 to $\tau(q^*) - y$, the loan necessary to finance the efficient quality, the left hand side of (6) decreases from w to $w - [\tau(q^*) - y](1-\mu)$. From Assumption 1, one has $\tau'' > 0$, and since also τ^{-1} is increasing, the right hand side increases in $\hat{b}$. At $\hat{b} = 0$, from $\tau(q^*) > y$ the right hand side is $\tau'(\tau^{-1}(y)) < w$, and at $\hat{b} = \tau(q^*) - y$, it equals w. Thus, $\hat{b}$ is unique and satisfies $0 < \hat{b} < \tau(q^*) - y$.

The solution $q(b)$ to programme (5) depends on whether the actual loan exceeds the threshold $\hat{b}$ or not (see figure 1). Specifically, if $b \geq \hat{b}$, the solution is determined by $w - b(1-\mu) = \tau'(q(b))$ and $b + y \geq \tau(q(b))$. In this case, the loan is so large that the liquidity constraint is not binding and the optimal quality is given by equating marginal benefit and marginal cost of education. If $b < \hat{b}$, then the solution satisfies $b + y = \tau(q(b))$ and $w - b(1-\mu) \geq \tau'(q(b))$. In this case the liquidity constraint binds, so that the student chooses the best education she can afford, and the marginal benefit of an additional improvement in quality may exceed the marginal cost.

Differentiating the defining equation in each case, one finds that $q'(b) = 1/\tau' > 0$ if $b < \hat{b}$ and $q'(b) = -(1-\mu)/\tau'' < 0$ if $b > \hat{b}$. As long as the loan is smaller than the critical value, increasing it relaxes the liquidity constraint and the chosen quality rises accordingly. For loans above the critical value, a further increase has no impact on the liquidity constraint but, since expected repayment rises in quality, it reduces the marginal benefit of quality. Hence, the optimal quality decreases in the loan once the threshold is overcome. Altogether, $q(\hat{b})$ is the largest quality which can be reached by any loan $b \geq 0$.

Anticipating the choices of students as summarised by the function $q(b)$, a local jurisdiction decides on the loan b to be provided to students. Introducing this function and the inverse supply of universities $\tau(q)$ into the objective from (4),

we obtain the optimisation problem

$$\max_{b} \quad \ell\big[y + w_o + q(b)w - \tau(q(b))\big] + e \tag{7}$$

Differentiating yields $[w - \tau'(q(b))]q'(b)$. Now in both regimes $b < \hat{b}$ and $b > \hat{b}$, one has $w - b(1-\mu) \geq \tau'(q(b))$, so that $w - \tau'(q(b)) > 0$ as long as $b > 0$ and $\mu < 1$. Hence, an increase in the loan b raises (decreases) welfare of the local jurisdiction if and only if it raises (decreases) the quality of education chosen by students. Therefore, the optimal choice of loan is the one which maximises quality, which is $\hat{b}$, and the resulting quality is $\hat{q} = \tau^{-1}(\hat{b} + y)$.

The following proposition summarises this finding.

Proposition 1 (Educational quality in Tiebout equilibrium).

(a) If $y \geq \tau(q^*)$ or $\mu = 1$, the educational quality provided in a Tiebout equilibrium with student loans is q^*.

(b) If $y < \tau(q^*)$ and $\mu < 1$, the educational quality provided in a Tiebout equilibrium with student loans is $\hat{q} < q^*$.

For comparison, part (a) of this proposition considers the obvious cases where students' endowment is large enough to make the liquidity constraint redundant or where the loan has to be repaid in full even if the student does not succeed at university. In these cases, a decentralised market of higher education with mobile students and competitively determined tuition fees yields the efficient quality of higher education. However, part (b) of Proposition 1 shows that quality is underprovided in Tiebout equilibrium if these two conditions are not satisfied. Whenever the liquidity constraint is relevant and the obligation arising from the loan is conditional on educational success, raising the loan will at some point result in students choosing a university offering a lower quality. They do so since a lower quality reduces expected income, and thereby also expected repayment of the loan. Hence, a system of student loans mitigates the decline in educational quality induced by a liquidity constraint, but it fails to restore efficiency.

Replacing in (6) the loan according to $\hat{b} = \tau(\hat{q}) - y$, one can rewrite the equilibrium condition as $w - [\tau(\hat{q}) - y](1-\mu) - \tau'(\hat{q}) = 0$. Differentiating, one finds

Proposition 2 (Comparative statics). *If $y < \tau(q^*)$ and $\mu < 1$, one has*

$$\begin{aligned}
\frac{d\hat{q}}{d\mu} &= \frac{\hat{b}}{\tau'' + (1-\mu)\tau'} &> 0\,,\\
\frac{d\hat{q}}{dy} &= \frac{1-\mu}{\tau'' + (1-\mu)\tau'} &> 0\,,\\
\frac{d\hat{q}}{dw} &= \frac{1}{\tau'' + (1-\mu)\tau'} &> 0\,.
\end{aligned}$$

According to Proposition 2, a larger repayment rate μ, a larger endowment y, and a larger wage differential w increase equilibrium quality. If a larger share of the loan has to be repaid in case of failure, failure becomes less attractive and hence students choose a better university. When the endowment rises, the loan necessary to finance any given quality of education decreases and hence the incentive to reduce quality so as to avoid repayment also decreases. Finally, a higher wage premium for graduates increases the incentives to attend a good university and so improves quality.

Beyond these quite straightforward effects, Proposition 2 displays some interesting interactions. Inspecting the expression for $d\hat{q}/dw$, one sees that the impact of a wage increase on equilibrium quality is reduced when μ declines. Thus, a socially motivated debt relief does not only reduce quality directly, but also dampens the effect of rising returns to skills on educational investments. Moreover, from $d\hat{q}/dy$, equilibrium quality becomes more sensitive to endowment if the repayment rate μ is low. Thus, the opportunity for unsuccessful graduates to discharge part of their debt increases the importance of initial wealth for the quality of education chosen. In that sense, the social design of the loan scheme reinforces the severity of the problem which the loan is supposed to solve; income dependent debt relief works against equalising opportunities.

5 Conclusion

The analysis provided in this note suggests that there is a trade-off between, on the one hand, social policy goals which might call for a debt relief for students who do not earn the income expected from a graduate, and, on the other hand,

the aim to provide an efficient quality of higher education. As the benchmarks described in section 3 show, such a trade-off does not arise when students cannot freely choose a university, either because they are not mobile, or because the university system is regulated and financed centrally. Thus, the model shows that, also in higher education, it is difficult to pursue redistributive goals when beneficiaries are mobile. Consequently, one might either want to abandon such goals in education policy, or centralise the latter.

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