SUBSIDIZING ENJOYABLE EDUCATION

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Abstract

We explain why means-tested college tuition and means-tested government grants to college students can be efficient. The critical idea is that attending college is both an investment good and a consumption good. If education has a consumption benefit and tuition is uniform, the marginal rich student is less smart than some poor people who choose not to attend college, thus reducing the social returns to education and increasing the college's cost of education. We find that competition among profit-maximizing colleges results in means-tested tuition. In addition, to maximize the social returns to education government should means-test grants. We thus provide a rationale for means-tested tuition and grants which relies neither on capital market imperfections nor on redistributive objectives.

JEL Code: H52, I2.

Keywords: tuition policy, education subsidies, self-selection.

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1 Introduction

College tuition and government grants to students are commonly means-tested.[1] The literature offers three main arguments for this: capital market imperfections, redistribution, and price discrimination by monopolistic colleges. Although all these arguments are appealing, none is fully satisfactory. First, means-tested tuition fees or grants are inefficient ways of correcting capital constraints. Providing students with loans (with repayment conditional on future income) is the efficient and more equitable way of dealing with missing capital or insurance markets (Jacobs and Van Wijnbergen (2005)). Second, though optimal redistribution may require means-tested grants (Dur, Teulings, and Van Rens (2004)), the redistribution argument cannot explain why private colleges in a competitive education market charge different tuition to students with different incomes. Third, it is unlikely that exploitation of monopolistic power by colleges can fully explain why tuition varies with income. As Epple, Romano, and Sieg (2004, p. 5) note, "The stylized fact that colleges can extract so much revenue from higher income households is clearly an empirical puzzle given many colleges competing for students. ... More future research is needed to find other compelling explanations for this puzzle."

We provide a new rationale for why both college tuition and government grants to students are means-tested. The critical idea is that attending college is both an investment which increases future earnings, and a consumption good. One implication of the model is that a rich person of low ability may be willing to pay more for college than would a poor person of high ability. So colleges which want to attract smarter students may charge poor students a lower price than rich students. Moreover, when the social return to education exceeds the private return, allocative efficiency requires government grants to students to be means-tested.

The idea that education is not merely an investment but also provides consumption benefits is widely acknowledged. Some empirical evidence shows a consumption value of higher education. Lazear (1977), using data on young males in the United States, finds that individuals with much education (M.A.'s and Ph.D's), push education beyond the level that maximizes the present value of future income, suggesting that education has consumption

[1] See the review of tuition policy and student support in 13 countries by the Irish Department of Education and Science (2003). See National Center for Education Statistics (2003) for details about tuition and financial aid to students in the United States.

value. The reverse holds for lower levels of education. Heckman, Lochner, and Taber (1999), using data on male earnings in the United States, find that individuals in the second highest ability quartile enjoy large nonpecuniary benefits from attending college; individuals in the two lowest and in the highest ability quartiles suffer nonpecuniary costs.[2] Using a larger dataset, Carneiro, Hansen, and Heckman (2003) estimate that, when ignoring psychic gains, 40% of the persons going to college would regret attending college. Once they account for psychic benefits and costs of attending college, only 8% of college graduates regret attending college. They conclude, therefore, that much of the gain from college is nonpecuniary.[3] Using Dutch data, Oosterbeek and van Ophem (2000) find evidence that schooling is a good that raises future income and generates utility. Alstadsæter (2004) provides similar evidence for Norway.

2 Literature

Since Schultz (1960) and Becker (1964) developed the theory of human capital, economists have neglected the consumption benefits from education. Exceptions are Alstadsæter (2003) and Malchow-Møller and Skaksen (2004), who study optimal taxation and financing of education when education yields both a pecuniary and a non-pecuniary return. Both papers employ a representative agent framework and so abstract from heterogeneity in ability and in wealth among agents, which are crucial in our model. Bovenberg and Jacobs (2003) allow for consumption benefits from education in a model where

[2] Judd (2000) argues that when students of high-ability expect their financial returns to college to equal the average returns to college, the finding of nonpecuniary cost for the highest ability quartile may arise from the correlation between expectational errors and ability. Also note that the second-highest ability quartile (that is, the group which enjoys a nonpecuniary benefit from college education) is particularly relevant for our argument as it contains many marginal college students.

[3] Likewise, they find that many of the persons who choose not to go to college would incur a nonpecuniary cost when going to college. These costs (e.g, the pain of studying) likely arise not from college attendance *per se*, but instead increase with the effort a student devotes to studying. If increased studying increases future income, and if the marginal utility from income declines with its level, then effort will be higher the lower a student's initial income. This could make it increasingly attractive for a college to attract poorer students. Our model can thus be extended to allow for both consumption benefits and psychic costs of college attendance, with qualitative results similar to those we report below.

agents have heterogeneous ability, but no wealth.

Our paper relates to Wickelgren (2001). He argues that given past discrimination, non-discriminatory employers or universities may voluntarily practice affirmative action in their hiring or admission decisions—a person who overcame discrimination is likely more able than someone in the same position who faced no such obstacle. Likewise, in our paper, colleges charge lower tuition to poor students, who have higher expected ability than the rich students they displace. This stems, however, from the consumption benefit from education rather than from past discrimination.

De Fraja (2005) argues that high-potential individuals from groups with relatively few high-potential individuals ('disadvantaged' groups) should receive higher government grants, since grants to such people entail lower budgetary cost (lower inframarginal subsidies). As we shall see, such a result also appears in our model. We identify two other reasons (of which one also holds even when the government budget constraint does not bind) for why government should give larger grants to poorer people.

3 Assumptions

College students differ in two ways. First, students differ in ability, denoted by a. Second, at the start of their college career, students differ in wealth, w. Each person knows his own ability, but the colleges and the government do not; the colleges and government can only observe a student's wealth.[4] We assume that students' ability and wealth are distributed according to the joint density function $f(a, w)$. In Sections 4 and 5, we assume that the ability distribution is independent of wealth, that is, $f(a, w) = f(a)$ for all w. Section 6 discusses the implications of relaxing this assumption.

For simplicity, we consider a two-period model. In period 1 a person can choose whether to attend college. In period 2, a person who did not attend college has income a. A person who attended college earns $a + p(a)$, where

[4] This assumption simplifies the analysis, but is more restrictive than we need. We could allow a college to observe an imperfect signal of ability (e.g., high school grades or scores on standardized tests), as in Fernandez and Gali (1999). The consumption benefits of education would still mean, however, that for a given signal, a rich student with a given ability would be more willing to pay for college than would a poor student with the same ability.

$p'(a) > 0$: the return to college increases with ability.[5] We also assume that $p''(a) = 0$. As we shall see, this assumption ensures that we can safely ignore opportunities to work in period 1 by people who do not attend college.

For simplicity, suppose consumption of goods occurs only in period 2; since we assume perfect capital markets, that simplification does not affect our results. Consumption in period 2 by a person with initial wealth w who did not attend college is $a + w$. Let college tuition to a person with wealth w be $t(w)$. It follows that consumption by a person with initial wealth w who attended college is $a + p(a) + w - t(w)$.

The utility from consuming goods is given by the function $v(\cdot)$, with the usual properties: $v'(\cdot) > 0$, $v''(\cdot) < 0$, and $v'''(\cdot) \geq 0$. The consumption benefit from attending college is b. This benefit can reflect the opportunities to date members of the opposite sex, to enjoy the sports facilities, to take part in the excitement of school football games, to live away from home, and so on. For convenience, we assume that utility is separable in consumption goods and the consumption benefit of education.[6]

The topic we address becomes interesting if a college prefers to enroll smart students. This can arise for many reasons. 1) Peer group effects within colleges can make increased attendance by smart students benefit all other students (see Rothschild and White (1995) and Epple and Romano (1998)). 2) Faculty may find it more pleasant or interesting to teach smart students, and so a college may attract better faculty, or attract a given quality of faculty at lower cost, the better are its students.[7] 3) Studious students may be less likely to engage in behavior (such as drunkenness) which may impose costly legal liability on the college. 4) Attracting smarter students may enhance a college's prestige and increase future alumni donations.

We find that a simple but fruitful approach is to suppose that a college's costs decline with the quality of its students. Let a college's cost of educating

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[5] Most empirical studies find complementarity between ability and education, see Harmon, Oosterbeek and Walker (2003) and Dur and Teulings (2004).

[6] Note that allowing b to depend on ability a does not affect our results qualitatively. Allowing b to depend on w strengthens the results when $b'(w)$ is positive, but may reverse the results when $b'(w)$ is negative.

[7] At Yale University, the "faculty was astonished and delighted by the leap in academic ability" of freshmen after it changed undergraduate admission policies in the 1960's. See "The birth of a new institution: How two Yale presidents and their admissions directors tore up the 'old blueprint' to create a modern Yale" by Geoffrey Kabaservice, *Yale Alumni Magazine*, December 1999, (http://www.yalealumnimagazine.com/issues/99_12/admissions.html)

a student with ability a be $c(a)$, with $c'(a) < 0$. Throughout, we assume perfect competition in the market for college education.

4 Market equilibrium

A student with ability a and wealth w attends college if

$$v\left[a + p(a) - t(w) + w\right] + b \geq v(a + w). \tag{1}$$

Let $a^*(w)$ denote the ability of a student with wealth w, who, in equilibrium, is indifferent about attending college. In a competitive equilibrium, the following two conditions hold for all w:

$$v\left\{a^*(w) + p[a^*(w)] - t(w) + w\right\} + b = v[a^*(w) + w], \tag{2}$$

$$t(w) = \frac{\int_{a^*(w)} f(a,w)c(a)\mathrm{d}a}{\int_{a^*(w)} f(a,w)\mathrm{d}a}. \tag{3}$$

The first equation describes, for each level of wealth the students who attend college. Since smarter students have a higher return to education, $p'(a) > 0$, a person with wealth w and with ability $a \geq a^*(w)$ attends college.[8] The second equation describes the equilibrium level of tuition. Perfect competition implies that tuition for a student with wealth w equals the expected cost of educating a student with wealth w.

If education has no consumption value ($b = 0$), equation (2) reduces to

$$p[a^*(w)] = t(w). \tag{4}$$

Therefore, a person will attend college only if the return to education is higher than or equal to tuition. Using (3), we can verify that when $b = 0$, equilibrium tuition is independent of wealth, $t'(w) = 0$. For suppose wealthier

[8] If people who do not attend college work in period 1, equation (2) becomes

$$v\left\{a^*(w) + p[a^*(w)] - t(w) + w\right\} + b = v[2a^*(w) + w].$$

If p is a linear function of a, none of our results are affected. When, however, $p(a)$ is concave, the highest ability students may prefer working in period 1 over attending college, because their opportunity cost of education may exceed their return to education. We abstract from this.

students were charged higher tuition, $t'(w) > 0$. Then equation (4) would imply that a^* increases with wealth w. Given that the distribution of ability is independent of wealth, this means that richer students would on average be smarter. As $c'(a) < 0$, the right-hand side of equation (3) then implies that a college's expected average cost is lower when admitting richer students. So when $t'(w) > 0$, the expected cost per student declines with the wealth of the student body, whereas tuition increases with student's wealth. Clearly, when $t'(w) > 0$, the zero-profit condition (3) is violated for some w. A similar argument applies for $t'(w) < 0$, and for any other nonuniform tuition policy. Only when tuition is uniform, $t'(w) = 0$, can the zero-profit condition hold for all levels of wealth. With uniform tuition, the average ability of students, and so the expected cost per-student, will be independent of the wealth of students. So if attending college has no consumption value, tuition will be uniform.

When $b > 0$, condition (2) implies that some students with $p(a) < t(w)$ attend college. Though this reduces their lifetime consumption of goods, they enjoy the consumption benefit, b, of college.

Proposition 1: If college education has consumption benefits ($b > 0$), colleges charge higher tuition to richer students ($t'(w) > 0$).

Proof: See Appendix.

The intuition behind Proposition 1 is straightforward. By the concavity of $v(\cdot)$, the marginal utility of consuming goods declines with wealth, so that a rich person is more willing than is a poor person to reduce consumption of goods in return for the consumption benefits from education. With uniform tuition, the least able poor student in college will therefore be smarter than the least able rich student. This also implies that poor students will on average be smarter than rich students. As a college's cost of education declines with student's ability, in the competitive equilibrium colleges charge lower tuition to poorer students. In equilibrium, the rich will nevertheless be over-represented in college. For proportional representation would imply equal expected ability and, so, in a competitive equilibrium, uniform tuition.

In equilibrium, some persons who avoid college are smarter than some who attend college. Since the smarter persons get a higher return from education, aggregate output would be higher if they attended college. When, however, externalities are absent, the equilibrium is Pareto-efficient. Forcing a poorer but smarter person to replace a richer but dumber student at the same tuition rate would reduce the utility of both students. Though the smarter person would enjoy a higher rate of return and would enjoy the same consumption benefit from education, the tuition payment reduces the utility from consumption goods of the poor student more than it reduces the utility of the rich student.

Our examination of means-tested college tuition contrasts with the idea that colleges aim to attract poor and minority students to promote diversity or equity. Differentiation of tuition by colleges for these reasons could make the average poor student in college less able than the average rich student, and some current evidence shows that difference (e.g. Rothstein (2004)). But other evidence shows, as our model predicts, that poor students enrolled in college are of higher average ability than rich students, and that means-tested financial aid can increase the quality of the student body. At a National Press Club event centered around the book *America's Untapped Resource: Low-Income Students in Higher Education*, a former College Board official claimed that "The fact is, the dumbest rich kids have as good a chance of going to college as the smartest poor kids."[9] Consistent with this view, a study by the Maryland Higher Education Commission found that community college students who receive need-based financial aid perform as well as or better than their wealthier peers. For example, 74.3 percent of the low-income students who received financial aid returned for a second year of study at their community college, transferred, or earned a credential, compared to 62.5 percent of non-recipients. Similarly, 40.5 percent of new full-time freshman who received need-based financial aid transferred to a public four-year institution and/or earned a community college degree within five years of matriculation, as opposed to about one-third of non-recipients. Similar results hold for Texas.[10]

The history of means-tested financial aid at Yale University offers another instructive example.[11] In the Class of 1957, before Yale offered means-tested

[9]See National Association of Student Financial Aid Administrators, news release January 15, 2004, at www.NASFAA.org.

[10]For Maryland, see Janis Battaglini, "A comparison of the retention, transfer and graduation rates of need-based financial aid recipients at Maryland public colleges and universities with the performance of non-recipients," February 2004. (http://www.mhec.state.md.us/higherEd/about/Meetings/EdPolicyMeetings/03-10-04/). For Texas, see "Messing with success." *Houston Chronicle*, March 12, 2005, p. B12.

[11]The following is drawn from "The birth of a new institution: How two Yale

financial aid and before it practiced needs-blind admissions, graduates of private schools (who were overwhelmingly wealthy) constituted more than 60 percent of the Class of 1957. But they constituted less than half the membership of Phi Beta Kappa (the most prestigious national honor society) and one-sixth of the membership of Tau Beta Pi, the national engineering honor society. The largest feeder schools (Andover, Exeter, Lawrenceville, Hotchkiss, and St. Paul's, all of which are private), sent about 20 percent of the class; but each accounted for only one of the 64 members of Phi Beta Kappa. Other traditional feeder schools such as Groton, Hill, Kent, St. Mark's, St. George's, and Taft contributed no members to Phi Beta Kappa.

In 1963 Yale greatly increased its financial aid, and by 1966 adopted a fully needs-blind admissions policy: the University no longer rejected qualified applicants who could not afford Yale's costs, eliminated any quota on the number of scholarship students, and placed no limit on the amount of money available for grants and loans. The class entering in 1966 was composed of 58 percent public school students, a higher percentage than ever before, and a jump from 52 percent the previous year; financial aid jumped to nearly $1 million, 30 percent above what it had been the year before; gift aid from the University increased by almost 50 percent. This class entered with higher SAT scores than ever before; a student who scored its mean SAT verbal mark of 697 would have been at the 75th percentile of the class that entered four years before.

5 Government means-tested grants

So far, we ignored externalities from education. Suppose now that, in addition to the private return $p(a)$, there is a public return to education $\lambda p(a)$. Of course, only the private benefits, not the social returns, affect a person's decision to attend college, or a college's tuition policy. The resulting underinvestment in human capital can be removed by subsidies. We shall see in this section that the consumption benefit from education implies that optimal subsidies will be means-tested rather than uniform.

One reason the social return to education may exceed the private return is taxation. If each student ignores how his education can increase government's

presidents and their admissions directors tore up the 'old blueprint' to create a modern Yale,"by Geoffrey Kabaservice, *Yale Alumnni Magazine*, December 1999. (http://www.yalealumnimagazine.com/issues/99_12/admissions.html) income tax revenues, and if the cost of education is not fully deductible at the same rate as the returns to education are taxed, taxation results in underinvestment in education (see, among others, Boadway, Marceau, and Marchand (1996), Anderson and Konrad (2003), and Bovenberg and Jacobs (2003)). Education can also generate externalities in production. For instance, if innovation increases with the knowledge workers gained in college, and innovations are afforded imperfect patent protection, then the private return to education is less than the social return. Such externalities feature prominently in models of endogenous economic growth (Lucas (1988), Romer (1986), 1990)). Recent empirical evidence is provided by among others Moretti (2004) and Teulings and Van Rens (2003), and surveyed in Sianesi and Van Reenen (2003).

Consider a government that aims to maximize national output net of the costs of college education.[12] The government's objective is thus to

$$\max \int \int^{a^*(w)} f(a,w) a \mathrm{d}a \mathrm{d}w + \int \int_{a^*(w)} f(a,w)[a + (1+\lambda)p(a) - c(a)] \mathrm{d}a \mathrm{d}w. \quad (5)$$

Let government affect behavior by providing grants, $g(w)$, to students, which can be conditioned on their wealth. In equilibrium, students' demand for college education becomes

$$v\left\{a^*(w) + p[a^*(w)] + g(w) - t(w) + w\right\} + b = v[a^*(w) + w]. \quad (6)$$

Tuition is still given by (3). For simplicity, we assume that the government has a given budget, denoted by G, for student grants:

$$\int \int_{a^*(w)} f(a,w) g(w) \mathrm{d}a \mathrm{d}w \leq G. \quad (7)$$

We will consider both a binding and a non-binding budget constraint.

Consider first education which has no consumption benefit ($b = 0$). Then, as we saw in the previous section, in equilibrium all people whose return to education exceeds the tuition attend college. Moreover, tuition is independent of a student's wealth and equals the expected cost of education. Hence,

[12] Alternatively, we could assume that the government maximizes social welfare. However, since utility is concave in consumption goods, our efficiency argument would be intertwined with redistributive concerns.

if externalities are absent ($\lambda = 0$), optimal student grants are zero ($g(w) = 0$ for all w): grants would induce people whose return to education is lower than the expected costs of college education to attend college. When the social returns to education exceed the private returns ($\lambda > 0$), optimal student grants are positive, so that students internalize the externality of their education on national output. Optimal student grants are independent of student's wealth. If grants varied with student's wealth, students receiving high grants would on average be less smart than students receiving low grants. This would result in lower output (since $p'(a) > 0$) and higher cost of college education (since $c'(a) < 0$) than when the government spends the same budget on uniform grants.

Consider next education which has consumption benefits ($b > 0$).

Proposition 2: If college education has consumption benefits ($b > 0$), and the government budget constraint does not bind, optimal student grants are means-tested ($g'(w) < 0$).

Proof: See Appendix.

The intuition behind Proposition 2 follows. The consumption benefit from education implies that with uniform grants (or without grants) some poor people not attending college are smarter than the least able rich student. Since the return to education increases with a student's ability, a grant to a poor student has higher social benefits than a grant to a rich student—it induces smarter students to attend college. When the government's budget constraint is not binding (the shadow cost of public funds is zero), the grant policy must induce the social return to education to equal the marginal cost of education for the marginal student at any given level of wealth:

$$(1 + \lambda)\, p[a^*(w)] - c[a^*(w)] = 0, \tag{8}$$

implying that college education is independent of student's wealth. The tuition charged by profit-maximizing colleges will therefore be independent of wealth. But to induce the poor to attend college, government must provide larger grants to poorer students. We can see from equation (6) that (8) requires poorer students be given higher grants. Note that this also holds when $\lambda = 0$, that is, in the absence of externalities. Then, the government optimally taxes college education for the rich and subsidizes college education for the poor, so as to increase national output.

Proposition 3: If college education has consumption benefits ($b > 0$), and the government budget constraint binds, a sufficient condition for optimality of means-tested student grants ($g'(w) < 0$) is that

$$\frac{\int \int_{a^*(w)} f(a,w)\mathrm{d}a\mathrm{d}w}{f\left[a^*(w),w\right]}$$

weakly increases with wealth w.

Proof: See Appendix.

When the government budget constraint binds (the shadow cost of public funds is positive), achieving full equality of education by means-tested government grants is not optimal. Poor students attending college will be smarter than rich students attending college, and so profit-maximizing colleges will make tuition increase in student's wealth. For three reasons optimal government grants decrease with student's wealth. First, as with a non-binding budget constraint, in the absence of a grant some poor people who do not attend college are smarter than some rich students, so that the social return to increasing education of the poor is larger. Second, because the marginal utility of income declines with income, the poor respond more than the rich to an increase in government grants. Hence, a given increase in college participation is attained at lower cost.[13] Third, an increase in the grant to rich students involves a higher budgetary cost than a similar increase in the grant to poor students, as the rich are more numerous in college than the poor ($\int \int_{a^*(w)} f(a,w)\mathrm{d}a\mathrm{d}w$ increases with w). Clearly, this should be compared with the number of students at the margin, $f\left[a^*(w),w\right]$, who respond to an increase in the grant. When the condition in Proposition 3 holds, concentrating grant provision on poor students reduces the government's cost, as relatively fewer grants are provided to students who would choose to attend college anyhow.[14]

[13] Some evidence shows that the price elasticity of demand for higher education declines with income; e.g. McPherson and Schapiro (1991) and Kane (1994). However, Cameron and Heckman (1999), Dynarski (2000), and Stanley (2003) find no or the reverse effect.

[14] This third reason has also been identified by De Fraja (2005) as an efficiency rationale for reverse discrimination in education.

6 Generalization: Ability correlated with wealth

We assumed that the distribution of students' ability is independent of wealth. Clearly, relaxing this assumption may affect our results.

Consider first our result on a college's tuition policy. We saw that when education is enjoyable poor students are on average smarter than rich students, and so profit-maximizing colleges make tuition increase with student's wealth. When the ability distribution depends on wealth, this need not hold. Though the marginal rich student will have lower ability than some poor students, the rich may on average be smarter than poor students, for instance when students' ability and wealth are strongly positively correlated. Then, in the competitive equilibrium tuition may decline with wealth. Only when the consumption benefit from education is sufficiently large, will average ability decline with student's wealth, and so will tuition increase with student's wealth.

Next consider our result on means-tested government grants. When the government budget constraint does not bind, allowing for more general distribution functions does not affect our result. This is seen by inspecting (6) and (8). Equation (8) implies that optimality requires a^* to be independent of wealth, independent of how ability and wealth are distributed over the population. Equation (6) then implies that grants should decrease with wealth.

Our result on government grants may differ when the government budget constraint binds. First, the effect of an increase in grants to persons with a given wealth depends on the density of students at the margin for that wealth, $f[a^*(w), w]$. (See the first term in first-order condition (13) in the Appendix.) Second, the rich need not necessarily outnumber the poor in college, and so the cost of inframarginal subsidies may be higher for poorer groups. (See the second term in first-order condition (13) in the Appendix.) Thus, the trade-off between increasing the social benefits from education and the budgetary cost of grant provision may be affected. Since, at the margin, poorer students are still smarter than richer students, our main argument, that grants to poorer students have higher social benefits than grants to richer students, still holds. This is the more so, the higher is the consumption benefit from education. So when the consumption benefit from education is sufficiently large, grants will still decrease with student's wealth.

7 Conclusion

We showed that the consumption benefit from attending college makes rich students, who are most willing to pay for the consumption benefit, especially eager to attend college. Among the poor, only the brightest attend college. Hence, when colleges prefer to enroll smart students, the market equilibrium will have tuition be means-tested. Rich students are nevertheless overrepresented in college, and the marginal rich student has lower ability than the marginal poor student. To maximize the social returns to education, government should therefore means-test grants. The consumption benefit from education can thus provide a rationale for why both college tuition and government grants to students are means-tested.

The general effect we identified can apply in areas outside of college. Consider the effects of the move of the German capital from Bonn to Berlin. Bonn was an unattractive location, while Berlin is a highly attractive city in which to work and live. Therefore, governmental offices in Bonn may have attracted officials dedicated to public policy; offices in Berlin would also attract people who want a government job not because they like the job, but for the opportunity to work in Berlin. Or think of a professional conference. If the intent is to attract people interested in the contents of the conference, then the organizers may want to hold it in a location which is unattractive for a vacation.

8 Appendix

Proof of Proposition 1:

Let (1) hold with equality and replace a with a^*. Totally differentiating with respect to a^* and w results in:

$$\frac{da^*}{dw} = -\frac{[1 - t'(w)]v'\left[a^* + p(a^*) - t(w) + w\right] - v'(a^* + w)}{\left[1 + p'(a^*)\right] v'\left[a^* + p(a^*) - t(w) + w\right] - v'(a^* + w)}. \tag{9}$$

Note that (2) implies that if $b > 0$, then for all w:

$$a^* + p(a^*) - t(w) + w < a^* + w.$$

Hence, since $p'(a^*) > 0$ and $v''(\cdot) < 0$, the denominator of (9) is always positive. The sign of the numerator depends on the value of $t'(w)$.

Suppose that $t'(w) \leq 0$. Then (9) implies that $da^*/dw < 0$, and so, since $f(a, w) = f(a)$, the right-hand side of (3) increases with w. Since $t'(w) \leq 0$ implies that the left-hand side of (3) weakly decreases with w, the zero-profit condition (3) will be violated for some w.

If $t'(w) > 0$, da^*/dw may be positive, namely when $t'(w)$ is very large, see (9). This implies that the right-hand side of equation (3) decreases with w. Since $t'(w) > 0$ implies that the left-hand side of (3) increases with w, this cannot hold in a competitive equilibrium. Only if $t'(w) > 0$ for all w, but not too large so that $da^*/dw < 0$ for all w, will both the left-hand side and the right-hand side of (3) increase with w. Note that $t'(w) < 1$, because $t'(w) \geq 1$ would imply $da^*/dw > 0$. Note also that $0 < t'(w) < 1$ and $p'(a^*) > 0$ imply that $-1 < da^*/dw < 0$.

Proof of Proposition 2:

The government maximizes (5) with respect to $g(w)$ and subject to (3) and (6). In the optimum, for each w it must hold that:

$$-\frac{da^*(w)}{dg(w)} f\left[a^*(w), w\right] \left\{(1 + \lambda)\, p[a^*(w)] - c[a^*(w)]\right\} = 0, \tag{10}$$

where:

$$\frac{da^*(w)}{dg(w)} = -\frac{v'\left\{a^*(w) + p\left[a^*(w)\right] + g(w) - t(w) + w\right\}}{\left\{1 + p'\left[a^*(w)\right]\right\} v'\left\{a^*(w) + p\left[a^*(w)\right] + g(w) - t(w) + w\right\} - v'\left[a^*(w) + w\right]} < 0, \tag{11}$$

which follows from (6). Since both $da^*(w)/dg(w)$ and $f\left[a^*(w), w\right]$ are nonzero, the first-order condition (10) reduces to:

$$(1+\lambda)\, p[a^*(w)] - c[a^*(w)] = 0. \tag{12}$$

That is, the optimal grant scheme $g(w)$ is such that for the marginal student from each wealth group, the social return to education equals the marginal cost of education. Clearly, this implies that in the optimum $a^*(w)$ is independent of student's wealth. Tuition $t(w)$ will therefore also be independent of student's wealth, see (3). Totally differentiating (6) with respect to w and g, keeping $a^*(w)$ and $t(w)$ constant, yields:

$$\frac{dg}{dw} = -\frac{v'\left\{a^*(w) + p\left[a^*(w)\right] + g(w) - t(w) + w\right\} - v'\left[a^*(w) + w\right]}{v'\left\{a^*(w) + p\left[a^*(w)\right] + g(w) - t(w) + w\right\}} < 0.$$

Hence, first-order condition (12) can only be satisfied when grants decrease with student's wealth, $g'(w) < 0$.

Proof of Proposition 3:

The government maximizes (5) with respect to $g(w)$ and subject to (3), (6), and (7). In the optimum, for each w it must hold that:

$$-\frac{da^*(w)}{dg(w)} f\left[a^*(w), w\right]\left\{(1+\lambda)\, p[a^*(w)] - c[a^*(w)] - \Lambda g(w)\right\} - \Lambda \int \int_{a^*(w)} f(a, w) \mathrm{d}a \mathrm{d}w = 0, \tag{13}$$

where Λ is the Lagrange-multiplier for the budget constraint, and $da^*(w)/dg(w)$ is given by (11). The first part of first-order condition (13) describes the benefits of increasing grants to students with wealth w. Starting from any uniform grant scheme, $g'(w) = 0$, the marginal benefits of grant provision decrease with student's wealth w since:

1) The term in curly brackets is larger for smaller w since $a^*(w)$ decreases with w, and $p'(a) > 0$ and $c'(a) < 0$.

2) The term $-da^*(w)/dg(w)$ is larger for smaller w by the concavity of $v(\cdot)$. We can rewrite (11) to:

$$\frac{da^*(w)}{dg(w)} = -\frac{1}{1 + p'\left[a^*(w)\right] + \frac{-v'\left[a^*(w)+w\right]}{v'\left\{a^*(w)+p[a^*(w)]+g(w)-t(w)+w\right\}}} < 0.$$

Since $p''(a) = 0$, we only need to know how the last term in the denominator changes when w changes. Straightforward algebra shows that since $v''(\cdot) < 0$ and $v'''(\cdot) \geq 0$, the last term in the denominator increases in w. Hence, $da^*(w)/dg(w)$ increases in w (is closer to zero, the higher is w).

The term $f[a^*(w), w]$ in (13) may decrease or increase with w, depending on the properties of the distribution function. The marginal benefits of grant provision decrease with w if $f[a^*(w), w]$ decreases with w. The second part of (13) describes the budgetary costs of increasing grants to students with wealth w. Starting from any uniform grant scheme, $g'(w) = 0$, the marginal cost of grant provision increase with student's wealth w since $a^*(w)$ decreases with w. After dividing the first-order condition (13) by $f[a^*(w), w]$, the first part of (13) always decreases with w, whereas the second part decreases with w if the condition in Proposition 3 holds. Hence, the condition in Proposition 3 is a sufficient condition for optimality of means-testing government grants.

9 Notation

a Ability

b Consumption benefit of college education

$c(a)$ College's cost of educating a student with ability a

$f(a, w)$ Density of the population as a function of ability a and wealth w

$g(w)$ government-provided grant to a student with wealth w

$p(a)$ Return to education of college graduate with ability a

$t(w)$ Tuition at college for a student with wealth w

$v(\cdot)$ Utility from income

w Wealth

References

[1] Alstadsæter, Annette (2003) “Income tax, consumption value of education, and the choice of educational type.” CESifo Working Paper No. 1055.

[2] Alstadsæter, Annette (2004) “Measuring the consumption value of higher education.” Norwegian School of Economics and Business Administration discussion paper 04/2004.

[3] Andersson, Fredrik and Kai A. Konrad (2003) “Human capital investment and globalization in extortionary states.” *Journal of Public Economics*, 87(7-8): 1539-1555.

[4] Becker, G.S. (1964) *Human capital. A Theoretical and Empirical Analysis, With Special Reference to Education.* New York: Columbia University Press.

[5] Boadway, Robin, Nicolas Marceau, and Maurice Marchand (1996) “Investment in education and the time inconsistency of redistributive tax policy.” *Economica*, 63(250): 171-189.

[6] Bovenberg, A. Lans and Bas Jacobs (2003) “Redistribution and educations subsidies are siamese twins.” CEPR Discussion Paper No. 3309. *Journal of Public Economics*, forthcoming.

[7] Cameron, Stephen and James J. Heckman (1999) “Should college attendance be further subsidized to reduce rising wage inequality?” In: Marvin Kosters (editor), *Financing College Tuition: Government Policies and Educational Priorities*, Washington, DC.: AEI Press.

[8] Carneiro, Pedro, Karsten T. Hansen, and James J. Heckman (2003) “Estimating distributions of treatment effects with an application to the returns to schooling and measurement of the effects of uncertainty on college choice.” *International Economic Review*, 44(2): pp. 361-422.

[9] De Fraja, Gianni (2005) “Reverse discrimination and efficiency in education.” *International Economic Review*, 46(3): 1009-1031.

[10] Department of Education and Science (2003) *Supporting Equity in Higher Education; A Report to*

the Minister of Education and Science. Dublin. http://www.education.ie/servlet/blobservlet/he_supporting_equity.pdf

[11] Dur, Robert and Coen Teulings (2004) "Are Education subsidies an efficient redistributive device?" In: Jonas Agell, Michael Keen and Alfons J. Weichenrieder (editors), *Labor Market Institutions and Public Regulation*, pp. 123-161, Cambridge, Massachusetts: MIT Press.

[12] Dur, Robert, Coen Teulings, and Thijs van Rens (2004) "Should higher education subsidies depend on parental income?" *Oxford Review of Economic Policy*, 20(2): 284-297.

[13] Dynarski, Susan (2000) "Hope for whom? Financial aid for the middle class and its impact on college attendance." *National Tax Journal*, 53(3-2): 629-661.

[14] Epple, Dennis and Richard E. Romano (1998) "Competition between private and public schools, vouchers, and peer-group effects." *American Economic Review*, 88(1): 33-62.

[15] Epple, Dennis, Richard Romano, and Holger Sieg (2004) "Admission, tuition, and financial aid policies in the market for higher education." Mimeo, Carnegie Mellon University.

[16] Fernandez, Raquel and Jordi Gali (1999) "To each according to ... ? Markets, tournaments, and the matching problem with borrowing constraints." *Review of Economic Studies*, 66(4): 799-824.

[17] Harmon, Colm, Hessel Oosterbeek, and Ian Walker (2003) "The returns to education: Microeconomics." *Journal of Economic Surveys*, 17(2): 115-155.

[18] Heckman, James J., Lance Lochner, and Christopher Taber (1999) "General-equilibrium cost-benefit analysis of education and tax policies." In: G. Ranis and L.K. Raut (editors), *Trade, Growth, and Development*, pp. 291-349, Amsterdam: Elsevier Science.

[19] Jacobs, Bas and Sweder J.G. van Wijnbergen (2005) "Capital market failure, adverse selection and equity financing of higher education." Tinbergen Institute Discussion Paper 2005-037/3.

[20] Judd, Kenneth L. (2000) "Is education as good as gold? A portfolio analysis of human capital investment." Mimeo, Hoover Institution.

[21] Kane, Thomas J. (1994) "College entry by Blacks since 1970: The role of college costs, family background, and the returns to education." *Journal of Political Economy*, 102(5): 878-911.

[22] Lazear, Edward (1977) "Education: consumption or production?" *Journal of Political Economy*, 85(3): 569-598.

[23] Lucas, R. (1988) "On the mechanics of economic development." *Journal of Monetary Economics*, 22: 3-42.

[24] Malchow-Møller, Nikolaj and Jan Rose Skaksen (2004) "How to finance education — Taxes or tuition fees?" CEBR discussion paper 2003-28.

[25] McPherson, Michael S. and Morton Owen Schapiro (1991) "Does student aid affect college enrollment? New evidence on a persistent controversy." *American Economic Review*, 81(1): 309-318.

[26] Moretti, Enrico (2004), "Estimating the social return to higher education: Evidence from longitudinal and repeated cross-sectional data." *Journal of Econometrics*, 121(1-2): 175-212.

[27] National Center for Education Statistics (2003) "How families of low- and middle-income undergraduates pay for college: Full-time dependent students in 1999-2000." http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2003162.

[28] Oosterbeek, Hessel and Hans van Ophem (2000) "Schooling choices: Preferences, discount rates, and rates of return." *Empirical Economics*, 25: 15-34.

[29] Romer, P. (1986) "Increasing returns and long run growth." *Journal of Political Economy*, 94(5): 1002-1037.

[30] Romer, P. (1990) "Endogenous technological change." *Journal of Political Economy*, 98(5): S71-102.

[31] Rothschild, Michael and Lawrence J. White (1995) "The analytics of the pricing of higher education and other services in which the customers are inputs." *Journal of Political Economy*, 103(3): 573-586.

[32] Rothstein, Jesse M. (2004) "College performance predictions and the SAT." *Journal of Econometrics*, 121(1-2): 297-317.

[33] Schultz, Theodore W. (1960) "Capital formation by education." *Journal of Political Economy*, 68(6): 571-583.

[34] Sianesi, Barbara and John Van Reenen (2003) "The returns to education: Macroeconomics." *Journal of Economic Surveys*, 17(2): 157-200.

[35] Stanley, Marcus (2003) "College education and the midcentury GI bills." *Quarterly Journal of Economics*, 118(2): 671-708.

[36] Teulings, Coen and Thijs van Rens (2003) "Education, growth and income inequality." CEPR discussion paper 3863.

[37] Wickelgren, Abraham L. (2001) "The efficiency of affirmative action with purely historical discrimination." Mimeo, University of Texas at Austin.

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