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University Graduation Dependent on Family's Wealth, Ability and Social Status

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Abstract

This paper presents a model showing an incentive for a group of people to vote for higher tuition fees, even if these fees have no quality effect. The incentive is based on a non-monetary influence on utility, namely the social status or prestige of graduating. The basic assumption is that the higher the prestige is, the lower the number of people studying. In a static equilibrium, it is shown that a group of wealthier and more able people can exist that attempts to prevent others from studying.

JEL: I22, J24, H52

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1 Introduction

Nowadays, tuition fees are the topic of discussion in many countries, particularly whether they should be introduced, increased, decreased or abolished. Three examples follow. In the U.S., tuition fees have always been charged. The tuition fees range from 3,000 to 40,000 dollars per year. England extended its permission to charge tuition fees from 1,000 to 3,000 pounds per year in 2005 (Frankfurter Allgemeine Zeitung (2005)). Currently, the House of Commons gave permission to increase the fees to up to 9,000 pound starting in 2012, accompanied by heavy student protests (Frankfurter Allgemeine Zeitung (2010)). In Germany, the reform of federalism in 2006 led to several readjustments in the distribution of the authority between the states and the federal government. The authority for education was largely shifted to the states. Accordingly, until present, seven German states introduced tuition fees in this move. But some have already returned to a fee-free system (Deutsches Studentenwerk e.V. (2009)).

By charging tuition fees, the amount of students may decline, which leads to a better standing of having a university degree. Huebner (2009) shows a small but significant reduction in the enrolment rates in seven German states after the introduction of a 1,000 Euro fee per year. The present paper takes the scarcity of students as a basis for higher status after graduating. As a result, more able and/or richer people could gain by artificially reducing the amount of students.

In contrary to Heckman (1976), who introduced a model, in which investment in human capital also results in better allocation of leisure and therefore increases "private" utility, the present paper introduces a model with an independent non-monetary utility increase, making people more inclined to study at university. This independent variable is the social status or the prestige being attained with a university degree. But the model can also cover additional non-monetary factors, e.g. an occupation which better fits to a personal's disposition and (at least until chapter 4) the joy of learning or of student's life.

With the controversial debate for and against tuition fees, people in favor often mention the quality effect for the students when the university has more money to spend to improve study conditions. Schwager (2008) presents a model in which the state is runs universities. The state chooses the quality with a trade-off between the value of local immobile students and the cost of running the universities. The higher the tuition, the lower the net costs for universities until too many students do not enroll into university. To keep the model simple, this paper does not take the quality effect into account. And since all students would more or less benefit from better study conditions, this would likely only shift the opinion of the more ables students towards higher fees.

Another model, presented by Kemnitz (2005), deals with the decision to study or not to study and describes the utility function as being dependent on the lifetime income. This model deals with the abolishment of the ban on tuition fees. The author assumes a relation between the quality effect for higher education and the amount of tuition.

Gary-Bobo and Trannoy (2008) present a signaling model in which universities are social surplus maximizers or profit maximizers. When assuming a welfare state and universities driven by the state, one would presume universities as social surplus maximizers. The students' decision to study depends on their wage surplus from studying which in turn depends on the intellectual ability.

All people maximize their own utility by maximizing their lifetime income with subtracted costs of study (Schultz (1961)). In other words, the young people calculate the benefits and efforts of "purchasing" a university degree. This is referred to as the investment approach (Campbell and Siegel (1967)). The costs of study include the effort of passing exams, but also different costs of living, books and opportunity costs in the form of income loss during the years of study. In the end, the investment must raise the individual utility compared to the opportunity decision. But this differs between richer and poorer families. Rich people would value the effort to study higher than poor people would and they would value the utility loss of paying tuition fees lower than poor people would.

Becker (1975) developed a detailed theory about human investment with costs and returns. The model in the present paper simplify the details by summarizing the variables for costs and earnings in a single variable.

Costs include tuition fees for attending university. This paper focuses on these tuition fees. It introduces a model which may help to explain a possible incentive of some classes within the society to impose a levy on the attendance of universities, fixing the fees at a level as high as possible. The assumption is that richer people are more interested in obtaining a high social status and therefore in raising their utility by obtaining prestige. Poor people, on the other hand, are firstly concerned in extending their finances. They raise their utility more quickly by obtaining more money, due to decreasing marginal utility of money.

2 The model

In the model, each student or non-student has a family, but no siblings or children. Each family has accumulated wealth of an individual value w. The student's utility consists of two variables: The first is the wage or income y he gets during his lifetime including w (this can be interpreted as income through inheritance). The second one is called the social status or prestige s. This variable has until chapter 4 two states, 0 if the person doesn't study and a positive value when she graduates (to study and fail is not an option). A student i has an individual utility function:

$$U_i = U(y_i, s_i).$$

A student may value these two variables in different ways. The assumption is that the evaluation depends on family's wealth. As stated before, this wealth (w) is included in the lifetime income y. The higher the lifetime income is, the more she will value the benefit of the status. The poorer the family is, the more he will value the higher income. Therefore, the utility of any student can be expressed as a function dependent on y and s $[U(y, s)]$ shown in figure 1. The assumptions are $\frac{\partial^2 U(y,s)}{\partial y \partial s} > 0$ and $\frac{\partial^2 U(y,s)}{\partial y^2} < 0$. But as we will see later, the results still hold, if we relax the first assumption to $\frac{\partial^2 U(y,s)}{\partial y \partial s} \geq 0$ and allow the same utility increase in s for any person.

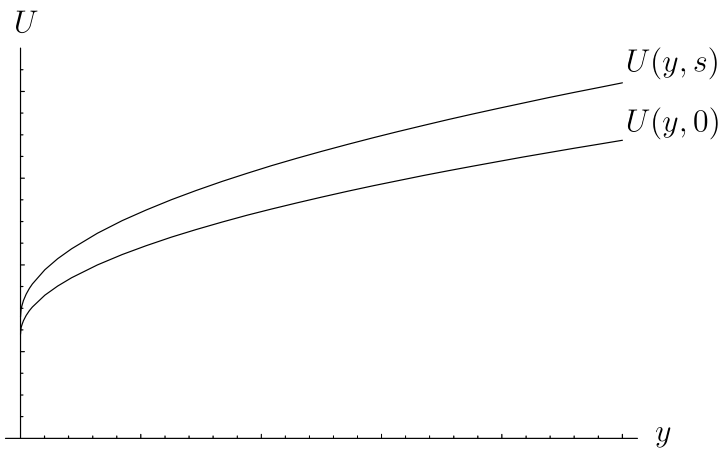


Figure 1: The utility U as a function of y (income including wealth) with and without a fixed value of the social status s; $\frac{\partial^2 U(y,s)}{\partial y \partial s} > 0$.

For the years of study all students pay an amount p for studying, including tuition fees. But afterwards they get a higher income $\alpha \Delta y$, compared to the income they would earn without studying. The Δy should be understood as the (minimum) difference in lifetime income, discounted to a specific time. This paper doesn't concentrate on interest rates or taxes, so Δy will be treated as a fixed value. Δy should also be understood as a actuarial expectation value with decision under uncertainty. No student can be sure to get a better payed job after studies. But since any person can have different abilities, the later income also depends on the individual ability level $\alpha \in [1, \overline{\overline{\alpha}}]$. The variable α can be interpreted as higher income through better grade, faster study and therefore a longer income period or just to receive a better paid job with good results in the assessment center. The utility function for any student is a function of $y = w + \alpha\Delta y - p$ and the non-monetary value s:

$$U = U(w + \alpha\Delta y - p, s). \tag{1}$$

Any person not studying has the utility:

$$U = U(w, 0). \tag{2}$$

3 Society divided into students and non-students by wealth and ability

There is a continuum of students, ordered by wealth and ability. The number of students is normalized at unity with density function $f(w, \alpha)$ and distribution function $\int_1^{\overline{\overline{\alpha}}} \int_0^{\overline{\overline{w}}} f(w, \alpha) dw d\alpha$, where $\overline{\overline{w}}$ is the richest realisation and $\overline{\overline{\alpha}}$ is the most able realisation in society.

Proposition 1. If there are individuals not studying at a given ability $\overline{\alpha}$, beside not all individuals with this ability reject studying, there is one $\widetilde{w}$, where for a given p, all young people sort themselves into two groups such that one group with the size $\int_0^{\widetilde{w}} f(w, \overline{\alpha}) dw$ are persons **not** studying. The other group with size $\int_{\widetilde{w}}^{\overline{\overline{w}}} f(w, \overline{\alpha}) dw$ are students.

Proof. See Appendix.□

Figure 2 shows the functions $U(w, 0)$ and $U(w + \overline{\alpha}\Delta y - p, s)$. All people with $w < \widetilde{w}$ choose not to study and get the utility from $U(w, 0)$. For a given $\overline{\alpha}\Delta y - p < 0$ there is one indifferent person with $w = \widetilde{w}$, getting the same utility on both functions: $U(\widetilde{w}, 0) = U(\widetilde{w} + \overline{\alpha}\Delta y - p, s)$. All people with $w > \widetilde{w}$ are getting a higher utility on $U(w + \overline{\alpha}\Delta y - p, s)$ than on the function $U(w, 0)$.

With $\overline{\alpha}$ all investigated persons are assumed to have the same intellectual ability, but society consists of persons with different abilities, $\alpha \in [1, \overline{\overline{\alpha}}]$. The indifferent person must

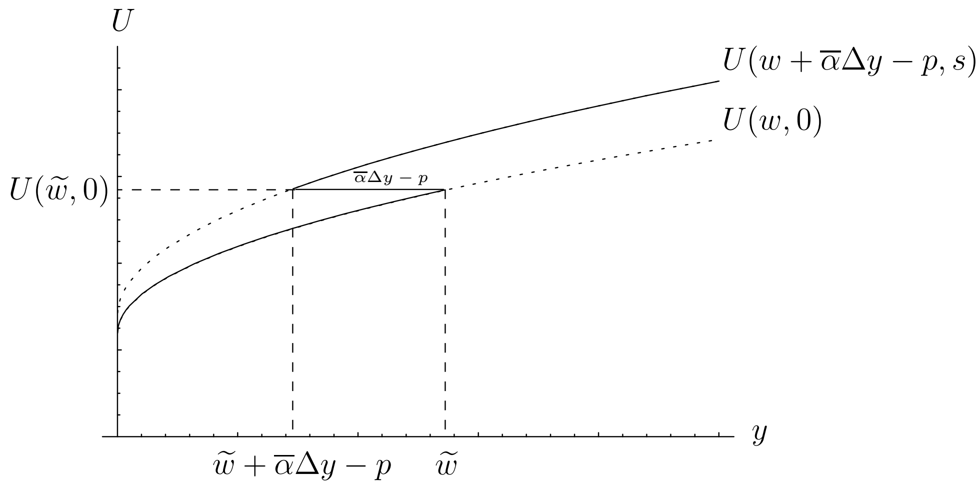


Figure 2: The utility after study decision below $\widetilde{w}$ and above.

have an $\alpha = \widetilde{\alpha}$, so that p is higher than $\widetilde{\alpha}\Delta y$. If $\widetilde{\alpha}\Delta y$ is higher or equal p, there will be no one indifferent, because the social status is per definition positive and anybody with this intellectual ability would study, independent of his monetary background (see fig. 2; $\overline{\alpha}\Delta y - p < 0$).

If there are individuals not studying at a given wealth $\overline{w}$, beside not all individuals with this wealth reject studying, there will also be one $\widetilde{\alpha}$, where for a given p, all young people sort themselves into two groups, where the more able people choose to study.

Proposition 2. There is a bijective relation between $\widetilde{\alpha}$ and $\widetilde{w}$. This function, $\widehat{w}(\alpha)$ or $\widehat{\alpha}(w)$, has a negative slope, where $0 < w < \overline{\overline{w}}$ and $1 < \alpha < \overline{\overline{\alpha}}$:

$$\widehat{w}(\alpha) = \begin{cases} \widetilde{w}(\alpha) & \text{if } \widetilde{w}(\alpha) > 0, \widetilde{w}(\alpha) < \overline{\overline{w}} \\ \overline{\overline{w}} & \text{if } \widetilde{w}(\alpha) > \overline{\overline{w}} \\ 0 & \text{if } \widetilde{w}(\alpha) < 0 \end{cases} \tag{3}$$

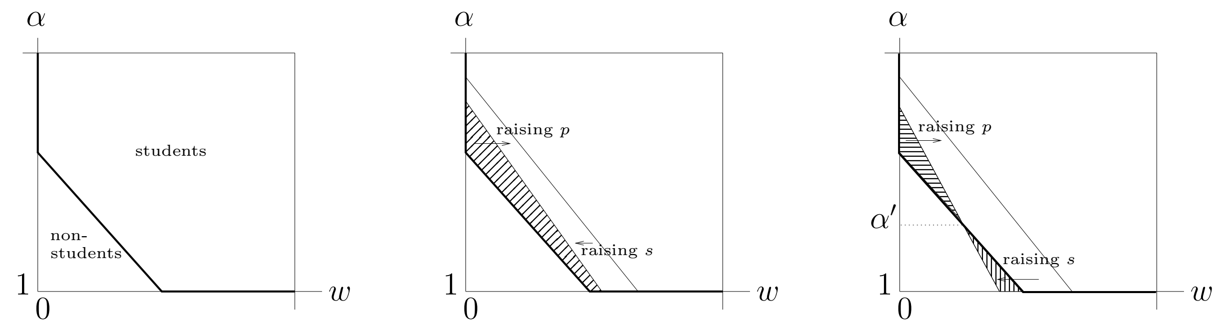
$$\widehat{\alpha}(w) = \begin{cases} \widetilde{\alpha}(w) & \text{if } \widetilde{\alpha}(w) > 0, \widetilde{\alpha}(w) < \overline{\overline{\alpha}} \\ \overline{\overline{\alpha}} & \text{if } \widetilde{\alpha}(w) > \overline{\overline{\alpha}} \\ 0 & \text{if } \widetilde{\alpha}(w) < 1. \end{cases} \tag{4}$$

Proof. The generalized indifference condition from (20) ($\overline{\alpha} \equiv \widetilde{\alpha}$) is an indirect function $\widehat{\alpha}(w)$ with derivative:

$$\frac{d\widehat{\alpha}}{dw} = -\frac{\frac{\partial U(\widetilde{w}+\widetilde{\alpha}\Delta y-p,s)}{\partial y} - \frac{\partial U(\widetilde{w},0)}{\partial y}}{\frac{\partial U(\widetilde{w}+\widetilde{\alpha}\Delta y-p,s)}{\partial y}\Delta y}. \tag{5}$$

The denominator of (5) is positive, since money always increases utility and Δy without the costs of the studies are also positive. The numerator is also positive if $\widetilde{\alpha}\Delta y - p < 0$. This means in the normal case with existence of an indifferent person, (5)< 0. So there is an indifference function $\widehat{\alpha}(w)$ with a negative slope. The inverse function $\widehat{w}(\alpha)$ can be proven analogous.□

This bijective function is shown in figure 3(a) as $\widehat{\alpha}(w)$.



(a) The indifference-relation between α and w.

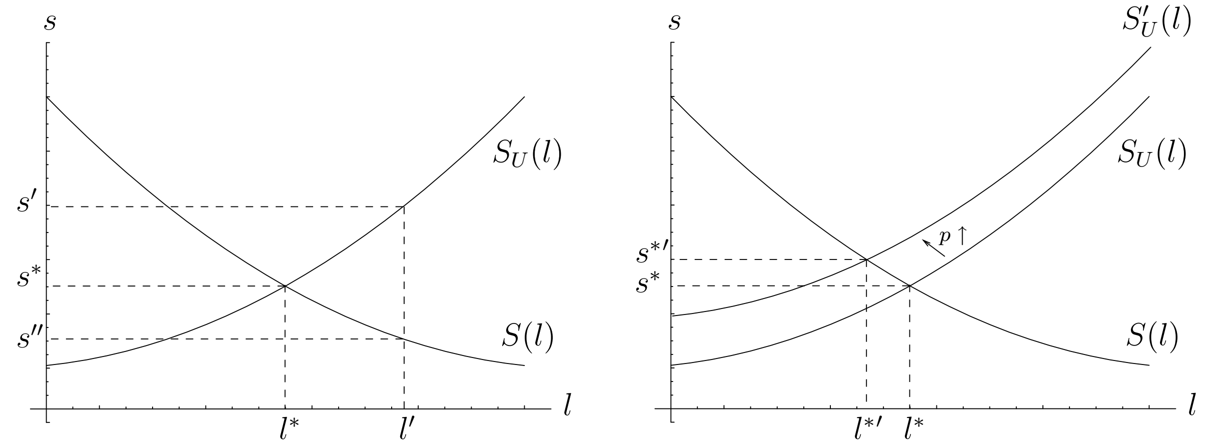
(b) The indifference-relation between α and w, raising p, then raising s.

(c) The same reaction like 3(b), but the richest indifferent person is now afterwards better off. The horizontally hatched area must be bigger than the vertically hatched area.

Figure 3: The students/non-students separating function, dependent on α and w. The area above the line shows the share of students in society. The area below represents the share of non-students.

4 Status depends on the quantity of graduates

Until now the status (s) was treated as a fixed positive value. Now assume that s depends on the number of graduates (l). The more graduates the economy has, the less prestige one will derive from graduating. This direct relation is called $S(l)$, $S'(l) < 0$. From the individuals' point of view we get the opposite relation. When s increases, $\widetilde{w}$ decreases and with decreasing $\widetilde{w}$ the share of students (l) will increase. The relation is called $l(S_U)$, or for better comparison the inverse $S_U(l)$. In the static equilibrium, all people with specific α and w, which in combination leads to a higher status when graduating, will do so. This can be expressed as $l = \int_1^{\overline{\overline{\alpha}}} \int_{\widehat{w}(\alpha)}^{\overline{\overline{w}}} f(w,\alpha) dw d\alpha$, where $\widehat{w}(\alpha)$ is the students/non-students separating function (3), see also figure 3(a).



(a) Status s established by the society ($S(l)$) and an indirect function ($S_U(l)$), showing how many persons would study, dependent on the status s.

(b) Scrolling $S_U(l)$ by raising p. A new equilibrium at $(l^{*\prime}, s^{*\prime})$ is established.

Figure 4: Dependencies between social status, number of graduates and changing p. Where status and number of students are derived endogenously within a simultaneous equilibrium.

In figure 4(a) these static equilibrium relations are shown. Starting at the high status s'. For this status a specific low $\widetilde{w}$ will establish with corresponding high number of students l'. But this number of students will establish the low status s'' in society. In equilibrium s^* and l^* will establish.

For analysis of the simultaneous equilibrium, two equations must hold:

$$l - L(s,p) = 0, \tag{6}$$

$$s - S(l) = 0. \tag{7}$$

Where $L(s,p) = \int_1^{\bar{\bar{\alpha}}} \int_{\widetilde{w}(\alpha)}^{\bar{\bar{w}}} f(w,\alpha) dw d\alpha$, corresponding to the $S_U(l)$ function.

What happens to $S_U(l)$, if p changes or in other words if $S_U(l)$ is shifted, where is the new simultaneous equilibrium $s^*(p)$? From total differential of (6) and (7)

$$\begin{aligned} dl - \frac{\partial L}{\partial s} ds - \frac{\partial L}{\partial p} dp &= 0, \\ ds - \frac{\partial S}{\partial l} dl &= 0. \end{aligned}$$

we derive:

$$\frac{ds^*(p)}{dp} = \frac{\frac{\partial S}{\partial l}\frac{\partial L}{\partial p}}{1 - \frac{\partial L}{\partial s}\frac{\partial S}{\partial l}}. \tag{8}$$

Proposition 3. A raise in price, will lead to a higher status in equilibrium and vice versa. In other words $\frac{ds^*(p)}{dp} > 0$.

Proof. See Appendix.□

5 Who is in favor of tuition fees?

When p is not given exogenous, but can be set e.g. by election, the question arises: Who could have an interest in raising or lowering p? In other words, who is loser and who is winner when p is rised? The utility function is redefined as dependent on w, α and p, where equilibrium status is endogenously determined by p according to (6) and (7).

$$V(w, \alpha, p) \equiv U(w + \alpha\Delta y - p, s^*(p)). \tag{9}$$

Differencing $\frac{\partial V}{\partial p}$ gives:

$$\frac{\partial V}{\partial p} = -\frac{\partial U(w + \alpha\Delta y - p, s^*(p))}{\partial y} + \frac{\partial U(w + \alpha\Delta y - p, s^*(p))}{\partial s^*(p)} \frac{ds^*(p)}{dp}.$$

The first part is the direct effect on utility for lowering the wealth or respectively for raising fees. The second term is the effect on utility for the indirect rise of status multiplied with the actual rise in s. The total effect on utility depends on the strength of both effects:

$$\frac{\partial V}{\partial p} \begin{cases} > 0 & \text{if } \frac{\partial U(w+\alpha\Delta y-p,s^*(p))}{\partial s^*(p)} \frac{ds^*(p)}{dp} > \frac{\partial U(w+\alpha\Delta y-p,s^*(p))}{\partial y} \\ < 0 & \text{if } \frac{\partial U(w+\alpha\Delta y-p,s^*(p))}{\partial s^*(p)} \frac{ds^*(p)}{dp} < \frac{\partial U(w+\alpha\Delta y-p,s^*(p))}{\partial y}. \end{cases} \tag{10}$$

The higher w, the lower is the income effect $\frac{\partial U(w+\alpha\Delta y-p,s^*(p))}{\partial y}$ and the higher is the effect on utility by rising status. In the upper part of the old indifference line, the former indifferent person had been loser in raising p, if he would have studied. But since he was indifferent, he can switch to no-study. If the crowding out effect for the poorer people is high enough, situation figure 3(c) can occur. Then the richer indifferent persons would win in rising p.

In situation figure 3(b) there are five groups now in society. The group of people poorer than $\widetilde{w}(\alpha)$ don't care about the fees. They don't study anyway and don't win or lose by rising p. The second group ranges from $\widetilde{w}(\alpha)$ to the indifference point of the new indifference function. They are losers by raising p. They change their decision for study. They would have studied before the rise and will now decline to study. They lose utility in the amount of $U(w + \alpha\Delta y - p^o, s^{o*}(p)) - U(w, 0)$ (^{o} = old value). The third group still studies, but the price-effect is higher than the status effect (see (10), $\frac{\partial V}{\partial p^o} < 0$). The forth

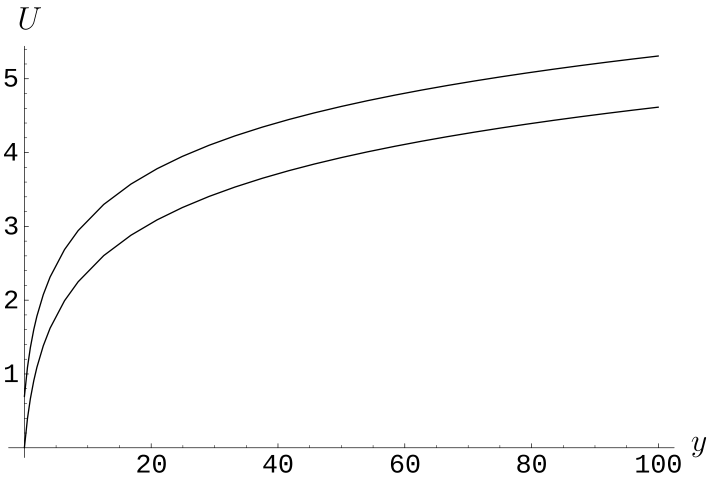


Figure 5: Individual utility, dependent on y, with $s = 1$ $(U(y, s) = ln(y + 1) + ln(2)$ and $U(y, s) = ln(y + 1))$.

group had an incentive to raise p, but not as much as it has been raised ($\frac{\partial V}{\partial p} < 0 < \frac{\partial V}{\partial p^o}$). They are now against further raising. The fifth group win after the raise, their price-effect is lower than the gain on rising status.

In situation figure 3(c) with $\alpha > \alpha'$, we have the same five groups. For the indifferent person with $\alpha = \alpha'$, the status effect cancels the price effect exactly out. But this does not mean, that there is no winner in rising p. Since the status is higher than before, the utility function is steeper now. All people with $w(\alpha') > \widetilde{w}(\alpha')$ are winners in raising p. On this level of α there are no losers in raising p. This applies for all $\alpha \leq \alpha'$. This means in situation figure 3(c) there is a big winning group, when p is raised. This group includes all students with $\alpha \leq \alpha'$, but also a number of students with $\alpha > \alpha'$ with higher wealth.

But even if normal reaction (figure 3(b)) occurs, there can be a group in the right region (the rich part of society), gaining more from higher status than losing from higher prices for university. If there exists such a group and how big it is depends on the disparity of wealth in the society.

6 Example

For the example we choose an additive reparable utility function:

$$U(y, s) = ln(y + 1) + ln(s + 1), \tag{11}$$

$$\frac{\partial^2 U}{\partial^2 y} = \frac{-1}{(y + 1)^2}, \tag{12}$$

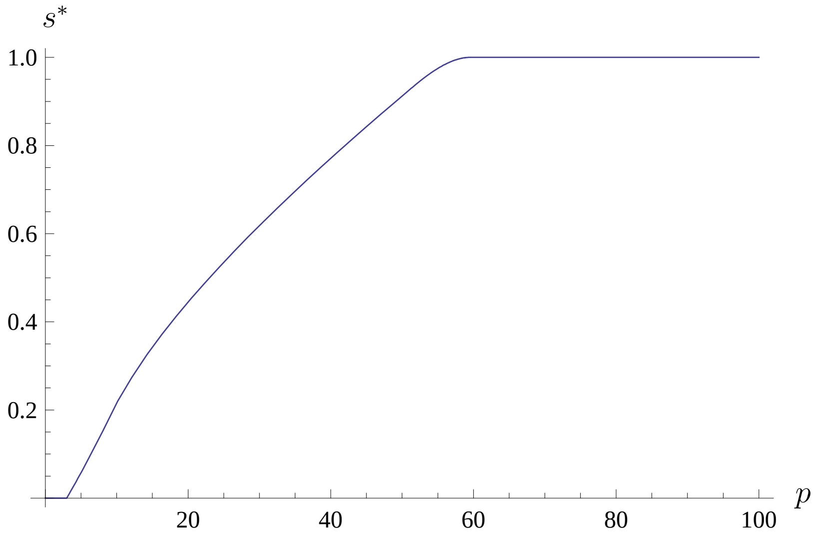


Figure 6: Status dependent on the price to study, $\Delta y = 3$, $1 \leq \alpha \leq 3$, $0 \leq w \leq 100$.

$$\frac{\partial^2 U}{\partial y \partial s} = 0. \tag{13}$$

The individual income under study decision equals:

$$y = w + \alpha \Delta y - p. \tag{14}$$

The individual income without decision to study:

$$y = w. \tag{15}$$

For an individual in an economy with $s = 1$, the utility functions dependent on y can be found in figure 5. Since we modeled an additive separable utility function, there is just a shift and no rotation between the function for study and for no study. With presumable non negative and non zero utilities the indifference can be expressed as:

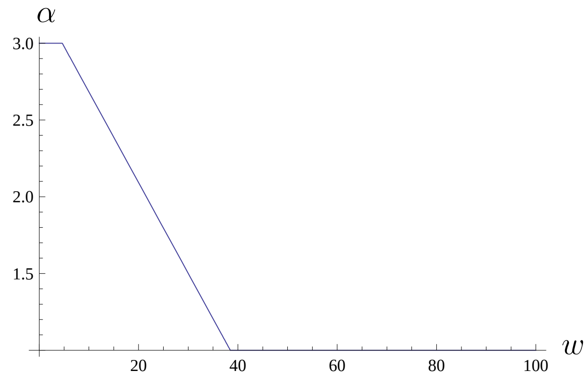
$$\begin{aligned} ln(\widetilde{w} + \alpha\Delta y - p + 1) + ln(s+1) &= ln(\widetilde{w} + 1), \\ (\widetilde{w} + \alpha\Delta y - p + 1)(s+1) &= \widetilde{w} + 1, \end{aligned} \tag{16}$$

$$\widetilde{w}(\alpha) = \frac{(\alpha\Delta y - p)(s+1)}{s} - 1. \tag{17}$$

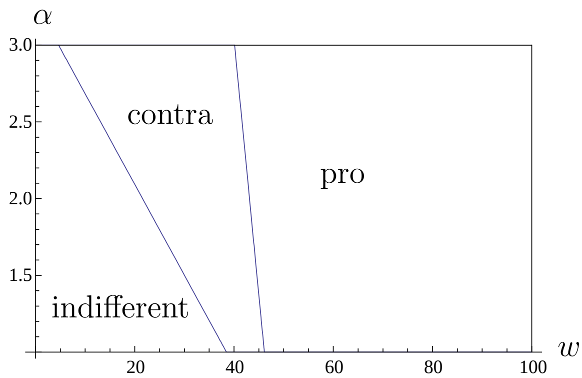
In the example I assume α between 1 and 3 and w between 0 and 100. For simplicity I assume an uniform distribution over all α and w. Hence the social functions can be expressed as follows:

$$L_U(s,p) = \int_1^3 \int_{\widehat{w}(\alpha)}^{100} \frac{1}{200} dw d\alpha, \tag{18}$$

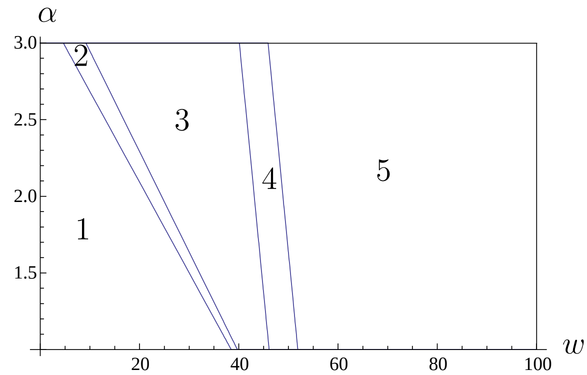
$$L(s) = 1 - s. \tag{19}$$



(a) Indifference line with price for study $p = 10$.



(b) Pro and contra for a price raise at $p = 10$.



(c) Groups in society, raising the price from $p = 10$ to $p = 11$.

Figure 7: Indifference line to study (fig. 7(a)). Indifference line for a price change ($\frac{\partial V}{\partial p}$) with resulting pro and contra groups for raising prices (fig. 7(b)). Groups in society, raising p from 10 to 11 (fig. 7(c)).

The income difference Δy is set to 3. Now there is a status function, dependent on the price to study (fig. 6). The status is 0 until the price gets higher than 3, because with $p \leq 3$ even the most unable person would gain (or at least does not lose) when studying, independently of his family wealth.

If we set a price level for study to 10, we can find the indifferent persons for study and for changing prices (fig. 7). In figure 7(a) the indifference line for studying is shown. Figure 7(b) shows in addition the indifference line for a price change. This leads to three groups voting for an infinitesimal little change in price. If there is a plan to change the price from 10 to 11, the already mentioned (see chapter 5) 5 groups will appear (fig. 7(c)).

In this example at $p = 10$ the group in favor of raising prices to $p = 11$ is quite high (group 5 in fig. 7(c)). Since group 1 is indifferent, there would be a good chance, that the median voter is in favor of raising the price. But this is not clear. Though group 1 is indifferent, they are more likely against the raise, in the hope of being able to lower the price some when.

And on the other hand, the higher the price the smaller this group will be. Finally, when p is high enough only the smartest and richest upper right corner group will be in favor raising the price.

7 Conclusion

In this paper a model is presented to explain a possible incentive for the richer and/or more able subset of a society to raise tuition fees, even if there is no direct utility such as better study conditions or better equipment. The fundamental idea is a non-monetary utility influence through a "social status", which increases if fewer people decide to study.

The model is kept as simple as possible. Hence, the quality effect of tuition is not considered to concentrate on the influence of the status effect. And if one takes into account a possible uncertainty for the poor about future income and the fear of running into debt, the presented crowding out effect could be even stronger.

Another reason why the effect could be stronger than demonstrated, is because even if utility of life would increase by attending university, some might refrain from enrolling due to uncertainty and incorrect assessment of opportunities in future.

More over, this paper does not say anything about political influence and size of the group in favor of tuition fees. When thinking about a median voter situation, this group will likely not be large enough to raise the tuition markedly. But if there is no popular vote for the fees, the influence of the richer group in the form of representatives could be even higher.

Social planners must be aware that charging tuition fees will prevent some people from attaining universities, namely the poor and less able people. The social problem results when the poorer do not enroll solely due to a high utility value loss if they had payed tuition.

8 Appendix

Proof of Proposition 1 The cross-derivative $\frac{\partial^2 U(y,s)}{\partial y \partial s} \geq 0$ must hold (richer people have the same or higher marginal utility from social status, see fig. 1, showing $\frac{\partial^2 U(y,s)}{\partial y \partial s} > 0$), so that there is one threshold dividing the persons by wealth w. First consider a student, indifferent between study and no study. His wealth is $w = \widetilde{w}$. The utility must hold:

$$U(\widetilde{w} + \overline{\alpha}\Delta y - p, s) = U(\widetilde{w}, 0). \tag{20}$$

Now consider a student, whose wealth is above the threshold, $w > \widetilde{w}$. The utility is

$$U(w + \overline{\alpha}\Delta y - p, s) = U(\widetilde{w} + \overline{\alpha}\Delta y - p, s) + \int_{\widetilde{w}}^{w} \frac{\partial U(z + \overline{\alpha}\Delta y - p, s)}{\partial z} dz$$

if he studies and

$$U(w, 0) = U(\widetilde{w}, 0) + \int_{\widetilde{w}}^{w} \frac{\partial U(z, 0)}{\partial z} dz$$

if he doesn't. The difference in the utilities is:

$$\begin{aligned} &U(w + \overline{\alpha}\Delta y - p, s) - U(w, 0) \\ &\quad = U(\widetilde{w} + \overline{\alpha}\Delta y - p, s) - U(\widetilde{w}, 0) + \int_{\widetilde{w}}^{w} \left[\frac{\partial U(z + \overline{\alpha}\Delta y - p, s)}{\partial z} - \frac{\partial U(z, 0)}{\partial z} \right] dz. \end{aligned}$$

The first two terms on the right hand side are equal, because a person with $w = \widetilde{w}$ is indifferent between study and no study (see (20)). Therefore,

$$U(w + \overline{\alpha}\Delta y - p, s) - U(w, 0) = \int_{\widetilde{w}}^{w} \left[\frac{\partial U(z + \overline{\alpha}\Delta y - p, s)}{\partial z} - \frac{\partial U(z, 0)}{\partial z} \right] dz. \tag{21}$$

If $\frac{\partial^2 U(y,s)}{\partial y \partial s} \geq 0$ holds,

$$\frac{\partial U(y, s)}{\partial y} \geq \frac{\partial U(y, 0)}{\partial y}. \tag{22}$$

The marginal utility of money (y) decreases, $\frac{\partial^2 U(y,s)}{\partial y^2} < 0$ and $\overline{\alpha}\Delta y < p$ (otherwise the indifference in (20) would not hold):

$$\frac{\partial U(w + \overline{\alpha}\Delta y - p, s)}{\partial y} > \frac{\partial U(w, s)}{\partial y}. \tag{23}$$

Comparing (22) and (23) with the inner square bracket of (21) shows that

$$\frac{\partial U(w + \overline{\alpha}\Delta y - p, s)}{\partial y} > \frac{\partial U(w, s)}{\partial y} \geq \frac{\partial U(w, 0)}{\partial y}, \tag{24}$$

and hence (21)> 0 for all $y \in (\widetilde{w}, w]$. So any student with $w > \widetilde{w}$ will study. By analogous argument, one can conclude, that all individuals with $w < \widetilde{w}$ choose not to study.□

Proof of Proposition 3 The crucial parts are the changes in $L(s, p)$ with respect to s and p. At first we look at $\frac{\partial L}{\partial s}$:

$$\frac{\partial L}{\partial s} = \int_{1}^{\overline{\overline{\alpha}}} \frac{\partial A(\alpha, \widehat{w}(\alpha, s, p))}{\partial s} d\alpha. \tag{25}$$

with $A(\alpha, \widehat{w}(\alpha, s, p)) = \int_{\widehat{w}(\alpha,s,p)}^{\overline{\overline{w}}} f(w, \alpha)dw$, the share of students for a given α. From the partial $\frac{\partial A}{\partial s} = \frac{\partial A}{\partial \widehat{w}} \frac{\partial \widehat{w}}{\partial s}$ we derive:

$$\frac{\partial A}{\partial s} = -f(\widehat{w}(\alpha, s, p), \alpha) \frac{\partial \widehat{w}(\alpha, s, p)}{\partial s}. \tag{26}$$

And from indifference constraint (20) we derive for $\frac{d\widehat{w}}{ds}$ for the interior solution ($\widehat{w} = \widetilde{w}$):

$$\frac{d\widehat{w}}{ds} = -\frac{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial s}}{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial y} - \frac{\partial U(\widehat{w},0)}{\partial y}}. \tag{27}$$

If $\widehat{w} = 0$, because at this α there is no indifferent person $\widetilde{w}$ (all people having this α will study), or because $\widehat{w}$ already reached maximum $\overline{\overline{w}}$, $\frac{d\widehat{w}}{ds} = 0$ and therefore $\frac{\partial L}{\partial s} = 0$:

$$\frac{d\widehat{w}}{ds} = \begin{cases} -\frac{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial s}}{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial y} - \frac{\partial U(\widehat{w},0)}{\partial y}} & \text{if } \widehat{w} = \widetilde{w} \\ 0 & \text{if } \widehat{w} = 0, \text{ or } \widehat{w} = \overline{\overline{w}}. \end{cases} \tag{28}$$

The whole effect over all α can be written as:

$$\frac{dL}{ds} = \int_1^{\alpha_0(s,p)} f(\widehat{w}(\alpha, s, p), \alpha) \frac{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial s}}{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial y} - \frac{\partial U(\widehat{w},0)}{\partial y}} d\alpha \tag{29}$$

Where $\alpha_0(s, p)$ is that α, where the indifferent person is just not existent anymore ($\widehat{w}(\alpha, s, p) = 0$).

$\frac{\partial L}{\partial p}$ can be expressed in a similar way:

$$\frac{dL}{dp} = \int_1^{\alpha_0(s,p)} -f(\widehat{w}(\alpha, s, p), \alpha) \frac{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial y}}{\frac{\partial U(\widehat{w}+\alpha\Delta y-p,s)}{\partial y} - \frac{\partial U(\widehat{w},0)}{\partial y}} d\alpha. \tag{30}$$

Now we can value the sign of (8). Since $\frac{\partial L}{\partial p} < 0$ and $\frac{\partial S}{\partial l} < 0$, the numerator is positive. The denominator is also positive, since $\frac{\partial L}{\partial s} > 0$ and $\frac{\partial S}{\partial l} < 0$. This means if p rises, the amount of students must decline and therefore s in equilibrium is rising.

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