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On the Timing of Education

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Abstract

We propose a simple investment model which shows that, in the presence of fluctuations in and uncertainty about the opportunity cost of time, marginal individuals may choose to delay their education if the opportunity cost of time is temporarily high. Importantly, it is when the completion of the degree is uncertain, but likely enough that individuals will consider delaying their education. As a result, when returns to education are relatively low, education and timing of education will be sensitive to fluctuations in the opportunity cost of time. If return is high, delay is never optimal. These findings are supported by Swedish university enrolment patterns, and cross-country evidence on age of university freshmen.

Keywords: Timing of education, Fluctuating opportunity costs

JEL-Codes: D81, J22, J24.

1 Introduction

University students are older now than before. There is substantial cross-country variation in age of university freshmen. The age of university freshmen appears to depend on family background. These statements, for which we will provide some empirical support, provide the basic motivation for studying the determinants of delayed educational investments.

The Ben-Porath (1967,1970) model of human capital investments over the life cycle predicts that the bulk of full time education should take place early in life, when it has the longest possible pay-back time, and the lowest opportunity cost.[1] The force of this argument, further strengthened by the work of Becker (1975) and Mincer(1974) and the fact that students historically went straight from high school to university may explain why the huge literature estimating the return to education has largely ignored the timing

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[1]Mincer (1997) summarizes Ben-Porath's contribution.

issue: It has simply been regarded as a non-issue. Since the median university freshman in a number of OECD countries, according to OECD (2001), is now far from fresh out of high school, it is clear that some factors influencing educational timing are not captured in the standard life-cycle model.

Although levels vary across countries, an increase in the age of students appears to be a general phenomenon. Figures 1 and 2, show that in 1970, some three quarters of US full-time students were 21 or younger. In 1980, the figure had declined to 70 per cent. After a further decline the figure appears to have stabilized around some 60 per cent in the late 1990's. Swedish data, for the 1990's presented in Figures 3 and 4, reveal that Swedish students are older than their US fellows. In 1993/94, only a quarter of all students were 21 or younger. Swedish students became more numerous and continued to grow older also during the 1990's. In 2001/2002, less than 20 per cent were below 22.

The Swedish university expansion during the 1990's was the result of an interplay between increased demand and political decisions to expand the universities in order to combat rising youth unemployment. Also the age distribution, is likely to have been affected by the rapid expansion and by other political measures encouraging already unemployed young adults to go to university.

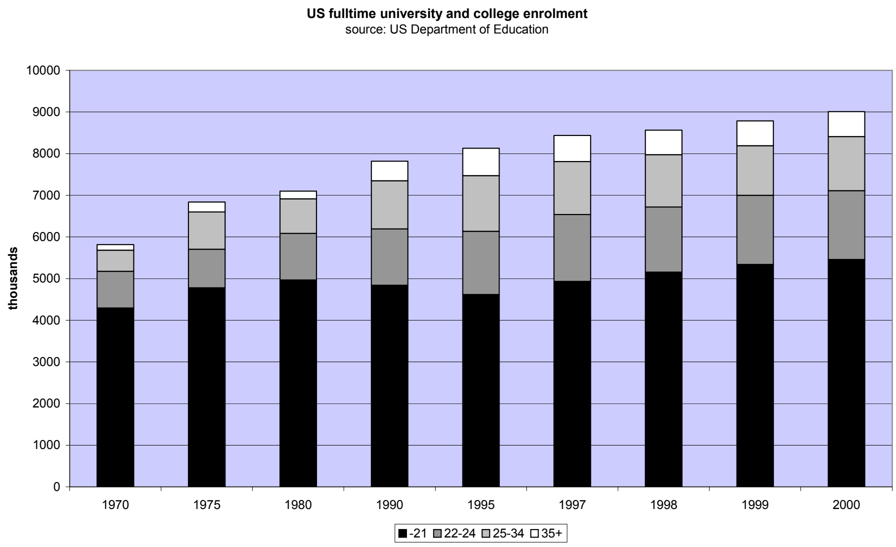

Figure 1

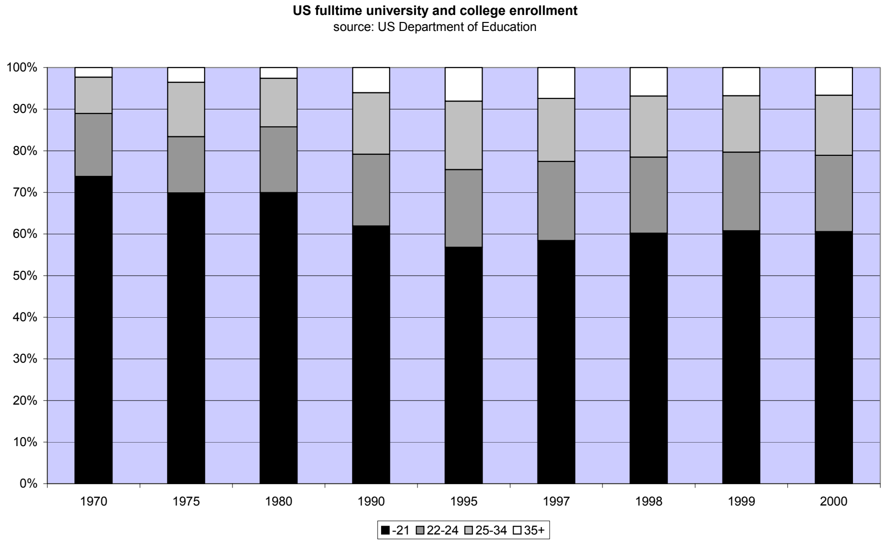

Figure 2

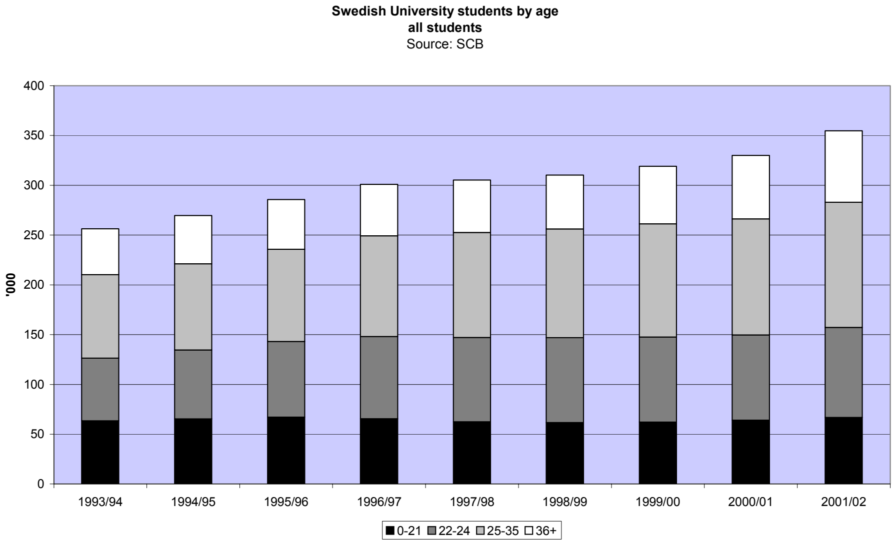

Figure 3

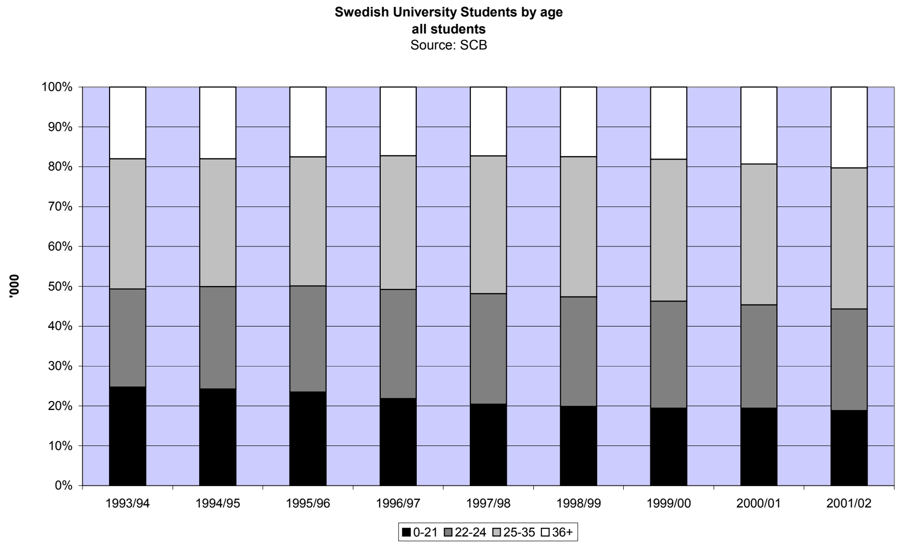

Figure 4

However, a striking feature of the age distribution of university freshmen is that parental education seems to influence the age at which individuals go to university. Average figures for the 1990's, in Figure 5, show that of all the freshmen with the least educated parents (less than high school) only 10 per cent were 21 or younger. The corresponding figure for the freshmen with highly educated parents was 35 per cent.

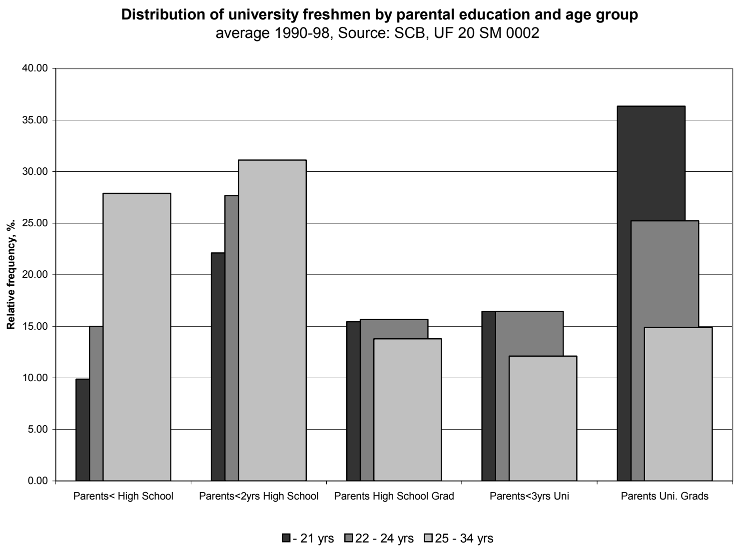

Figure 5

This paper presents a simple model of educational investments decisions which suggests that return to education should play a role in explaining cross country variation in freshman age and why Swedish students are older than their US fellows. A similar explanation is proposed for why parental education matters for freshman age distributions:

individuals with a low perceived return to education are more likely to delay. The proposed mechanism also suggests that university enrollment of student with low perceived return should be sensitive to the business cycle. A first glance at data does indeed bear this prediction out.

Not all previous studies have ignored timing. Griliches (1980), Light (1995) and Monk (1997 study the effects of interrupted schooling and delayed college attendance on US-data and conclude that late human capital investments give significantly smaller additions to earnings than early investments. Hence, these studies suggest that there is a link from late enrollment to low return while this paper provides a link going in the other direction.

Although there are few, if any models, explicitly dealing with the problem of delayed university enrollment, the framework developed by Ben-Porath and Becker is suggestive for finding possible explanations. Rapidly rising university premia is one, which would cause individuals to re-optimize and hence enroll late. Institutional factors, length of compulsory schooling and high school programs, availability of loans and admission rules (and changes in these) may also give rise to late enrollment. For instance, students who need to self-finance their education may be forced to delay or interrupt, while students who do not meet the entry requirements may need to improve their high school grades before being admitted. Ability uncertainty (and hence uncertainty about the expected marginal benefits of education) studied in Sjögren and Sällström (2002), is another reason for delay since it gives rise to a time consuming need to find out about ability before enrolling.

This paper proposes a simple educational investment model in which educational investments are made in the presence of fluctuations in, and uncertainty about the opportunity cost of time. It is shown that if times are good, and hence the individual's opportunity cost of time is high, marginal individuals, i.e. those who are almost indifferent to getting an education or not, may choose to delay their education. Importantly, it is when the benefits associated with completing a university degree are low and the event of completing the degree uncertain, but not too unlikely, that individuals will consider delaying their education. It is for this group of students, we will expect enrolment and educational timing to be sensitive to fluctuations in the opportunity cost of time. If the individual is sure (or almost) not to complete unless he studies early, education investments will be sensitive to fluctuations in the opportunity cost of time, but timing will not be an issue.

Although highly stylized, the model generates some testable predictions for university enrollment patterns. For instance, we should expect to find a negative correlation between return to university education and enrollment age not only because late enrollment gives lower return, but because low return gives delayed enrollment. A plot of estimates of returns to education for the 1985-1995 period against the median age of university freshmen in 1999 for fourteen countries, presented in Figure 10, shows an expected negative relation.

At the individual level, our model gives at hand that it is the group of individuals with mediocre or low returns that will be more prone to delay or not opting for education at all when facing fluctuating opportunity costs. We would therefore expect this group's university enrollment rates to fluctuate with e.g. the business cycle. Also this prediction is supported by evidence suggesting that while university enrollment behavior during the 1990's of Swedish students whose parents had more than the compulsory level of education showed little or no sensitivity to the business cycle, the enrollment pattern of students with weak educational background is very similar to the pattern of youth unemployment.

The paper proceeds as follows. Next, we develop a stylized model of the timing of education when the individual experiences fluctuating opportunity costs of time. Section 3 present some empirical evidence which can be interpreted to support predictions of the model. Section 4 concludes.

2 A model of education timing

Consider an individual who lives for four periods. He has to decide whether and when to go to university. To complete a university degree he must study at least two periods.[2] Workers with a degree get a salary, W. Workers without a degree are paid a wage which is high or low depending on the times. In good times the wage, $\overline{w}$, is higher than in bad times, $\underline{w}$. A particular period is good with probability p and bad with probability $(1-p)$.

Each period the individual without a degree decides whether to study or not after observing the opportunity cost, i.e. the wage rate (which is high or low depending on the times). We normalize the (dis)utility from studying to 0. There are no direct costs associated with education. The only costs are the foregone earnings. The individual discounts the future exponentially, with discount factor δ. We shall assume hereafter that $p \in (0,1)$ and $\delta \in (0,1)$.

The individual is forward looking and maximizes expected lifetime earnings(utility). The decision in each period will depend on the educational history, i.e. the number of periods in which the individual has previously studied. We solve the model by backward induction starting in period $t = 4$.

Let $h_t \in \{0,1,2\}$ denote the number of periods in which the individual has studied, at time t. In the last period ($t = 4$) the agent will of course never study. At $t = 3$, only individuals with $h_3 = 1$, will consider studying. We assume that such individuals will always study, namely

$$\begin{aligned} \delta W &\geq \overline{w} + \delta(p\overline{w} + (1-p)\underline{w}) \qquad (1) \\ \delta W &> \underline{w} + \delta(p\overline{w} + (1-p)\underline{w})) \end{aligned}$$

[2] We assume a degree requires two study periods in order to allow for the possibiliy of interruptions. These will, however, not be optimal in this set up. It should be noted that the delay result does not hinge on this "bulkyness" assumption. If a degree requires only one period, there is a possibility for delay, but for lower returns to education than in the present set up.

The conditions in (1) can be written as

$$\begin{aligned} V &\geq \frac{1}{\delta\gamma} + p\frac{1}{\gamma} + (1-p) \equiv g_3^1(p,\delta,\gamma), \text{ where} \\ V &\equiv \frac{W}{\underline{w}} \text{ and } \gamma \equiv \frac{\underline{w}}{\overline{w}}. \end{aligned} \tag{2}$$

The interpretation of this assumption is that the return to education is high enough to make the individual prefer to forego the high wage, $\overline{w}$, for *one period*, in return for one period of the graduate salary, W.[3]

2.1 Decisions at t=2

First consider the case when the individual never studied before, $h_2 = 0$. The individual will study if:

$$\delta^2 W \geq w_2 + \left(\delta + \delta^2\right) w, \tag{3}$$

where $w \equiv p\overline{w} + (1-p)\underline{w}$, and $w_2 \in \{\underline{w}, \overline{w}\}$ is the wage rate at $t = 2$. If times are good, (3) can be written as:

$$V \geq \frac{1}{\delta^2\gamma} + \frac{\left(\delta+\delta^2\right)\left(1-p+\frac{p}{\gamma}\right)}{\delta^2} = g_2^0(p,\delta,\gamma). \tag{4}$$

It is easy to verify that the RHS in(4) exceeds g_3^1 and the individual may study in good times, depending on the actual value of V, if he did not study before ($h_2 = 0$).

If times are bad, we write (3) as:

$$V \geq \frac{1}{\delta^2} + \frac{\left(\delta+\delta^2\right)\left(1-p+\frac{p}{\gamma}\right)}{\delta^2} = b_2^0(p,\delta,\gamma) \tag{5}$$

A sufficient condition for studying at $t = 2$ in bad times is that $b_2^0(p,\delta,\gamma) < g_3^1$. It is easy to show that $b_2^0(p,\delta,\gamma)$ lies above g_3^1 when $p \geq 1 - \gamma(\delta(1-\gamma))^{-1}$. $b_2^0(p,\delta,\gamma) = g_3^1$ at a $p \in (0,1)$ when $\gamma < \delta(1-\delta)^{-1}$. For $\gamma \geq \delta(1-\delta)^{-1}$, b_2^0 lies above g_3^1 for all $p \in (0,1)$. Hence, the individual always studies at $t = 2$ if $\gamma < \frac{\delta}{1+\delta}$ and $p \leq p_2^0(\delta,\gamma)$, where

$$p_2^0 = 1 - \frac{\gamma}{(1-\gamma)\delta}.$$

Otherwise the individual studies for high enough V. Decisions at $t = 2$ when $h = 0$ are illustrated in Figure 6.

[3] If we are to have delay when a degree takes one study period, we need $\frac{1}{\delta} + p\frac{1}{\gamma} + (1-p) \leq V < \frac{1}{\delta\gamma} + p\frac{1}{\gamma} + (1-p)$.

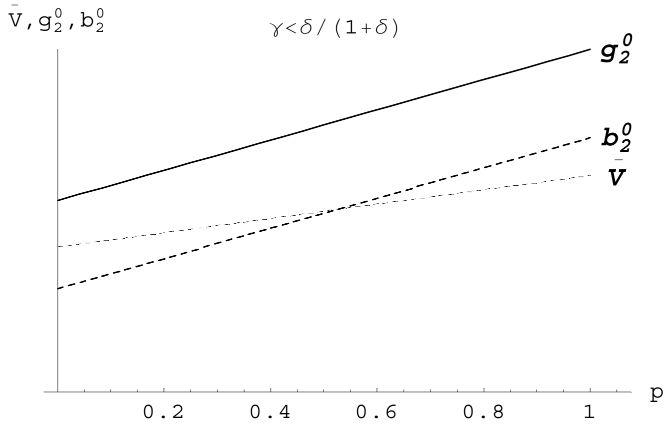

Figure 6: Decision at $t = 2$ with history $h_2 = 0$.

It is clear that when the individual has not studied before, a pay back time of only one period will not necessarily make studying for *two periods* optimal. If V is sufficiently high, it obviously will, regardless of the current opportunity cost. If the current opportunity cost is low (bad times), a small enough difference between good and bad times and a low enough probability that the next period is indeed good, will also guarantee studying. This illustrates that although a one period pay back time is not sufficient if times are always good, it may be sufficient if times are bad. This is why delayed education may be optimal when opportunity costs fluctuate.

Next consider the individual's decisions at $t = 2$ when he has already studied once, $h_2 = 1$. The individual will study if:

$$\left(\delta + \delta^2\right) W \geq w_2 + \delta^2 W \tag{6}$$

If times are good, (6) can be written as:

$$V \geq \frac{1}{\delta \gamma} = g_2^1(p, \delta, \gamma) \tag{7}$$

Since $g_2^1 < g_3^1$ the agent always studies at $t = 2$ in good times, if he studied before. If times are bad, (6) can be written as:

$$V \geq \frac{1}{\delta} = b_2^1(p, \delta, \gamma). \tag{8}$$

Again, since, $b_2^1 < g_3^1$ the agent always studies at $t = 2$ in bad times, if he studied before.

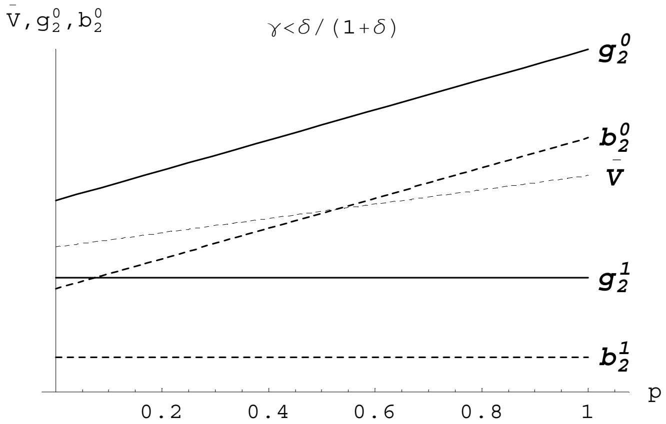

Figure 7: Decision at $t = 2$ with history $h_2 = 1$.

Clearly the individual is willing to give up one period of the high wage in return for two periods of the graduate salary, if he is willing to do it for one period of the graduate salary. This is why we, in general, expect individuals to study early.

2.2 Decisions at t=1

The next step is to analyze the educational decisions of our agent, given that he is forward looking regarding his future decisions. There are three possibilities. In Case A, the return to education is high enough to make the individual willing to forgo two periods of the high wage in return for only one period of the graduate salary, $V \geq g_2^0$. This implies that the individual will study at $t = 2$ regardless of opportunity cost or history. In case B, the return Case C, the return is so low that a two period payback time is required also if the individual is going to to education is intermediate, so that the individual is willing to forgo one period of low and one period of high wages in return for a one period pay-back time, $g_2^0 > V \geq b_2^0$. This implies that the individual will not study at $t = 2$ if the opportunity cost is high and he did not study before. In be willing to forgo one period of the low and one period of the high wage, $V < b_2^0$.

Case A. $V > g_2^0$: The agent always studies at t=2, irrespective of the decision taken at t=1.

The agent will study at $t = 1$ when:

$$\left(\delta + \delta^2\right) W > w_1 + \delta^2 W. \tag{9}$$

If times are good, (9) can be written as:

$$V \geq \frac{1}{\delta \gamma} = g_1^A(p, \delta, \gamma). \tag{10}$$

Since $g_1^A < g_3^1$ an the agent always studies at $t = 1$ in good times, if he plans to study at $t = 2$. If times are bad, (9) can be written as:

$$V \geq \frac{1}{\delta} = b_1^A(p, \delta, \gamma). \tag{11}$$

Since $b_1^A < g_3^1$, the agent always studies at $t = 1$ in bad times, if he plans to study at $t = 2$. Case A is illustrated in Figure 8.

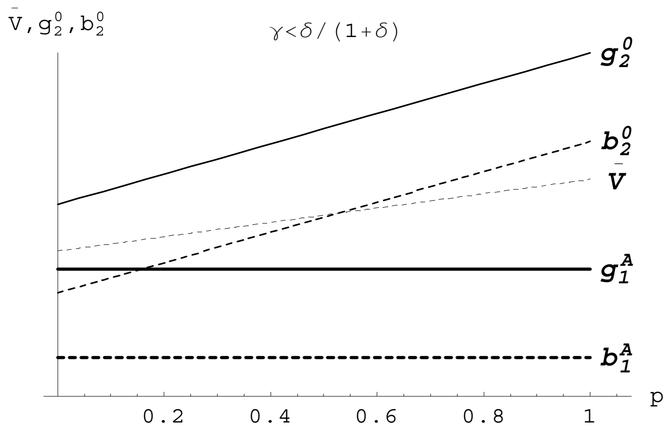

Figure 8: Decision at $t = 1$. Case A.

Again, we have an illustration of that if it pays to get an education one period from now, it will pay more to get it immediately. When the return is sufficiently high, education will not be delayed.

Case B. $b_2^0 \leq V < g_2^0$: The agent studies at $t = 2$ unless times are good and he did not study before.

The agent will study at $t = 1$ when:

$$\left(\delta^2 + \delta^3\right) W > w_1 + p(\delta\overline{w} + (\delta^2 + \delta^3)w) + (1-p)\delta^3 W. \tag{12}$$

When times are good, this can be written as:

$$V \geq \frac{\frac{1}{\gamma} + \frac{\delta p}{\gamma} + p\left(\delta^2 + \delta^3\right)\left(1 - p + \frac{p}{\gamma}\right)}{\delta^2\ (1 + \delta\, p)} = g_1^B(p, \delta, \gamma). \tag{13}$$

When $\gamma > (1 + \delta + \delta^2)^{-1}$, $g_1^B < b_2^0$ for all p and the agent always studies at $t = 1$. If $(1-\delta) < \gamma < (1+\delta+\delta^2)^{-1}$, $g_1^B \lesseqgtr b_2^0$ for all $p \gtreqless (1-\gamma(1+\delta+\delta^2))/(\delta^2(1-\gamma))$. $\gamma < (1-\delta)$, $g_1^B > b_2^0$. If times are bad the condition for working at $t = 1$ is:

$$V \geq \frac{1 + \frac{\delta p}{\gamma} + p\left(\delta^2 + \delta^3\right)\left(1 - p + \frac{p}{\gamma}\right)}{\delta^2\ (1 + \delta\, p)} = b_1^B(p, \delta, \gamma), \tag{14}$$

which is always below b_2^0, hence the agent always studies at $t = 1$ if times are bad. Results for Case B are illustrated in Figure 9.

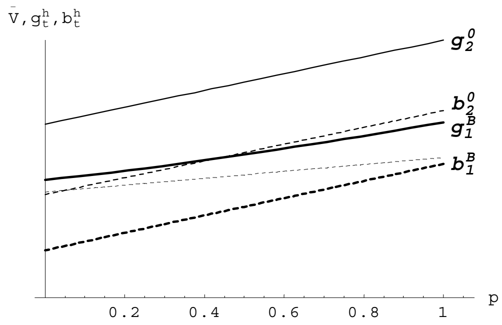

Figure 9: Decision at $t = 1$, Case B.

When the agent knows that he will study (and hence complete his education) at $t = 2$ (and $t = 3$) if the times are bad, he will decide to delay the education investment if times are good at $t = 1$. The conditions are such when the good wage is large in relation to the bad wage (γ is low) and the probability of good times is low. The delay result hinges in that the agent may, but is not sure to complete his degree if he decides not to study at $t = 1$. If he is sure to complete (Case A), it will always give a better pay off to complete early. If he is not sure to complete, but the value of the high wage is not interesting enough (γ is high) or if the likelihood of completion is too low, (p is high) the individual does not dare delay.

Case C: $V < b_2^0$, namely the agent studies at $t = 2$ only if he studied before.

He will study at $t = 1$ when

$$\left(\delta^2 + \delta^3\right) W > w_1 + (\delta + \delta^2 + \delta^3)w \tag{15}$$

when times are good (15) can be written as

$$V > \frac{\frac{1}{\gamma} + \delta \left(1 + \delta + \delta^2\right)\left(1 - p + \frac{p}{\gamma}\right)}{\delta^2 \left(1 + \delta\right)} = g_1^C(p, \delta, \gamma). \tag{16}$$

When $\gamma > (1+\delta+\delta^2)^{-1}$ $g_1^C < b_2^0$ for all p and the agent will study at $t = 0$ if V is high enough. If $(1-\delta) < \gamma < (1+\delta+\delta^2)^{-1}$, $g_1^C \lesseqgtr b_2^0$ for all $p \gtreqless (1-\gamma(1+\delta+\delta^2))/(\delta^2(1-\gamma))$. $\gamma < (1-\delta)$, $g_1^C > b_2^0$. Hence, if γ is low, the agent never studies in good times at $t = 1$.

If times are bad (15) can be written as

$$V > \frac{1 + \delta \left(1 + \delta + \delta^2\right)\left(1 - p + \frac{p}{\gamma}\right)}{\delta^2 \left(1 + \delta\right)} = b_1^C(p, \delta, \gamma). \tag{17}$$

It can be shown that $b_1^C < b_2^0$. Furthermore, for $\gamma > \delta$, $b_1^C > g_3^1$. When $\gamma \in (\delta^2, \delta)$, $b_1^C > g_3^1$ for $p > (1+\delta)(\delta-\gamma)(\delta(1-\gamma))^{-1}$.When $\gamma < \delta^2$, $b_1^C < g_3^1$. Hence if $\gamma < \delta^2$, the agent always studies in bad times. If $\gamma \in (\delta^2, \delta)$, the agent will always study in bad times, provided that the probability of good times in the next period is low enough. Otherwise the agent will study in bad times only if V is high enough.

If the agent knows that he will only study at $t = 2$ if he studied before, delay is not an option.

We can conclude that under certain conditions we will observe that individuals delay their education. Delay will be a possibility only if there is uncertainty about completion and if the difference between the high and the low wage is large enough. Furthermore, if the risk of not completing is too high, (p high) delay does not take place. If the return to education is very high, delay does not occur and the decision to study is then independent of the realization of the opportunity cost. If completion is uncertain, but probable the individual will decide to delay if times are initially good. The delayer will only complete his education if times are bad at $t = 2$.

3 Some empirical evidence on education timing

Our stylized model generates at least two testable hypotheses. First, it is clear that delayed education is an alternative only if returns to education are relatively low. Second, fluctuations in the opportunity cost of time should affect the timing of education only if the return to education is relatively low. Formally testing these implications is beyond the scope of this paper, but we shall nevertheless present some evidence in support of these hypotheses.

Figure 10 presents a scatter-plot of the OLS estimates for male return to education for the 1985-1995 period from Trostel et al (2002) against OECD data on the median age of University freshmen (Tertiary A type educations) for 1999. There is a clear, and statistically significant at the 5 percent level, negative relation. The slope of the line implies that an increase by one percentage point of the return to education is associated with 2-3 months lower freshman age. The linear trend line has an $\mathrm{R}^2 = 0.13$. It is interesting to note that Israel has a remarkably high median age, probably as a result of lengthy mandatory military service. If the outliers, UK and Israel are excluded, $R^2 = 0.24$, and the negative relation is still significant at the 10 per cent level and implies that increasing the return to education by one percentage point lowers the freshman age by 4-5 months.

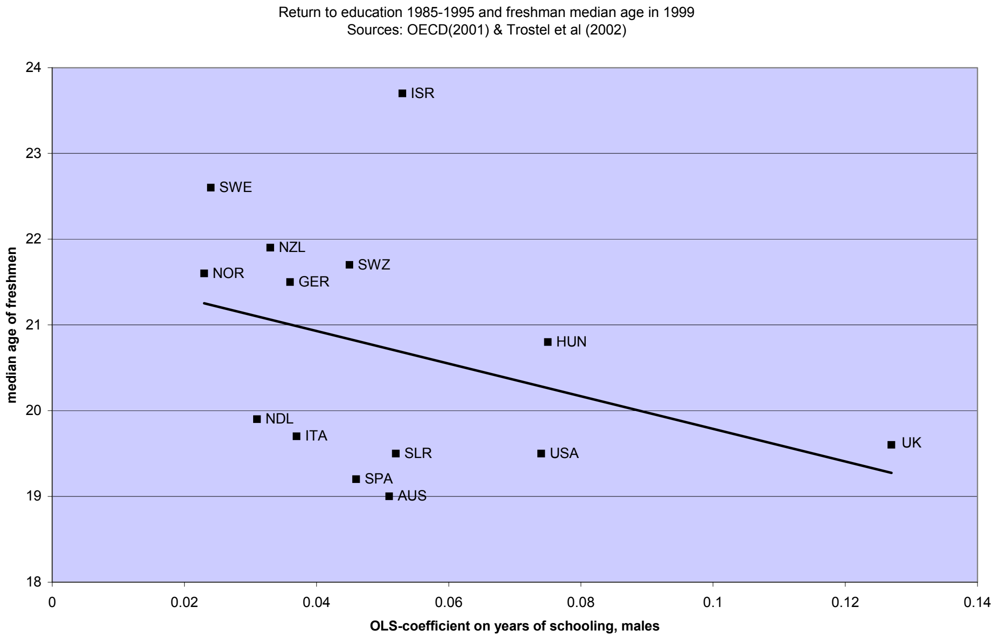

Figure 10

Figure 11 illustrates the evolution of Swedish young (21 or younger) freshman enrollment for students with different family background. The figure reports the evolution of enrollment indexes where the number of enrolled freshmen is set to 100 in 1990/91. Overall enrollment of young freshmen increased remarkably in the early nineties and leveled off in the mid nineties. Students whose parents have at least some university education show an enrollment pattern very similar to the total of all young students, neither seems to be affected by the improved unemployment figures of the late 1990's. The evolution of enrollment of the young freshmen whose parent have only basic education shows a pattern strikingly similar to the unemployment figures. Their enrollment is positively affected by the university expansion and by the rising unemployment figures of the early nineties, but contrary to their fellow freshmen, this group's enrollment figures decline as the economic climate improves and unemployment falls.

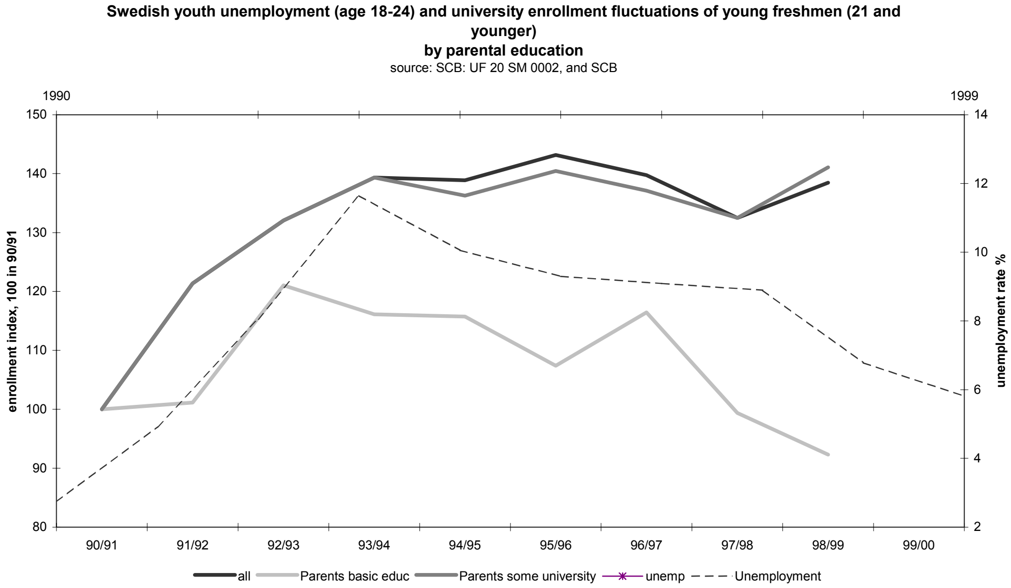

Figure 11

4 Conclusions

We have shown that when there are fluctuations in, and uncertainty about the opportunity cost of time, marginal individuals may choose to delay their education if times are good. It is when the benefits associated with education are low and the event of completing the degree uncertain, but not too unlikely, that individuals will consider delaying their education. This prediction of the paper finds some support when estimates of returns to education and median age of university freshmen are compared across countries. At the individual level, it is the group of individuals with mediocre or low returns that will be more prone to delay or not opting for education at all when facing fluctuating opportunity costs. Also this prediction finds some support in Swedish enrollment patterns.

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