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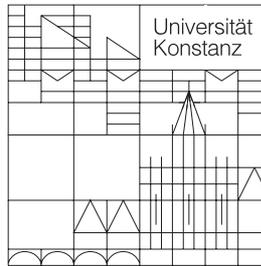
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**Policies in Tertiary Education and the
Change in Attendance and
Time-to-Degree**

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Zusammenfassung:

This paper investigates the effect of reforms on the time-to-degree and attendance at colleges. My model predicts that with imperfect credit markets imposing tuition fees may raise instead of reducing the time-to-degree. In the final section of the paper, I present a proposal for a reform which incorporates differentiated fees and a credit point system. I derive an optimal fee for maximal attendance in higher education.

Policies in Tertiary Education and the Change in Attendance and Time-to-Degree

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August 31, 2004

Abstract

In this paper, I investigate the effect of reforms on the time-to-degree and attendance at colleges. My model predicts that with imperfect credit markets imposing tuition fees may raise instead of reducing the time-to-degree. In the final section of the paper, I present a proposal for a reform which incorporates differentiated fees and a credit point system. I derive an optimal fee for maximal attendance in higher education.

Keywords: educational decisions, costs of education

JEL classifications: I21, I28, I29

1 Introduction

Across OECD-countries, we find an enormous variation in the time between enrolment and graduation at universities.[1] Table 1 shows that particularly Germany and Finland are characterised by a large time span between enrolment and graduation. In contrast, the US and the UK provide a system in which students attain their college degree relatively fast. Unsurprisingly, in the countries with long durations of study, we notice an ongoing debate about reforms in higher education in order to reduce the time-to-degree.

The theoretical starting point for the analysis in this paper is given by human capital theory.[2] This theory provides a fundamental explanation for human capital accumulation. However, the framework is targeted on a general explanation for the accumulation process. But students in higher education face special circumstances: First, students live in a world with imperfect credit markets in which they cannot unrestrictedly borrow money.[3] Most of the time, they have to contribute to the financing of their study by earning money. The jobs students can find are usually characterised by a lower wage level than after graduation. An explanation for this phenomenon can be derived from signalling theory. All undergraduates are treated similarly by employers. Corresponding to my model, individuals receive two different wages, one without college degree and a higher one after college graduation.[4] Secondly, students in higher education are free to decide the extent of their

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[1]See also OECD (2003), OECD (1998) and NCES (2003).

[2]See Becker (1964), Ben-Porath (1967), Wallace and Ihnen (1975) and Heckman (1976).

[3]This also includes a restricted governmental budget for educational expenses. Thus, we assume that subsidies have to be paid by students.

[4]There is a bunch of literature on signals and return to schooling. The relation between both is called "sheepskin-effect". This effect describes that returns to schooling do not change during the achievement of a certain degree. Only after graduation, there is a considerable change in returns. See also Antelius (2000) as well as Hungerford and Solon (1987).

leisure time. Once an individual participates in the labour market, this liberty decreases dramatically. Employees have to fulfill their labour contracts which determine their spare time.[5]

In addition, one observes that the consumption of goods which do not belong to essential commodities plays a minor role for students.[6]

The existing literature does not account for all these circumstances and does not aim to investigate the essential decision to attend at college or not. A paper by Fisher and Keuschnigg (2002) presents a proposal for a reform in order to optimize human capital accumulation. Given their assumption, the authors derive a policy which incorporates tuition fees and personal stipends. Epple and Romano (1998) and others focus their discussion on the effect of vouchers on the attendance at private versus public schools. These papers assume that high-school graduates have already decided to attend university. In general, the papers apply only to a differentiated higher education system.

In higher education, undoubtedly, the most widely debated reforms are the imposition or increment of tuition fees and the introduction of a credit point system.[7] In the case of tuition fees, one can distinguish between fees which apply to students during their studies and delayed fees which an individual has to pay after graduation. The main intention of such policies is to lower time-to-degree and to regulate enrolments at colleges.[8] Additionally,

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[5]The reader is reminded that leisure consumption only includes a certain quality of leisure, such as taking days off during the week or traveling for several months.

[6]This observation is confirmed by the latest report on the social and economical situation of German students in Higher Education, published by the German Federal Ministry of Education and Research. See GFMER (2003).

[7]By this, I refer to a system which demands a certain amount of credit points in each term to advance with the study. The consequence is an upper bound for the time-to-degree.

[8]Due to the stylized fact that education is one of the most propellent factors for economic growth, policymakers are interested in the regulation of the number and the selection of students. The number of students turns out to be important if the government faces

the analysis of the change in enrolment seems essential also from a political perspective, since opponents of tuition fees argue that the imposition of fees causes a discrimination between poor and rich students. Following this association, I define a reform as efficient if it reduces the time-to-degree subject to the constraint that the most able students have the possibility to study. The remainder of the paper is outlined as follows: In section 2, I present the basic model. In section 3, I use the basic model to investigate the effect of policies in tertiary education on completion time and attendance. Based on these results, I develop an alternative reform concept in section 4. Section 5 concludes.

2 A Model

After high-school graduation individuals face the decision whether to attend college or to participate in the labour force. In my model, individuals differ in two respects. First, they differ in ability a, where $a > 0$ and $\in [\underline{a}, \overline{a}]$, and secondly, students receive different financial support from their parents. I express this aspect in form of different net study costs c which arise in each unit of time at college, where $c > 0$. Hence, an individual i is characterized by a given ca-combination. For simplicity, I assume that a and c are uniformly distributed and the discount rate is zero.

If an individual opts to enrol at college, he will study at college in the first phase of his life and participates in the labour market in the second phase. Otherwise, an individual starts working in the labour market after

capacity problems at universities. See also Barro and Sala-i Martin (1995).

high-school graduation. I assume that individuals consume leisure, t^l, only being at college and goods, x, only during the working phase. Additionally, individuals receive a wage w without college degree and $\tilde{w}$ after graduation, with $w < \tilde{w}$.

During college, a student´s time is devoted to work t^w, study t^g and leisure t^l. For simplicity, I assume that the fractions are constant over time. For each unit of time at college, I obtain

$$1 = t^w + t^g + t^l. \tag{2.1}$$

Individuals attending college are confronted with a borrowing constraint. Thus, they are forced to work while studying at college. Therefore, a student i faces the following budget constraint in each unit of time at college[9]

$$c_i = t_i^w w. \tag{2.2}$$

with $c_i < w$.

An individual attains his degree as soon as he has accumulated a certain amount of human capital $\bar{H}$. I assume that the accumulation process for student i per unit of time hinges on the following production function

$$F(a_i) = a_i t^g. \tag{2.3}$$

Hence, the time-to-degree S_i is determined by

$$\bar{H} = S_i F(a_i) = S_i t^g a_i. \tag{2.4}$$

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[9]Given my assumptions, it is easy to show that students do not save while being at college.

Accounting for the budget constraint (2.2) and (2.1), I obtain

$$S_i = \frac{\bar{H}}{a_i(1 - \frac{c_i}{w} - t^l)}. \tag{2.5}$$

After graduation, the budget constraint has the following form

$$x = \tilde{w}. \tag{2.6}$$

Without loss of generality, I normalise $\bar{H}$ to 1. Taking all the above facts into account, I receive the following overall utility for a student i:

$$U(t^l, x) = \int_0^{\frac{1}{a_i(1 - \frac{c_i}{w} - t^l)}} u(t^l) dt + \int_{\frac{1}{a_i(1 - \frac{c_i}{w} - t^l)}}^T \tilde{w} dt, \tag{2.7}$$

where T denotes the life span after high-school graduation. The utility function behaves such that $u(0) = 0$ and $u' > 0$. In addition, u' is logarithmically convex with $u'' < 0$ and $u''' > 0$.[10] The maximisation of overall utility is achieved by student's optimal choice of t^l. To assure an interior solution, I set the lower bound of $\tilde{w}$, $\underline{\tilde{w}}$, such that $\tilde{w} > u(t^l) \; \forall \; t^l$.

Using the Leibniz-rule, the FOC delivers the well-known result that the marginal profits must be equal to the marginal costs

$$\frac{\partial u(t^l)}{\partial t^l} \frac{1}{a(1 - \frac{c_i}{w} - t^l)} + \frac{u(t^l)}{a(1 - \frac{c_i}{w} - t^l)^2} = \frac{\tilde{w}}{a(1 - \frac{c_i}{w} - t^l)^2}. \tag{2.8}$$

Solving for t^l yields

$$t^{l*}(c_i, \tilde{w}) = 1 - \frac{c_i}{w} + \frac{u(t^l) - \tilde{w}}{u'(t^l)}, \tag{2.9}$$

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[10]Logarithmically convex means that $(ln u')'' > 0$. This assumption holds for almost any concave function.

with $t_1^{l*}, t_2^{l*} < 0$.[11] Inserting the optimal choice of t^l in our initial time-to-degree equation, I obtain

$$S^*(c_i, a_i) = \frac{1}{a_i(1 - \frac{c_i}{w} - t^{l*})}. \tag{2.10}$$

Given the optimal leisure consumption t^{l*}, the indirect utility function for individual i attending college in the first phase is

$$V(c_i, a_i, \tilde{w}) = \int_0^{S^*} u(t^{l*})dt + (T - S^*)\tilde{w}dt. \tag{2.11}$$

Yet, the individual i is able to compare this utility with the alternative of participating in the labour market right away. In this case, the individual's utility is

$$\bar{U}(t^l, x) = Tw. \tag{2.12}$$

Individuals decide to attend college, if

$$V(c_i, a_i, \tilde{w}) > Tw. \tag{2.13}$$

Graphically, this decision is illustrated in Figure 2.2. It becomes clear immediately that attending college is mainly worthwhile for intelligent and rich students. Empirical studies by Lauer (2000) and Corak, Lipps, and Zhao (2004) confirm this result. The authors investigate enrolments at German and Canadian universities and identify family background as the crucial determinant for attendance in higher education.

In general, the decision hinges mainly on the completion time S^*. From equation (2.10), we know that an increasing a_i results a decreasing S^*. Across the wealth status c_i, the effect of an increasing c_i is ambiguous on the completion

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[11]The proof for the derivatives is in the appendix.

time. Since students with higher c_i have to spend more time to work and consume less leisure than their peers, with

$$\frac{dS^*(c_i, a_i)}{dc_i} = \frac{\partial S^*}{\partial c_i} + \frac{\partial S^*}{\partial t_i^{l*}} \frac{\partial t_i^{l*}}{\partial c_i}. \qquad (2.14)$$

Furthermore, the level of leisure depends crucially on the post college wage $\tilde{w}$.

Lemma 1 *Given the assumption, the cross partial derivative $\frac{\partial^2 t^l}{\partial c_i \partial \tilde{w}}$ is positive.*

Lemma 1[12] proves that an increasing post-college wage mitigates the negative leisure effect, since high future income implies high opportunity costs of leisure consumption.

Proposition 2.1 *For each $\tilde{w}$ with $\underline{\tilde{w}} \leq \tilde{w} < \overline{\tilde{w}}$, there exists a wealth status $\bar{c}$ such that $\frac{\partial S^*}{\partial t_i^{l*}} \frac{\partial t_i^{l*}}{\partial c_i} = \frac{\partial S^*}{\partial c_i}$, where $\overline{\tilde{w}}$ implies $\bar{c} = 0$.*

Due to lemma 1, proposition 2.1 indicates that for $\underline{\tilde{w}} \leq \tilde{w} < \overline{\tilde{w}}$, there exists one group of students having S^* such that a change in c_i does not affect the completion time S^*, since the positive working effect is equal to the negative leisure effect.

Figure 2.1 illustrates the change of $\bar{c}$ by variation of $\tilde{w}$. We observe that the lower $\tilde{w}$ the higher the proportion of students attaining their degree with a

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[12]The proof for lemma 1 is given in the appendix.

completion time S^* where $\frac{\partial S^*}{\partial t_i^{l*}} \frac{\partial t_i^{l*}}{\partial c_i} > \frac{\partial S^*}{\partial c_i}$. Once the post-college wage exceeds $\overline{\overline{w}}$, a change in c_i leads to $\frac{dS^*(c_i, a_i)}{dc_i} > 0$, since $\frac{\partial S^*}{\partial t_i^{l*}} \frac{\partial t_i^{l*}}{\partial c_i} < \frac{\partial S^*}{\partial c_i}$.

With regard to the indifference curve between college attendance and labour market participation, I obtain two different shapes.

Proposition 2.2 *The indifference curve appears S-shaped, if $\underline{\tilde{w}} \leq \tilde{w} < \overline{\overline{w}}$. For $\tilde{w} \geq \overline{\overline{w}}$, the curve is convex in c_i.*

The possible reduction in time-to-degree with increasing c_i explains the S-shaped indifference curve. Within a group of students with low net study costs, individuals with a higher cost level need only a modest increase in their ability to achieve the same utility level, since they attain a college degree faster than students with lower c_i and the same ability level.[13]

3   Policies in Higher Education

In this section, I analyse the effect of different policies in tertiary education. In particular, we focus on the change in time-to-degree and enrolment which is caused by each reform.

Imposition of tuition fees

The imposition of tuition fees is probably the most widely advocated policy. Many countries have already established fees in tertiary education. Thus,

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[13]The mathematical proof is given in the appendix.

I handle the increment and the imposition of fees synonymously. In my model the imposition of a tuition fee is equivalent to an increase in c_i for every student. Additionally, my model also enables to discuss student aids reduction[14], since I denote c_i as a net value of study costs.

At first I consider the change in time-to-degree. Algebraically, I look at the derivative of S^* with respect to c_i

$$\frac{dS^*(c_i, a_i)}{dc_i} = \frac{\partial S^*}{\partial c_i} + \frac{\partial S^*}{\partial t_i^{l*}} \frac{\partial t_i^{l*}}{\partial c_i}. \tag{3.15}$$

There are two effects of the introduction of tuition fees on the time-to-degree. First, the direct effect, which is equal to

$$\frac{1}{wa_i(1 - \frac{c_i}{w} - t^{l*})^2} > 0 \tag{3.16}$$

and is due to the fact that students have to expand their working time to earn their living. Secondly, there is the indirect effect through a decrease in optimal leisure time.

A reduction in the time-to-degree only occurs if

$$-\frac{\partial S}{\partial t_i^{l*}} \frac{\partial t_i^{l*}}{\partial c_i} > \frac{\partial S}{\partial c_i}. \tag{3.17}$$

or

$$-\frac{\partial t_i^{l*}}{\partial c_i} > \frac{1}{w}. \tag{3.18}$$

Corollary 1 *The imposition of tuition fees reduces the completion time if*

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[14]Like the reduction of public subsidies and scholarships. In Germany, this policy could apply to a reduction in child benefits for persons over 18 being in higher education, since a German student obtains child benefit until age 27.

$\underline{\tilde{w}} < \tilde{w} < \bar{w}$ *and* $c_i < \bar{c}$.

Corollary 1 is explained by proposition 2.1 and figure 2.1. Only within the stated scope, an increasing c_i leads to shorter times-to-degree, because the negative "leisure effect" exceeds the positive "working effect".

The analysis of the impact of tuition fees on the overall utility yields

$$\frac{\partial V(c_i, a_i, \tilde{w})}{\partial c_i} = (u(t^l) - \tilde{w})\frac{\partial S^*}{\partial c_i} < 0. \tag{3.19}$$

Evidently, poor students are the most affected from an increase in tuition fees. Given certain wealth, the effect on $V(c_i, a_i, \tilde{w})$ changes with ability and study costs as follows:[15]

$$\frac{\partial^2 V(c_i, a_i)}{\partial c_i \partial a_i} > 0$$

and

$$\frac{\partial^2 V(c_i, a_i)}{\partial^2 c_i} > 0 \quad \text{if } \underline{\tilde{w}} \le \tilde{w} < \overline{\tilde{w}} \quad \wedge \quad 0 < c_i < \bar{c},$$

$$\frac{\partial^2 V(c_i, a_i)}{\partial^2 c_i} \le 0 \quad \text{if } \underline{\tilde{w}} \le \tilde{w} < \overline{\tilde{w}} \quad \wedge \quad c_i \ge \bar{c},$$

$$\frac{\partial^2 V(c_i, a_i)}{\partial^2 c_i} \le 0 \quad \text{if } \tilde{w} \ge \overline{\tilde{w}}.$$

According to the cross partial derivatives, high ability students suffer less than their counterparts. The effect among different wealth hinges again on the possibility to reduce time-to-degree. Clearly, this possibility shrinks after the imposition of tuition fees.

Figure 3.3 illustrates the change in college attendance after an increase of c. We see that particularly poor students are discouraged to attend college if

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[15]See appendix for the proof.

tuition fees increase. This finding corresponds to the studies by Kane (1995) and Light and Strayer (2000). The authors empirically analyse American students and observe exactly the same result.

Among the rich students, Figure 3.3 indicates that the least affected type possesses a $c_i > 0$ for a given initial S-shaped indifference curve.

Other policies

Another widely discussed policy is the introduction of an academics tax. Here, students have to pay a tax after their college completion. In the model, this corresponds to a proportional reduction in $\tilde{w}$. Using the analogous analysis I receive

$$-\frac{\partial S(c_i, a_i)}{\partial \tilde{w}} = -\frac{1}{a(1 - \frac{c}{w} - t^l)^2} \frac{\partial t^l}{\partial \tilde{w}} > 0. \tag{3.20}$$

This policy reduces the opportunity costs and therefore increases the time-to-degree unambiguously.

The academics tax also reduces the student's overall utility, with

$$-\frac{\partial V(c_i, a_i)}{\partial \tilde{w}} = -T + S^* < 0. \tag{3.21}$$

For the cross partial derivatives, I obtain[16]

$$-\frac{\partial^2 V(c_i, a_i)}{\partial \tilde{w} \partial c_i} < 0 \qquad \text{if } \underline{\tilde{w}} \leq \tilde{w} < \overline{\tilde{w}} \qquad \wedge \qquad 0 < c_i < \bar{c},$$

$$\frac{\partial^2 V(c_i, a_i)}{\partial \tilde{w} \partial c_i} \geq 0 \qquad \text{if } \underline{\tilde{w}} \leq \tilde{w} < \overline{\tilde{w}} \qquad \wedge \qquad c_i \geq \bar{c},$$

$$-\frac{\partial^2 V(c_i, a_i)}{\partial \tilde{w} \partial c_i} \geq 0 \qquad \text{if } \tilde{w} \geq \overline{\tilde{w}}$$

and

$$-\frac{\partial^2 V(c_i, a_i)}{\partial \tilde{w} \partial a_i} < 0.$$

Students with a short completion time are the most affected by this policy, because they pay more than their counterparts during the working phase. Figure 3.4 confirms this result. Mainly, students with a high a are discouraged from attending college, since an academics tax induces a steeper indifference curve, with

$$-\frac{\partial^2 a}{\partial c \partial \tilde{w}} = -\frac{a}{w(1 - \frac{c}{w} - t^l)^2} \frac{\partial t^l}{\partial \tilde{w}} > 0. \tag{3.22}$$

The third policy which I analyse is called credit point system. As mentioned before, this policy leads to an upper bound for completion time, $\bar{S}$. Therefore, students lose their privilege to choose the extent of leisure consumption freely. Why is this the case? Students are born with an individual ca-combination determining a minimum time to achieve $\bar{H}$. If policymakers fix the upper bound for graduation, some students will not be able to achieve

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[16]See in the appendix for the proof.

12

$\bar{H}$ within this bound, some others achieve $\bar{H}$ without leisure consumption and some students still receive their degree with leisure time. To be sure, students with a low ability and from a poor family background are most likely to fail when they are exposed to such a policy. Generally, the credit point system guarantees that students may not study longer than before and the policy affects mainly the least able students. However, the credit point system does not support the poor intelligent students and hence, it does not mitigate the existing inequality in enrolments.

4 Efficiency and the Patchwork Strategy

In the previous section, I investigated the effect of three different policies on attendance and time-to-degree.[17] In this section, I examine whether the discussed reforms are efficient and present a policy which enhances the efficiency.

Definition 4.1 *A policy in tertiary education is efficient if it reduces the time-to-degree subject to the constraint that the high ability students have the possibility to study.*

It is efficient that the high ability students obtain the possibility to attend colleges, because this group gains the most from enrolment:

$$E[U|a_1, c] > E[U|a_2, c] \text{ where } a_1 > a_2.$$

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[17] See also Table 2.

With regard to my definition of efficiency, the academics tax reform cannot be efficient. This policy leads to an increasing time-to-degree and affects mainly the students possessing a high value of a_i.

The imposition of a uniform tuition fee in higher education also appears to be inefficient, since high ability students from low family background are discouraged to attend universities. Furthermore, the effect on time-to-degree is ambiguous.

The credit point system guarantees that each enroled student finishes his study at least in the same time or even shorter than before introducing this policy. However, the credit point system fails to mitigate the initial inequality in enrolment between rich and poor students.

To enhance the efficiency of a higher education policy, I propose a reform consisting in a patchwork of the discussed policies. The main criteria are the introduction of a credit point system and the imposition of tuition fees for rich students. These fees are used to subsidise the poor students.

In Finland there is still a public discussion about time-to-degree in higher education. In the recent past, the government attempted to reduce the completion time utilizing student aids. These subsidies were supposed to cause a diminishment of the working time while being a student. A paper by Häkkinen and Uusitalo (2003) shows that the introduction of this measure affects the time-to-degree only modestly. The authors identify the students' rejecting behaviour as the crucial factor.[18] We learn from this lesson that student aids are not efficient if the government fails to enforce its policy with a strict

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[18]In Finland, students face more or less no time constraint to finish university. I interpret this as the main factor for failure, because it seems extremely difficult to convince students of prospective policies in such a system.

monitoring system.

To maximise students' enrolment at colleges without discouragement of the intelligent students, I analyse a variant of the model with two classes of wealth, rich students, $\underline{c}$, and poor students, $\bar{c}$. The proportion of the poor students is denoted by α. Furthermore, f is the fee which rich students have to pay and m is the subsidy which poor students directly receive. I assume that a is uniformly distributed between 0 and 1 and independent of wealth. The policymaker utilizes a credit point system to set an upper bound $\bar{S}$. Since I focus on the attendance at college, I am interested in the time-to-degree when leisure is zero. Thus, this completion time denotes the fastest track to accumulate $\bar{H}$ for a given ca-combination. The function for the minimal time-to-degree is

$$S(c_i, a_i) = z(a_i) + h(c_i). \tag{4.23}$$

where z(a) and h(c) are both convex in their arguments.[19] To take the participation constraint into account, I simplify $U[S(c_i, a_i) \mid \bar{S}, f, t^l = 0] > \bar{U}, \ \forall \ \bar{S} \ \forall \ ca$-combinations.

Since the policymaker sets $\bar{S}$, the maximal attendance is achieved if the maximal number of students are able to attain their degree within $\bar{S}$ given the individual ca-combination. This maximisation problem corresponds to the minimisation of the expected minimal time-to-degree. Therefore, I handle the optimisation problem as minimisation of the expected minimal time-to-degree.

In order to make the analysis as transparent as possible, I start with the establishment of $\bar{S}$. Once there is such an upper bound, I receive new support

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[19]The functional forms are derived from the basic model.

for the ability distribution for each wealth type.[20] Considering the poor students, I obtain

$$a \geq z^{-1}(\bar{S} - h(\bar{c})). \tag{4.24}$$

and analogously for the rich ones

$$a \geq z^{-1}(\bar{S} - h(\underline{c})). \tag{4.25}$$

Accounting for the change in support of the ability distribution for each type, I receive the following conditional probability for a poor being a student after the imposition of $\bar{S}$

$$Pr(c = \bar{c} \mid \bar{S}) = \frac{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c})))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c}))) + (1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c})))}.$$

Analogously, the conditional probability being a wealthy student is

$$Pr(c = \underline{c} \mid \bar{S}) = \frac{(1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c})))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c}))) + (1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c})))}.$$

After setting $\bar{S}$, the expected time-to-degree is

$$
\begin{aligned}
E(S \mid \bar{S}) \;=\; & \frac{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c})))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c}))) + (1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c})))} \Big\{ h(\bar{c}) \\
& + \frac{1}{1 - z^{-1}(\bar{S} - h(\bar{c}))} \int_{z^{-1}(\bar{S} - h(\bar{c}))}^{1} z(a)da \Big\} \\
& + \frac{(1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c})))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c}))) + (1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c})))} \Big\{ h(\underline{c}) \\
& + \frac{1}{1 - z^{-1}(\bar{S} - h(\underline{c}))} \int_{z^{-1}(\bar{S} - h(\underline{c}))}^{1} z(a)da \Big\}.
\end{aligned}
$$

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[20]See also Figure 4.5.

Now, I also allow for transfers between rich and poor students. The transfers are restricted by

$$Pr(c = \bar{c} \mid \bar{S}, f)m = Pr(c = \underline{c} \mid \bar{S}, f)f, \qquad (4.26)$$

where

$$Pr(c = \bar{c} \mid \bar{S}, f) = \frac{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c} - m)))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c} - m))) + (1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c} + f)))}$$

and

$$Pr(c = \underline{c} \mid \bar{S}, f) = \frac{(1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c} + f)))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c} - m))) + (1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c} + f)))}.$$

Solving (4.26) yields $m(f)$.[21] Since I only consider the efficient part of the Laffer-curve meaning to achieve a certain m with the smallest f, I receive m'(f)>0.[22]

When we take transfers into account, the new support for the ability distribution for poor students is given by

$$a \geq z^{-1}(\bar{S} - h(\bar{c} - m^*(f))) \qquad (4.27)$$

and for wealthy students

$$a \geq z^{-1}(\bar{S} - h(\underline{c} + f)). \qquad (4.28)$$

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[21]Of course, m hinges on several parameters. Since I am only interested in the impact of f on m, I express m only with the argument f.

[22]See also figure 4.6.

The "social study planner" faces the following optimisation problem:

$$\min_{f} E(S \mid \bar{S}, f) = \frac{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c} - m^*(f))))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c} - m^*(f)))) + (1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c} + f)))}$$
$$\left\{ h(\bar{c} - m^*(f)) + \frac{1}{1 - z^{-1}(\bar{S} - h(\bar{c} - m^*(f)))} \int_{z^{-1}(\bar{S} - h(\bar{c} - m^*(f)))}^{1} z(a) da \right\}$$
$$+ \frac{(1 - \alpha)(1 - z^{-1}(\bar{S} - h(\underline{c} + f)))}{\alpha(1 - z^{-1}(\bar{S} - h(\bar{c} - m^*(f)))) + (1 - \alpha)(z^{-1}(\bar{S} - h(\underline{c} + f)))}$$
$$\left\{ h(\underline{c} + f) + \frac{1}{1 - z^{-1}(\bar{S} - h(\underline{c} + f))} \int_{z^{-1}(\bar{S} - h(\underline{c} + f))}^{1} z(a) da. \right\}$$

Proposition 4.3 *Given imperfect capital markets, the optimisation problem is solved by the unique equilibrium, such that $f^* = \alpha(\bar{c} - \underline{c})$.*

The proposition holds if Lemma 1 is valid

Lemma 2 *A transfer causes an increasing expected time-to-degree for the group which has to pay the transfer*

$$\frac{\partial S(c_i \mid \bar{S}, f)}{\partial f} > 0 \quad where \quad \frac{\partial S(c = \bar{c} \mid \bar{S}, f)}{\partial f} > \frac{\partial S(c = \underline{c} \mid \bar{S}, f)}{\partial f}.$$

Given imperfect credit markets, policymakers maximise the attendance at colleges such that poor and rich students obtain the same wealth status. The equality in wealth also guarantees that all high ability students have the possibility to attend college.

Including leisure consumption, I am now able to analyse whether there is a conflict in minimisation of the completion time and maximisation of attendance. From the basic model, I know that $\frac{\partial S^*}{\partial c_i}$ depends on the post-college wage $\tilde{w}$ and the wealth status c_i. According to the case that $\tilde{w} \geq \bar{\bar{w}}$, the maximal enrolment coincides with the minimal time-to-degree. However, the

optimised completion time depicts only a second-best solution. In this case, the first best world is $c_i = 0 \ \forall \ i$.

Given $\underline{\tilde{w}} \leq \tilde{w} < \overline{\tilde{w}}$, I distinguish between three cases: Firstly, the common wealth status c_i after the transfer lies above $\bar{c}$. In this case, the policymaker minimises the completion time with a subsidy $m = c_i - \bar{c}$. Secondly, c_i after the transfer corresponds to $\bar{c}$ and thirdly, c_i lies below the previous case. In this case, an extra fee diminishes the completion time, but it also leads to an reduction in enrolments. In general, the conflict between both targets arises, if students expect a low post-college income.

According to my efficiency criterion, the presented policy dominates the other reforms. Through the transfers, the policy discourages the less intelligent student to enrol at colleges and supports the intelligent students such that the completion time decreases.

5   Conclusion

In a world with imperfect capital markets for students, an increase of general fees intensifies the disparity between poor and rich students at colleges. The goal of a general reduction in time-to-degrees seems implausible, since the reduced effect can only be observed for a limited group which is characterised by low study costs and an low expected future income. A delayed fee reform, like an academics tax, effects an increase in time-to-degree unambiguously. Hence, I propose a higher education system which is similarly framed as the systems in the US and the UK. The crucial components are the establishment of a credit point system which assures the efficient accomplishment of student aids and a transfer mechanism which balances the disparity of wealth among

the students.

Moreover, this paper comprises the following policy implications: Firstly, the governments ought to fund students who expect a high post-college earnings fully. Secondly, a conflict between maximal attendance and minimal time-to-degree arises, if students expect a low post-college income.

However, the results are based on special assumptions of the time-to-degree function. Hence, a quantitative analysis of the different impact of the variables on completion time is indispensable.

Appendix

A1: Proof $t_1^{l*}, t_2^{l*} < 0$.

1.Differentiating (2.9) with respect to c_i yields

$$\frac{dt^{l*}}{dc_i} = -\frac{1}{w} + \frac{dt^{l*}}{dc_i} - \frac{u(t^l)u''(t^l)\frac{dt^{l*}}{dc_i}}{(u'(t^l))^2} + \frac{\tilde{w}u''(t^l)\frac{dt^{l*}}{dc_i}}{(u'(t^l))^2}. \qquad (5.29)$$

Equation (5.29) yields

$$\frac{dt^{l*}}{dc_i} = \frac{(u'(t^l))^2}{(\tilde{w} - u(t^l))u''(t^l)w} < 0. \qquad (5.30)$$

2.Differentiating (2.9) with respect to $\tilde{w}$ yields

$$\frac{dt^{l*}}{d\tilde{w}} = \frac{dt^{l*}}{d\tilde{w}} - \frac{1}{u'(t^l)} - \frac{u(t^l)u''(t^l)\frac{dt^{l*}}{d\tilde{w}}}{(u'(t^l))^2} + \frac{\tilde{w}u''(t^l)\frac{dt^{l*}}{d\tilde{w}}}{(u'(t^l))^2}. \qquad (5.31)$$

Equation (5.31) yields

$$\frac{dt^{l*}}{d\tilde{w}} = \frac{u'(t^l)}{(\tilde{w} - u(t^l))u''(t^l)} < 0. \qquad (5.32)$$

q.e.d.

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A2: Proof Lemma 1.

$$\frac{\partial^2 t^{l*}}{\partial c_i \partial \tilde{w}} = \frac{2u'(t^{l*})\frac{\partial t^{l*}}{\partial \tilde{w}}}{(\tilde{w} - u(t^{l*})w)} - \frac{u'(t^{l*})^2 u'''(t^{l*})\frac{\partial t^{l*}}{\partial \tilde{w}}}{u''(t^{l*})^2(\tilde{w} - u(t^{l*})w)}$$

$$- \frac{u'(t^{l*})^2(1 - u'(t^{l*})\frac{\partial t^{l*}}{\partial \tilde{w}})}{u''(t^{l*})(\tilde{w} - u(t^{l*})^2 w)}. \tag{5.33}$$

From equation (5.33), it yields

$$\frac{\partial^2 t^{l*}}{\partial c_i \partial \tilde{w}} > 0 \ \text{ if } \ u'(t^{l*})u'''(t^{l*}) \geq u''(t^{l*})^2. \tag{5.34}$$

Due to the logarithmic convexity of $u'(t^{l*})$, we know that $u'(t^{l*})u'''(t^{l*}) > u''(t^{l*})^2$. q.e.d.

A3: Proof for the marginal rate of substitution of the indirect utility function $-\frac{da_i}{dc_i} = \frac{\frac{\partial V(.)}{\partial c_i}}{\frac{\partial V(.)}{\partial a_i}}$.

1.The change in c_i has the following impact on V_i:

$$\frac{\partial V(c_i, a_i, \tilde{w})}{\partial c_i} = \frac{\partial u(t^l)}{\partial t^l}\frac{\partial t^l}{\partial c_i}S + \frac{\partial S}{\partial c_i}u(t^l) + \frac{\partial S}{\partial t^l}\frac{\partial t^l}{\partial c_i}u(t^l) - \frac{\partial S}{\partial c_i}\tilde{w} - \frac{\partial S}{\partial t^l}\frac{\partial t^l}{\partial c_i}\tilde{w}.$$

Due to the Envelope-Theorem, I obtain the following expression

$$(\frac{\partial u(t^l)}{\partial t^l}S + \frac{\partial S}{\partial t^l}u(t^l) - \frac{\partial S}{\partial t^l}\tilde{w})\frac{\partial t^l_i}{\partial c_i} = 0. \tag{5.35}$$

This yields

$$(u(t^l) - \tilde{w})\frac{\partial S}{\partial c_i}. \tag{5.36}$$

2.The change in a_i has the following impact on V_i:

$$\frac{\partial V(c_i, a_i, \tilde{w})}{\partial a_i} = (u(t^l) - \tilde{w})\frac{\partial S}{\partial a_i}. \tag{5.37}$$

From the equations 5.36 and 5.37, I receive

$$MRS = \frac{\frac{\partial S}{\partial c_i}}{\frac{\partial S}{\partial a_i}} = -\frac{a}{w(1 - \frac{c_i}{w} - t^l(c_i, \tilde{w}))}. \tag{5.38}$$

Furthermore, the marginal rate of substitution changes in c_i, with

$$\frac{d^2 a_i}{dc_i^2} = \frac{a(\frac{1}{w} + \frac{\partial t^l(c_i, \tilde{w})}{\partial c_i})}{w(1 - \frac{c_i}{w} - t^l(c_i, \tilde{w}))^2}. \tag{5.39}$$

This expression becomes > 0 if

$$\frac{1}{w} > \frac{\partial t^l(c_i, \tilde{w})}{\partial c_i}. \tag{5.40}$$

q.e.d.

A4: Proof for $\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial c_i \partial a_i}$ and $\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial^2 c_i}$.

1.$\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial c_i \partial a_i}$:

$$\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial c_i \partial a_i} = -\frac{-\tilde{w} + u(t^l)}{a^2 w(1 - \frac{c}{w} - t^l)^2} > 0 \ \ \forall \ c_i$$

2.1 $\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial^2 c_i}$, given $\underline{\tilde{w}} \leq \tilde{w} < \overline{\overline{w}}$:

$$\frac{\partial^2 V(c_i, a_i, \tilde{w}))}{\partial^2 c_i} = \frac{\frac{\partial u(t^l)}{\partial t^l}\frac{\partial t^l}{\partial c_i}}{aw(1 - \frac{c}{w} - t^l)^2} +$$

$$\frac{(\frac{1}{w} + \frac{\partial t^l}{\partial c_i})(u(t^l) - \tilde{w})}{aw(1 - \frac{c}{w} - t^l)^3} > 0 \ \text{ for } \ 0 < c_i < \bar{c}$$

and

$$\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial^2 c_i} = \frac{\frac{\partial u(t^l)}{\partial t^l}\frac{\partial t^l}{\partial c_i}}{aw(1 - \frac{c}{w} - t^l)^2} +$$

$$\frac{(\frac{1}{w} + \frac{\partial t^l}{\partial c_i})(u(t^l) - \tilde{w})}{aw(1 - \frac{c}{w} - t^l)^3} \leq 0 \ \text{ for } \ c_i \geq \bar{c}.$$

2.2 $\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial^2 c_i}$, given $\tilde{w} \geq \overline{\overline{w}}$:

$$\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial^2 c_i} = \frac{\frac{\partial u(t^l)}{\partial t^l}\frac{\partial t^l}{\partial c_i}}{aw(1 - \frac{c}{w} - t^l)^2} +$$

$$\frac{(\frac{1}{w} + \frac{\partial t^l}{\partial c_i})(u(t^l) - \tilde{w})}{aw(1 - \frac{c}{w} - t^l)^3} \leq 0 \ \ \forall \ c_i$$

q.e.d.

A5: Proof for $-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial c_i}$ and $-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial a_i}$.

1.1 $-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial c_i}$, given $\underline{\tilde{w}} \leq \tilde{w} < \overline{\overline{w}}$:

$$-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial c_i} = \frac{\frac{1}{w} + \frac{\partial t^l}{\partial c_i}}{a(1 - \frac{c}{w} - t^l)^2} \leq 0 \ \text{ for } \ 0 < c_i \leq \bar{c}$$

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and

$$-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial c_i} = \frac{\frac{1}{w} + \frac{\partial t^l}{\partial c_i}}{a(1 - \frac{c}{w} - t^l)^2} > 0 \ \text{ for } \ c_i > \bar{c}$$

1.2 $-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial c_i}$, given $\tilde{w} > \overline{\overline{w}}$:

$$-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial c_i} = \frac{\frac{1}{w} + \frac{\partial t^l}{\partial c_i}}{a(1 - \frac{c}{w} - t^l)^2} > 0 \ \ \forall c_i.$$

2. $-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial a_i}$:

$$-\frac{\partial^2 V(c_i, a_i, \tilde{w})}{\partial \tilde{w} \partial a_i} = -\frac{1}{a^2(1 - \frac{c}{w} - t^l)} < 0 \ \ \forall \ c_i.$$

q.e.d.

A6: Proof Lemma 2.

$$
\begin{aligned}
\frac{\partial S(c \mid \bar{S}, f)}{\partial f} = \ & (Z(1) - Z(z^{-1}(.)))(1 - z^{-1}(.))^{-2} \frac{\partial z^{-1}(.)}{\partial h(c+f)} \frac{\partial h(c+f)}{\partial f} \\
& - (1 - z^{-1}(.))^{-1} \frac{\partial Z(z^{-1}(.))}{\partial z^{-1}(.)} \frac{\partial z^{-1}(.)}{\partial h(c+f)} \frac{\partial h(c+f)}{\partial f} + \frac{\partial h(c+f)}{\partial f}.
\end{aligned}
$$

We know that the time-to-degree does not change for a student at the margin. Therefore, the following equation holds:

$$\frac{\partial h(c+f)}{\partial f} - (1 - z^{-1}(.))^{-1} \frac{\partial Z(z^{-1}(.))}{\partial z^{-1}(.)} \frac{\partial z^{-1}(.)}{\partial h(c+f)} \frac{\partial h(c+f)}{\partial f} = 0. \quad (5.41)$$

From equation (5.41), I obtain

$$\frac{\partial S(c \mid \bar{S}, f)}{\partial f} = (Z(1) - Z(z^{-1}(.)))(1 - z^{-1}(.))^{-2} \frac{\partial z^{-1}(.)}{\partial h(c+f)} \frac{\partial h(c+f)}{\partial f} > 0.$$

(5.42)

Equation (5.41) and (5.42) yields

$$\frac{(Z(1) - Z(z^{-1}(.)))\frac{\partial h(\bar{c}+f)}{\partial f}}{(1 - z^{-1}(.))\frac{\partial Z(z^{-1}(.))}{\partial z^{-1}(.)}} > \frac{(Z(1) - Z(z^{-1}(.)))\frac{\partial h(\underline{c}+f)}{\partial f}}{(1 - z^{-1}(.))\frac{\partial Z(z^{-1}(.))}{\partial z^{-1}(.)}}.$$

(5.43)

q.e.d.

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Country	Age of new entrants*	Age of graduates*
Belgium	18.8	22.8
Finland	21.6	27.6
Germany	21.4	28.9**
Spain	19.0	25.1
UK	19.4	22.0***
US	19.3	22.0***

*The Median attaining a diploma degree.
** On average.
*** For bachelor degree.
Sources: Education at a Glance (1998, 2003), Federal Statistical Office Germany, NCES.

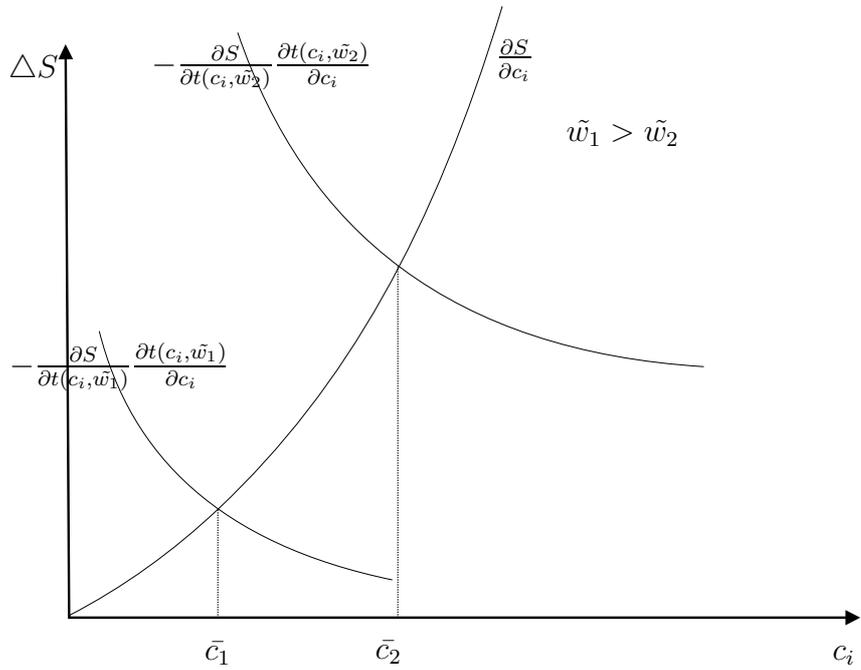Table 1: Age of entrants and graduates in higher education across OECD-countries

Figure 2.1: Change in completion time by variation of $\tilde{w}$.
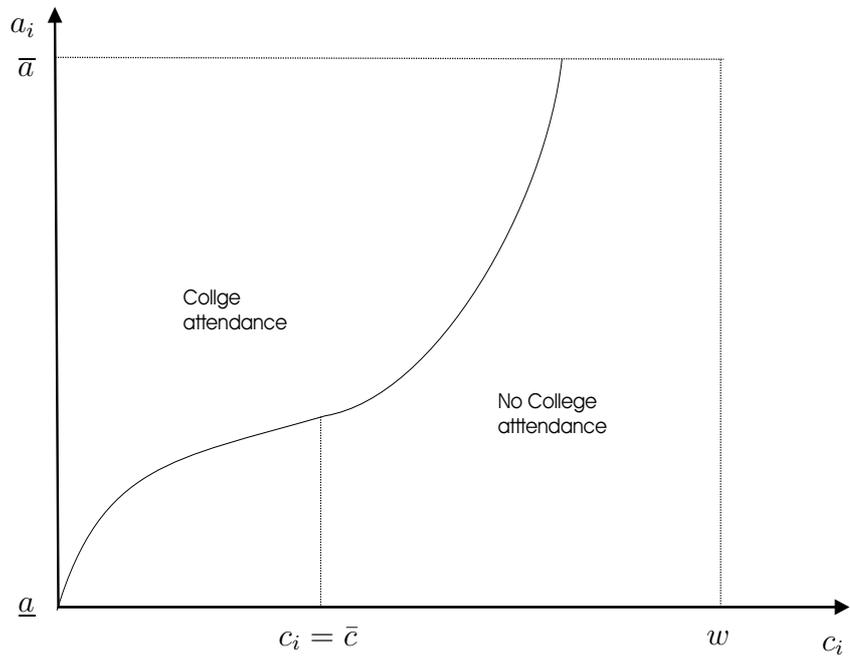
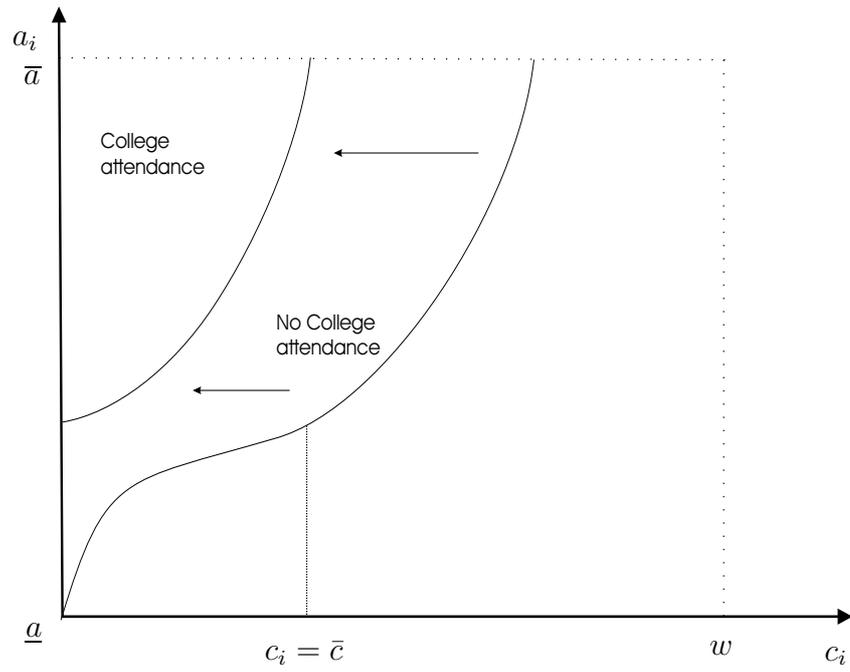Figure 2.2: Attendance at college, given $\underline{\tilde{w}} \leq \tilde{w} < \overline{\tilde{w}}$.

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Figure 3.3: Change in attendance at college by imposition/increase of tuition fees, given $\underline{\tilde{w}} \leq \tilde{w} < \overline{\tilde{w}}$, where $\triangle c = \bar{c}$.
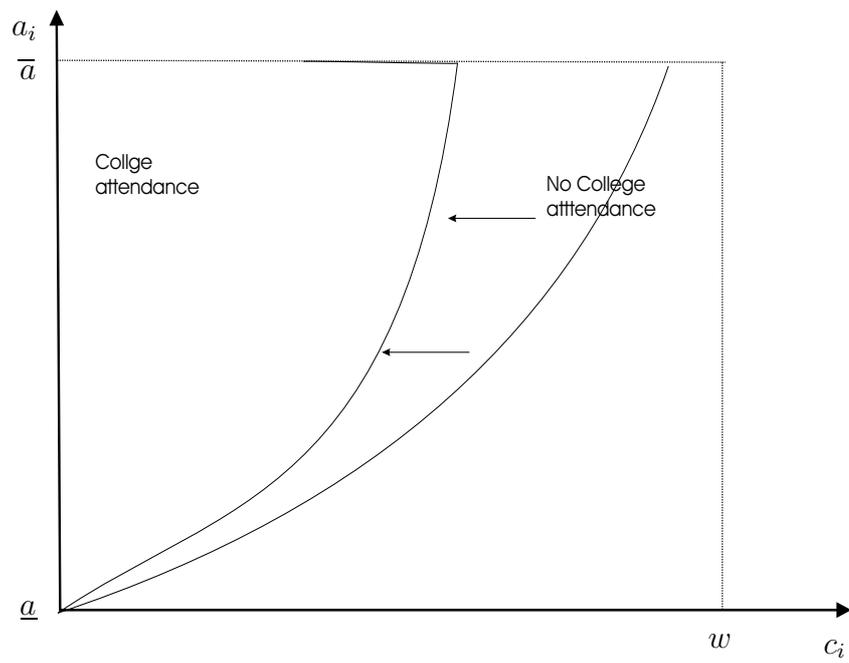
Figure 3.4: Change in attendance at college by introduction of an academic tax, given $\tilde{w} > \overline{\tilde{w}}$.

	Change in time-to-degree	**Change in utility**
Imposition of tuition fees	Shorter duration for wealthy students and a longer one for poor students for a given low post-college income. Otherwise, there is a general increase.	Poor students are the most affected
Academics tax	Longer duration for all students	Intelligent students are the most affected
Credit point system	No student has a longer duration	Unintelligent students are the most affected

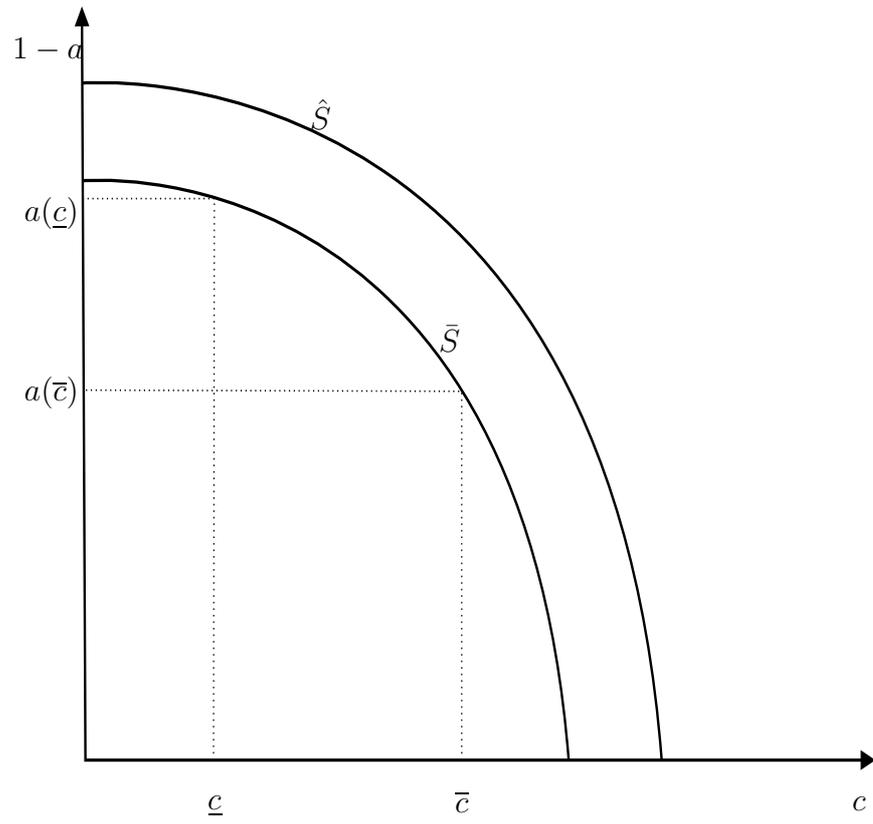Table 2: The effect of tuition fees, academic tax and credit point system on time-to-degree and attendance.

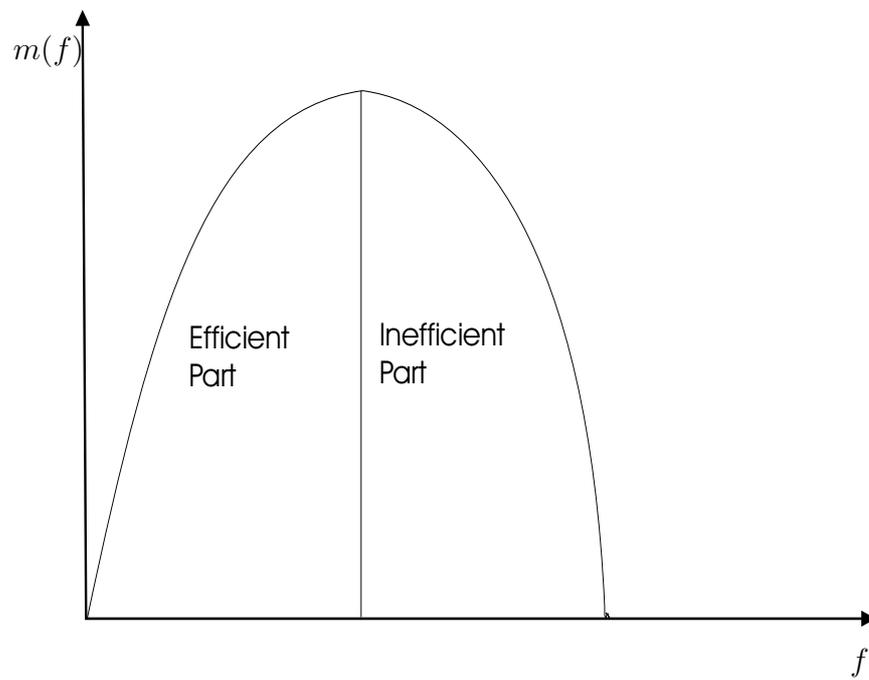Figure 4.5: The effect of an upper bound $\bar{S}$ on the attendance.

$m(f)$

Efficient
Part

Inefficient
Part

f

Figure 4.6: The Laffer-curve m(f).

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