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On the cyclicality of schooling: theory and evidence

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Economic theory indicates that opportunity- cost considerations tend to make schooling countercyclical whereas ability-to-pay considerations have the opposite effect. We examine the college enrollment decisions of individuals in the US using the Current Population Survey and find that their propensity to enroll is countercyclical. There seems to be significant substitution during the business cycle between human capital investment and competing economic activities.

1. Introduction

The influence of the state and the characteristics (e.g. severity) of the business cycle on the demand for education has received scant attention in the existing literature.[1] For instance, well known studies such as those by Orazem and Krottila (1991), who examine the determinants of both educational and occupational decisions of high school students in the US and Pissarides (1981, 1982), who has studied the demand for education of the 16- and 18-year-old age groups in the UK (see also Rice, 1987, 1999, and Leslie and Drinkwater, 1999) have not paid explicit attention to cyclical considerations. Betts and McFarland (1995), written contemporaneously with our paper, is an exception. They have examined cyclical changes in enrollment at public two-year colleges in the US during 1969 to 1985. They found than an increase in the unemployment rate by one percentage point is associated with a rise in full-time attendance of about 4.5%.

The objective of this paper is to study the cyclical behavior of the demand for higher education.[2] In the theoretical section of the paper we study the schooling decision within a setup with either homogeneous or heterogeneous labor. In the former case, all individuals select an optimal path for human capital acquisition throughout their lifetime where their earning opportunities vary as a function of both their skill level and of the business cycle. In the latter case, individuals decide

[1] For instance, the chapter on the demand for education in the *Handbook of Labor Economics* by R. Freeman (1986) does not contain any reference to the cyclical properties of human capital investment.

[2] Perli and Sakellaris (1998) study the reverse problem, namely how the process of human capital acquisition affects the properties of the business cycle.

which segment of the labor force to join (skilled versus unskilled) and when. The ones who do acquire education subsequently select the timing and quantity of human capital maintenance and enlargement. We study the cyclical dimensions of both of these decisions.

Investment in human capital is affected by the interaction between the ability to pay and the willingness to purchase education (Becker, 1975). We show that, in the absence of borrowing constraints, the process of human capital accumulation is countercyclical. The pattern, however, can become procyclical with imperfectly functioning credit markets under some—rather restrictive—assumptions on the cyclicality of finance and on the correlation between individual talents and liquidity. We argue that strong procyclicality of student loans, of student aid and grants as well as of part time job opportunities together with a negative correlation between skills and liquidity may negate the opportunity cost effects and induce a procyclical enrollment pattern.

The theoretical analysis demonstrates that the cyclicality of human capital accumulation is ambiguous and underlines the importance of its empirical determination. In the empirical part of this paper we examine the direction and the size of the cyclicality of college enrollment decisions in the United States.[3] We use the school enrollment information in the October supplement of the Current Population Survey to construct a time series of cross sections of 18- to 22-year-old high school graduates.

Individuals' propensity to enroll in college displays a strong, countercyclical pattern, after controlling for observable characteristics. For the period of 1968–88 a one percentage point increase in the unemployment rate is associated with about a 2% increase in college enrollment. Simulations suggest that cyclical fluctuations in aggregate economic activity may have caused significant swings in enrollment. For instance, in October 1982, when the unemployment rate stood about 1.9 points higher than 12 months earlier, our estimates indicate that college enrollment would have been lower by about 232,000 were it not for the recession. This is substantial in relation to the reduction in employment between October of 1981 and October of 1982 of about 1.163 million, even though it does not include enrollment of older individuals.

Section 2 presents the theoretical and Section 3 the empirical analysis. We offer some conclusions in the final section.

[3] We focus on education as opposed to other forms of human capital investment such as on-the-job training. It seems that educational expenditures are considerably larger than other training expenditures. Clotfelter (1991) estimated total educational in the US at $331 billion in 1989 whereas Mincer (1993) estimated expenditures on job training to about $165 bn in 1987. Among the many aspects of formal education we concentrate on college enrollments because of the availability of the relevant data set. Other forms of formal investment in human capital such as vocational school, training programs within and outside firms, adult education, etc. are interesting too. They ought to become the subject of serious investigation.

2. The model

Consider an economy where all individuals are born with the same initial endowment of human capital (skills). This initial amount can only be augmented in a lump sum fashion by completing college. Those who complete college are called skilled and have the opportunity to further adjust their level of skills by undertaking additional human capital investments. Those who do not complete college simply retain their initial stock of human capital and are called unskilled. This specification is selected so that both college and continuing education decisions can be studied in a very simple fashion.

We will assume that people differ in terms of learning ability, that is, some of them find it easier to go through college than others. As a result, some individual will never become skilled. Moreover, without loss of generality, we will postulate that college education takes one period to be completed; that it results in the creation of H_0 units of human capital; that it can only be pursued full time;[4] and that it carries a direct educational cost of $Q_t(j)$ where j is an individual of learning ability level j. In particular

$$Q_t(j) = Q_t + g(j) \quad dg/dj < 0 \quad j\epsilon(0,1) \tag{1}$$

According to (1), the direct cost of education consists of a time–varying component that is common to all individuals and an idiosyncratic component, which is time–invariant. A high ability individual (higher j) faces a lower cost of education.

An individual j who has not yet gone to college faces the following utility path

$$V_N(w_{Nt}, B_{Nt}, R_t, Q_t) = \max\{[v(c_{Nt}) + \beta E_t V_N(w_{Nt+1}, B_{Nt+1}, R_{t+1})], \tag{2}$$
$$[v(c_t) + \beta E_t V(H_0, w_{t+1}, B_{t+1}, R_{t+1})]\}$$

where v is utility from consumption, V_N and V (to be defined below) are the value function of an unskilled and skilled person respectively, w_{Nt} and w_t are the corresponding wages (we abstract from experience as a determinant of earnings), c_{Nt} and c_t are consumption levels and B_{Nt} and B_t are one–period, discount bond holdings (with an associated interest rate of R_{t-1}). Finally, H_0 denotes the level of human capital of the newly skilled (note that while the input of the educational activity differs across individuals, the output, H_0, does not). Note also that learning ability does not vary with age.

Consumption in period t satisfies either

$$w_{Nt} + B_{Nt} = c_{Nt} + B_{Nt+1}/R_t \tag{3}$$

or

$$B_{Nt} = c_t + B_{t+1}/R_t + Q_t(j) \tag{4}$$

We have normalized the labor endowment of the unskilled to unity. Educational expenses and consumption while attending college must be financed by either income accumulated before hand and/or by a loan. For the time being, we rule

[4] Allowing schooling to ast N periods or be part-time is straightforward at the cost of some additional technical complexity.

out the possibility of borrowing constraints (we also impose a no-Ponzi-game condition).

The criterion employed for deciding whether to go to school or not in period t depends on the difference between the two terms in the RHS of (2). Let $\Omega_t(j)$ be equal to the second minus the first term. That is

$$\Omega_t(j) = [v(B_{Nt} - B_{t+1}/R_t - Q_t(j)) + \beta E_t V(H_0, w_{t+1}, B_{t+1}, R_{t+1})] - [v(w_{Nt} + B_{Nt} - B_{Nt+1}/R_t) + \beta E_t V_N(w_{Nt+1}, B_{Nt+1}, R_{t+1})] \quad (5)$$

Individual j pursues schooling the first time that $\Omega_t(j) > 0$. The decision to go to college depends on the expected relative path of wages for the skilled and unskilled, past economic conditions as reflected in the current level of assets, the direct cost of education, the level of learning ability and the current level of wages for unskilled labor. If for individual j, $\Omega_t(j) > 0$ for all t then there is no cyclical dimension in his schooling decision. He simply goes to college when he comes of age independent of the current economic conditions.

When $\Omega_t(j) > 0$ for some but not all t then the cyclicality of college enrollment will depend on the cyclicality of Ω_t. It can be seen that $d\Omega_t/dw_{Nt} < 0$, $d\Omega_t/dE_t(w_{t+1} - w_{Nt+1}) > 0$, and $d\Omega_t/dQ_t < 0$. The sign of the effect of the real interest rate on Ω can be established by noting that $d\Omega_t/dR_t = v'(B_{Nt} - B_{t+1}/R_t - Q_t(j))B_{t+1}/(R_t)^2 - v'(w_{Nt} + B_{Nt} - B_{Nt+1}/R_t)B_{Nt+1}/(R_t)^2$. If a young worker is likely to be a net saver while a young student is likely to be a net borrower then $B_{t+1} < 0$ and $B_{Nt+1} > 0$ implying that $d\Omega_t/dR_t < 0$. A high current interest rate discourages the pursuit of educational activities due to opportunity cost. But even if both individuals are net borrowers, B_{t+1} is likely to be greater (in absolute value) than B_{Nt+1} because the college student does not have any current labor income to support consumption and he can also borrow against a higher future income than the low skilled.

In summary, the propensity to enroll in college is negatively related to the current wage of the unskilled, the real interest rate, and the direct cost of education, while it is positively related to the expected future wages of college graduates relative to those who remain unskilled. The real interest rate, R, is acyclical whereas the real wage, w is procyclical. It seems, then, that unless the direct cost of education is strongly countercyclical the rate of school enrollment will be countercyclical.[5]

Let us now turn to the human capital decision faced by a skilled individual. He faces the following lifetime utility path

$$V(H_t, w_t, B_t, R_t) = \max\{v(c_t) + \beta E_t V(H_{t+1}, w_{t+1}, B_{t+1}, R_{t+1})\} \quad (6)$$

[5] Another important factor is the relative volatility of the wages of skilled and unskilled. If the wage of unskilled labor is more cyclical than that of skilled, as argued by Dellas (1994) (due to differences in hiring or firing costs that induce differences in labor hoarding practices for different types of labor) then the ratio w_{Nt}/w_t will be countercyclical. This, in turn, induces countercyclicality in Ω.

subject to

$$w_t u_t H_t + B_t = c_t + B_{t+1}/R_t \tag{7}$$

where u_t is the fraction of his time endowment that is devoted to work. Human capital, H, evolves according to

$$H_{t+1} = (1-\delta)H_t + \theta(1-u_t)H_t \tag{8}$$

where δ is the rate of human capital depreciation ($0 < \delta < 1$) and θ is the marginal (and average) product of investment in human capital ($\theta > 0$).

Maximization of (6) with regard to u_t and B_{t+1} subject to (7) and (8) leads to the first order conditions (9) and (10) respectively

$$\begin{array}{rll} > & & u = 1 \\ w_t v_t' < & \beta E_t w_{t+1} v_{t+1}'(1-\delta+\theta)] & u = 0 \\ = & & 0 < u < 1 \end{array} \tag{9}$$

$$v_t' = \beta R_t E_t v_{t+1}' \tag{10}$$

In a partial equilibrium model such as ours where w and R are exogenous and can take arbitrary values, the probability that both first order conditions will be satisfied in an interior solution for u and B is zero. Since u is restricted to vary between zero and unity while B is unrestricted, eq. (10) will be satisfied as an equality but (9) will involve either full time work ($u = 1$) or full time schooling ($u = 0$). Moreover, under these conditions, u will be in a corner solution with probability one independent of the stochastic structure of the model. Without any loss of generality and for the sake of exposition we can postulate that w and R follow a deterministic pattern. In particular, for the sake of exposition let w and R exhibit a one-period deterministic cycle. Combining (9) and (10) results in the following solution for u

$$\begin{array}{lll} u_t = 1 & \text{when} & w_t R_t > \beta w_{t+1}(1-\delta+\theta) \\ u_t = 0 & \text{when} & w_t R_t < \beta w_{t+1}(1-\delta+\theta) \end{array} \tag{11}$$

The cyclical behavior of schooling activities is fully described by (11). People are more inclined to substitute away from work towards educational activities when the current wage is low relative to future wages and the current interest rate is low. If the real wage is procyclical and the interest rate is not too countercyclical[6] then people will find recessions an opportune time for improving future earning capacity by investing in schooling. That is, as before, a countercyclical pattern of education emerges.

How robust is this result? It can be easily shown that some model modifications will not affect the countercyclicality of education. For instance, allowing for leisure as an alternative margin of substitution away from work effort during recessions does not alter anything in the case of additively separable utility. Or, making the wage a function of the stock of human capital only affects the size of the cyclical pattern. Other alterations are harder to investigate. Studying cyclical effects when

[6] The *ex ante* real interest rate is difficult to compute. Nevertheless, various measures of it seem to be either acyclidal or slightly procyclical.

the production function has both human and physical capital poses very difficult technical problems in general equilibrium.[7]

2.1 Credit constraints

Let us again look at the role of credit constraints. Suppose there is a strict borrowing constraint, so that in (7) $B_t \geqslant 0$. In place of (10) we now have (10′) (again assuming a deterministic process for w and R)

$$v_t' = \beta R_t v_{t+1}' \quad B_t > 0 \qquad (10')$$
$$v_t' > \beta R_t v_{t+1}' \quad B_t = 0$$

Does a binding credit constraint make a procyclical pattern more likely? From (10′) a binding constraint means that $v_t'/\beta v_{t+1}' > R_t$. Let $v_t'/\beta v_{t+1}' = \mu_t + R_t$, where $\mu > 0$. Equation (9) on the other hand implies that $u_t = 1$ full time work if $v_t'/\beta v_{t+1}' > (w_{t+1}/w_t)(1 - \delta + \theta)]$. Combining these two conditions we have that a constrained individual will work full time when

$$w_t R_t + w_t \mu_t > w_{t+1}(1 - \delta + \theta)] \qquad (11)$$

For $\mu_t = \mu$ for all t it is obvious that the procyclicality in education becomes less pronounced. People may not go to school even if w_t and R_t are low because of the additional positive term $w_t \mu_t$. Nevertheless, the pattern remains countercyclical as the likelihood that (11) will not hold is negatively related to the values of R and w_t/w_{t+1}.

If, on the other hand, μ_t varies countercyclically, then (11) reveals the conditions under which a procyclical pattern in the pursuit of educational activities could obtain.

2.2 Heterogeneity

Consider now a set of individuals who may differ in initial wealth and learning capacity and may also become active—either economically or educationally—during periods of different macroeconomic conditions. To capture heterogeneity in the labor force we will assume that there exists an educational activity—such as college—that serves to create different segments in the labor force, with the different segments being imperfect substitutes for one another.

Let A_{it} be the level of assets owned by agent i in period t and Q_{it} be the total, direct educational costs that individual i needs to pay in order to complete his education if he enrolls in period t. Cross sectional differences in Q are used as a proxy for differences in schooling ability. In order to highlight the role of borrowing constraints in the presence of heterogeneity we find it convenient to initially ignore consumption smoothing considerations by employing a linear utility function (together with the restriction that consumption cannot be negative). The

[7] The only case that has been treated in the literature involves Cobb-Douglas utility and production. This however, implies that the shares of the various activities pursued are invariant to the state of the cycle.

linearity of the utility function implies that $\beta = R$ so one cannot study the influence of changes in the interest rate on educational decisions.

Suppose that all individuals are born as unskilled. They can then elect to become skilled in any period t by making the appropriate investment in education. Individual i who is still unskilled as of period t has to decide whether he will go to school during that period or whether he will maintain the option to change labor classification later. If he chooses the former then his lifetime utility is given by

$$V_{it} = E_t \sum_{j=t+T}^{\infty} \beta^{j-t} w_j - Q_{it} + A_{it} \tag{12}$$

Expression (12) is based on the assumption that schooling takes T consecutive periods to be completed and that discontinuation before completion is not possible; and that the wage[8] of a skilled is independent of other personal characteristics (Q_i and A_i).

The value function of an unskilled individual i is given by

$$VN(w_{Nt}, A_{it-1}) = \max\{[c_t + \beta E_t VN(w_{Nt+1}, A_{it})], V_{it}\} \tag{13}$$

where an N as a subscript denotes non-skilled.

If the first term in the RHS of (13) is larger than the second term then the individual remains unskilled for at least one more period. Otherwise he enrolls in school. Let

$$VN_t^* = E_t \sum_{j=0}^{\infty} \beta^j w_{Nt+j} + A_{it} \tag{14}$$

If there are no borrowing constraints then the optimal schooling decision of individual i is as follows: if (14) $>$ (12) for all t then he never invests in human capital. If (14) $<$ (12) for all t then he invests in human capital the first time he faces this choice independently of the level of his assets. Obviously, schooling does not exhibit any cyclical pattern in this case. Finally, if (14) $<$ (12) for some but not all t then the individual goes to school the first time this inequality is satisfied. The question of interest is whether this is more likely to happen during a recession. There are reasons that make an affirmative answer to this question likely. First, w_{Nt} is procyclical. Second, recessions tend to be persistent, which implies that low-skilled wages will likely remain low during at least some fraction of the period of educational pursuits. And third, the wages of the low skilled may be more sensitive to the cycle than the wages of the skilled. Subsequently, the difference $\beta^T w_{t+T} - w_{Nt}$ is likely to be greater during a recession.[9] Of course, if these effects

[8] Note that (12) abstracts from any further human capital accumulation that is undertaken by the skilled (as described in the previous subsection). It is a trivial task to allow for additional human capital fine tuning.

[9] If we allow for unemployment, than the relevant comparison involves expected incomes, that is $p_{t+T} w_{t+T} - p_{Nt} w_{Nt}$ where p represents the probability of employment. There exists some evidence that the p_N is more cyclically sensitive than p (Abowd and Ashenfelter, 1984). We examined the empirical behavior of $w_t - w_{Nt}$ but did not find any cyclical pattern.

are only weakly cyclical then they may be negated by a strongly countercyclical Q. While tuition and fees do not seem to be countercyclical at all, such costs net of government and employer subsidies may very well be.

The analysis has been carried out under the assumption of a linear utility function, which rules out consumption smoothing motives. Nevertheless, one can apply the argument used earlier in the case of homogeneous labor under perfect capital markets to establish that consumption smoothing is not an obstacle to opportunity cost considerations. A countercyclical pattern in education obtains even under heterogeneity as long as credit constraints are absent.

We now turn attention to liquidity constraints. We assume that prospective students face quantitative constraints concerning the amount of loan they can obtain.[10] Let K_t be the maximum amount of loan permitted. Let M be the number of individuals with an initial level of assets A_{i0} and direct cost Q_{it} such that $A_{i0} - Q_{it} > 0$, and N be the number of those with $A_{i0} - Q_{it} < 0$. Of the M (rich) individuals let $M1$, $M2$, and $M3$ ($M1 + M2 + M3 = M$) be those for whom $(14) > (12)$ 0 for all t, for some t, and for no t respectively. Subsequently, $M2$ of the affluent people will follow a cyclical pattern, and more specifically a countercyclical one because this groups is driven by opportunity cost. Of the N people let $N1$, $N2$ and $N3$ ($N1 + N2 + N3 = N$) be those for whom $(14) > (12)$ for all t, for some t, and for no t respectively. Subsequently, among poor people, $N1 + N2$ individuals would want to undertake schooling. To make the borrowing constraint cyclically interesting it can be assumed that for the $N1$ group, $A_0 + K_t - Q_t > 0$ only during expansions.[11] Obviously, $N1$ individuals will enroll immediately if the current period is an expansion but not if it is a recession. Things are more complicated for the $N2$ individuals because they face a conflict between desirability and feasibility. Schooling may be desirable but not feasible during a recession and feasible but not desirable during an expansion. This group's cyclical behavior depends on the relative importance of income and opportunity cost effects.

The general pattern that emerges from the preceding discussion is that the cyclical sign of schooling is ambiguous when a subset of the population is credit constrained. The main factor is the relative size of the two population groups, $M2$ and $N1$: 'average' ability individuals who have the necessary resources versus 'high' ability individuals who do not. And also the responsiveness of these groups to the

[10] A similar analysis can be carried out under the assumption that it is the borrowing rate instead that varies over the cycle and across different individuals.

[11] This may be a plausible scenario for several reasons. First, the maximum amount of load may depend on the value of available collateral (for instance, the market value of real estate owned), and the latter is likely to be procyclical. Second, grants and general school financial assistance may be procyclical as spending on education on the part of state authorities as well as private donors may be procylical. And third, part time job opportunities (an element that the present analysis abstracts from) may be more plentiful during good times, a factor that reduces the required amount of loan.

state of the business cycle. The study of the actual pattern of aggregate school enrollment can provide information on the relative importance of these two groups and hence on the relative importance of economy wide opportunity cost versus liquidity factors (the cyclical sign of $M2–N1$). It must also be kept in mind that the relative size of these groups may well vary with the particular schooling decision (e.g. college, vocational) as well as the age group considered. The study of the schooling decisions of different cohorts may then shed light on the type of existing borrowing constraints.

Dropping the linear utility assumption increases the strength of income effects and makes a procyclical pattern more likely to emerge under liquidity constraints. This is due to the fact that the marginal utility of consumption is high when income is low. Hence, the utility loss of taking income away from consumption to finance investment in education is higher during recessions (the future benefits due to education are also smaller because of the decreasing marginal utility of consumption).

3. The empirical results

3.1 The data

We use the School Enrollment information available in the October tapes of the Current Population Survey (CPS) conducted by the US Bureau of the Census. The October CPS is the most comprehensive source of data on college enrollment that we could locate spanning enough years to facilitate the study of enrollment behavior over the business cycle. We use data from 1968 to 1988. The time period covered includes four recessions for the US economy: (a) December 1969 to November 1970, (b) November 1973 to March 1975, (c) January 1980 to July 1980, and (d) July 1981 to November 1982. Our sample consists of all high school graduates between the ages of 18 and 22 surveyed during each of these years. Individuals of age 18 to 22 constitute the bulk of those enrolled in college. Because different individuals are interviewed (in general) in different years we cannot follow them through time, that is, we do not have longitudinal data. Thus, we cannot address the persistence of college enrollment decisions of individuals. We can examine, however, how these enrollment decisions of individuals vary over the business cycle after controlling for individual-specific demographic and other characteristics. The sample consists of 202,597 individuals. The minimum number of observations during a year is 7,815 and the maximum is 12,174 individuals (see the Appendix for variable definitions and Table 6 for their mean values).

We consider an individual enrolled if she attends a 2-year or 4-year college full-time or part-time. We use three measures for the cyclical state of the economy. The first two, the total civilian unemployment rate, and the first-difference in (log) real GNP are commonly used in the literature that studies the cyclicality of real wages (e.g. Solon *et al.*, 1994, and Abraham and Haltiwanger,

1995).[12] The third is a measure of the cyclical component of GNP constructed by Cochrane (1994), which we call the 'Cochrane measure'.[13] The Appendix contains means of some of the explanatory variables.

Cross-sectional studies of college enrollment (using primarily the data set 'High School and Beyond') have shown that parental background variables such as their level of education and income are important in predicting college enrollment (see Manski and Wise 1983). Unfortunately, the October CPS survey does not contain adequate information to recover parental background variables for our sample of students. This is a limitation in the empirical analysis that we will present.[14]

In Section 3.2 below we deal with the question of the existence and sign of cyclicality in schooling. In Section 3.3 we examine more closely the determinants of enrollment decisions identified in the theoretical part of the paper.

3.2 The cyclical behavior of college enrollment

Figure 1 contains a time plot of detrended aggregate unemployment and enrollment rates. The enrollment rate seems to display a countercyclical pattern. This can be seen also in Table 1, which contains the results of regressing the aggregate enrollment rate on the unemployment rate. An increase in the unemployment rate by one percentage point is associated with an increase in the enrollment rate of about 0.57 percentage points. The total number of 18- to 22-year-old high school graduates over the years in our sample is displayed in Fig. 2. The number peaks in 1981 reflecting the impact of the 'baby-boom'.

[12] We have also repeated the analysis with unemployment rates for 18-22 year old high school graduates and 22-30 year-old high school graduates that we constructed from the tapes and the qualitative nature of the results did not change.

[13] To obtain this 'cyclical' component one removes the trend, which is constructed as log consumption less the mean log GNP/consumption ratio. Cochrane (1994) shows that if consumption were a pure random walk (as it would be according to the permanent income model) then this series would correspond to the Berveridge and Nelson (1981) trend in GNP. This is a good approximation, in practice, since consumption growth is not very predictable. The Cochrane measure we use is the average over the four quarters of the year. All reported results were qualitatively unchanged by using just its value in the third quarter. The correlation between the Cochrane measure and the detrended unemployment rate is high (-0.72).

[14] The information to map students to parents exists only after 1983. Even then this can be done only for individuals that lived with their parents while attending college, a small fraction of the sample. Kane (1994) obtains parental background information by limiting his sample to dependent 18- and 19-year-old and by identifying the household head and spouse as the parents of the youth. We did not follow this approach for various reasons. We wanted to maintain as large and as representative a sample as possible so we did not drop individuals of ages 20 to 22. This resulted in the number of dependent youths dropping sharply. It is indicative that 23% of the youths in our sample are married and (most likely) independent. Furthermore, it is most likely that single young individuals who are independent are working and not enrolled in college. By excluding them on the basis of lack of availability of parental information we would be biasing our sample towards including more enrolled individuals. Finally, identifying the household head and spouse as the parents of the youth introduces a source of measurements error.

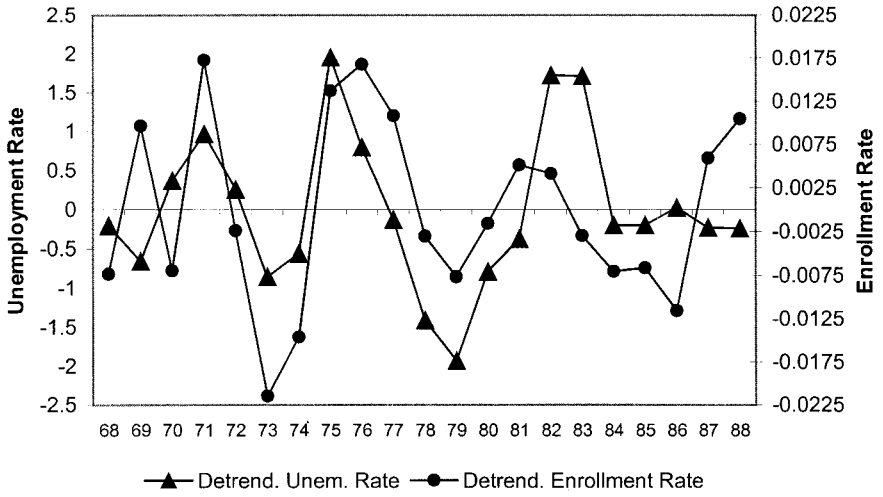

Fig. 1. The business cycle and enrollment

Table 1 Cyclicality of the aggregate enrollment rate

Unemployment rate	**0.0057 (.0020)**
R^2	0.84
DW	1.502

Notes: The number in parenthesis is robust standard error. Linear, quadratic, and cubic time trends and intercept are included but not reported. The sample consists of annual data for years 1968 to 1988.

We turn to the analysis of individual-level data. We use probit analysis to examine the time variation of the enrollment decisions of US high school graduates after controlling for certain individual specific characteristics (age, gender, race, marital status, region and state of residence, residence in an urban area or SMSA, and others). The values of the estimated coefficients on year effects are indicative of time variation in the propensity to enroll after controlling for individual characteristics. There is significant time variation in this propensity.[15] Figure 3 contains these year effects together with the aggregate enrollment rates. As may be seen from there the enrollment rate varies between about 37 and 47% and the correlation between the two series is 0.46 (0.84 after detrending them). The main difference seems to be in years 1976 and 1977: whereas the aggregate enrollment rate

[15] The exclusion restriction of the year effects is overwhelmingly rejected.

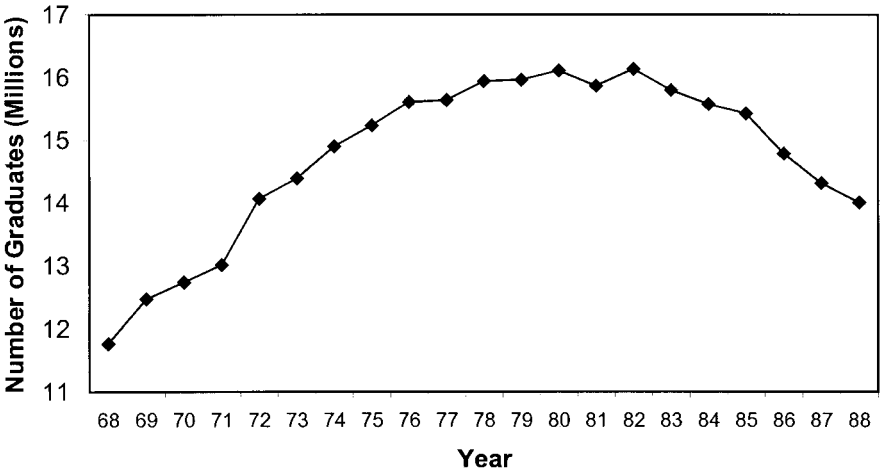

Fig. 2. High school graduates

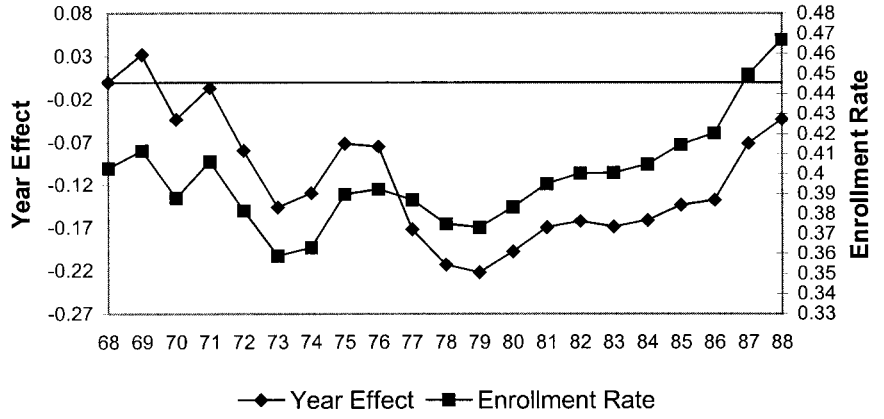

Fig. 3. Enrollment rate and year effect

remained steady during those years the propensity of individuals to enroll fell quite dramatically. During the preceding and following years the two series move in similar manner.

Replacing the year effects with trend terms and the US civilian unemployment rate we find evidence of a countercyclical pattern of college enrollment decisions.[16] The coefficient of the unemployment rate (see Table 2) is significantly positive. This indicates that the effect of the procyclical variation in the real wage and in

[16] The restriction that the year effects can be expressed in terms of the unemployment rate and linear, quadratic, and cubic time trends cannot be rejected at the 1% level of significance. The value of the $\chi^2(16)$ statistic is 31.18. The results reported in Table 2 did not change when we dropped the cubic time trend.

Table 2 Probit results

	Individual enrollment data							
Unemployment rate	0.021 0.0079	(0.004) (0.0015)	0.021 0.0081	(0.004) (0.0016)				
Contraction × unemployment rate			−0.001 −0.0002	(0.002) (0.0006)				
Growth rate of real GNP					−0.302 −0.114	(0.16) (0.061)		
Cochrane measure of the cycle							−1.244 −0.471	(0.321) (0.122)
$-logL$		121272.11		121271.95		121293.34		121280.92

Notes: The number of observations is 202,597. The first line for each entry contains the estimated coefficient, the second line the marginal effect. Robust standard errors (corrected for clustering/group aggregation) are in parentheses. The specification also includes the following variables: AGE, AGE^2, gender/race interaction dummies, SMSA dummy, two dummies for Hispanics living in the West and in the South, a dummy for blacks living in the South, marital status dummies, state dummies, and linear, quadratic and cubic trends.

other elements of the opportunity cost of education overwhelms the effect of the (possibly procyclical) variation in the ability to pay for education. The marginal effect on the average probability of enrollment in college of an increase in the unemployment rate by one percentage point is 0.8 percentage points (with a standard error of 0.15), more than a 2% change.[17] This estimated association between the unemployment rate and enrollment rates is about 40% higher than found in Table 1 using aggregate data.

Using the other two cyclical measures we arrive again at the conclusion that college enrollment is countercyclical. An increase in the growth rate of GNP by one percentage point is associated with a drop in the average probability of enrollment in college by 0.11 percentage points (with a standard error of 0.06). A value of the Cochrane measure of 0.01, which corresponds to the level of GNP being 1% above its trend, is associated with a lower average probability of enrollment by 0.47 percentage points (with a standard error of 0.12).[18] Having established that the

[17] All reported marginal effects are calculated at mean values of the covariates.

[18] In order to compare the magnitude of the marginal effects implied by the three business cycle measures we multiply them by the standard deviation of the respective measure: 1 for the detrended unemployment rate, 0.016 for the Cochrane measure, and 0.023 for the GNP growth rate. The associated marginal effects are, then, 0.8, 0.75, and 0.25 percentage points respectively. The fact that the GNP growth measure implies a different magnitude is not surprising since it captures changes in the level of economic activity whereas the other two measures capture the level. Finally, note that the unemployment rate is measured in percentage points (e.g. 6 percent) whereas the growth rate of GNP and the Cochrane measure are measured as a fraction (e.g. 0.04).

college enrollment decisions of individuals are responsive to the business cycle we examine whether the absolute magnitude of this response is different in expansions than in contractions. We classify a year as a contraction if the unemployment rate rose during that year. Table 2 (second column) contains the results of allowing the coefficient on the unemployment rate to differ in contractions. The exclusion restriction cannot be rejected at standard levels of significance.[19] It seems that the response of enrollment is symmetric to the stages of the business cycle.

3.2.1 *Simulations* It is interesting to examine how predicted aggregate enrollments, and therefore the acquisition of human capital, would change as a result of a decrease or an increase in the amplitude of the business cycle. We present here the results of a simulation where, in a sense, we 'shut down' the business cycle. If the economy were growing at its trend level during these years as opposed to its observed cyclical deviation from its trend what would have been the differences in college enrollments? This simulation should be viewed as a means of assessing the magnitude of the average marginal effect reported above in terms of the observed cyclical fluctuations.[20]

Figure 4 contains the results of the simulation (the plot with diamonds).[21] The results plotted there were obtained as follows. First, we detrended the unemployment rate by fitting cubic polynomial trends. Using quadratic trends did not alter the results significantly (these results are available from the authors upon request). Then, we calculated for each year the average treatment effect of removing the cyclical component in the unemployment rate. This was the change in the probability of enrollment as predicted by the probit, averaged over all individuals in a year. The numbers are quite dramatic for certain years. Specifically, it is predicted that if the economic activity in 1979 had not been at its observed high level college enrollments would have been higher by about 204,000 students. This translates to a 1.3 percentage point increase in enrollment rates (a change of 3.4%). In contrast, enrollments in 1975 would have been lower by about 193,000 students; a decrease in enrollment rates by about 1.3 percentage points.

[19] We obtained similar conclusions about asymmetry using the other measures of the cycle.

[20] Several caveats are in order. We assume that the decrease in the amplitude of the business cycle does not alter the sensitivity of enrollment to the level of economic activity as measured by the coefficient on the unemployment rate in our probit. Clearly, that is not going to be the case since the relationship estimated here is not structural. Another assumption is that a change in the amplitude of the business cycle would not affect the trend growth rate of the unemployment rate. This might not be warranted. Drazen (1985) provides a mechanism for an interaction between fluctuations and the natural level of economic activity. Similar mechanisms have been suggested by models of hysteresis.

[21] The results plotted there were obtained as follows. First, we detrended the unemployment rate by fitting cubic polynomial trends. Using quadratic trends did not alter the results significantly (these results are available form the authors upon request). Then, we calculated for each year the average treatment effect of removing the cyclical component in the unemployment rate. This was the change in the probability of enrollment as predicted by the probit, averaged over all individuals in a year.

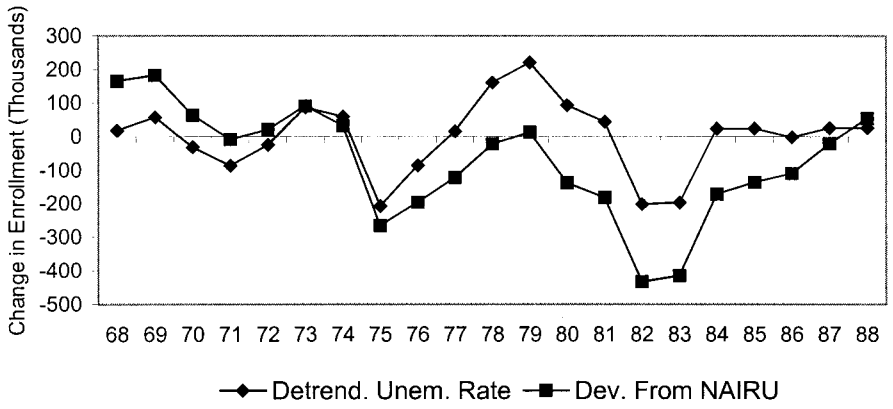

Fig. 4. Change in enrollment—after eliminating business cycle

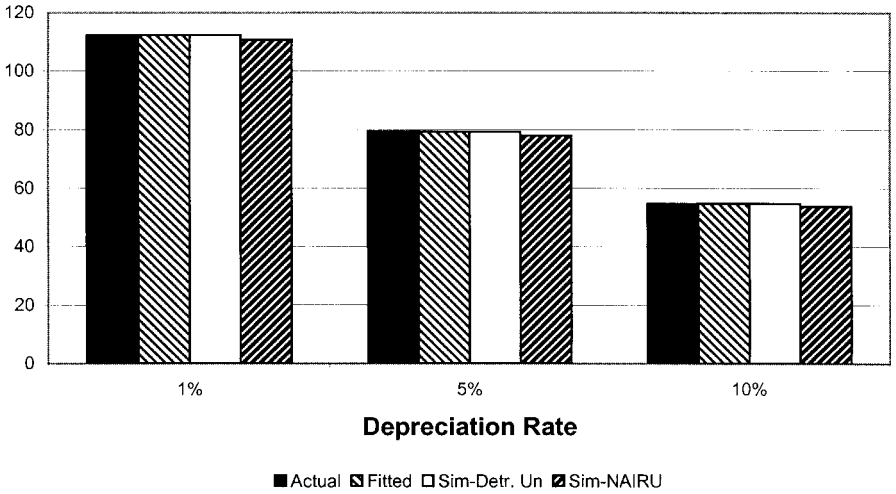

Fig. 5. Business cycle impact on human capital stock—at the end of 1988

A related issue concerns the approximate impact of 'shutting down' the business cycle on the part of human capital stock that is due to college education. We calculate this stock for 1988 from the enrollments of previous years using a 'perpetual inventory' method and assuming various rates of depreciation.[22] Figure 5 compares the actual stock (first bar), the fitted stock (second bar), and the simulated stock when the business cycle has been eliminated (third bar). The predicted

[22] There are several maintained assumptions here. First, the flow investment for human capital is the number of students enrolled during the period. Second, all types of study (e.g. liberal arts versus engineering, 2-year versus 4-year institution) have the same marginal productivity. Third, the creation of human capital in different calendar years (e.g. 1968 versus 1988) has the same marginal productivity.

change in human capital stock is negligible (average enrollments increase by about 10,000 students). This is a result of three features of this simulation: First, the response of enrollment decisions to the stages of the business cycle is symmetric with respect to 'good' times and 'bad' times. Second, the deviations from trend of the unemployment rate sum to zero, by construction. In a linear model, then, the average impact of expansions would cancel out the average impact of contractions. Since the model here is non-linear, this turns out to be only approximately true. Third, the aggregate amount of human capital is a linear function of investment in human capital.

We modify the second feature now by using the deviation of the unemployment rate from its natural level as the measure of the business cycle's impact on enrollment decisions. The natural level is captured here by Robert Gordon's NAIRU (non-accelerating inflation rate of unemployment), which ranges between 5.6 and 6.0 until 1980 and is 6.0 in the 1980s. The deviation ranges between -2.1 and 3.7 with an average of 0.61. The predicted differences in enrollments are now quite different and more dramatic (see Fig. 4, the 'squares' plot). Enrollments would have been lower in 1982 by about 408,000 students; a difference in enrollment rates of about 2.5 percentage points. At the opposite end, had the economic activity been at trend in 1969 enrollments would have been higher by about 168,000 students: a 1.3 percentage point increase in the enrollment rate. As a result of the elimination of the business cycle the stock of human capital would decrease by 1.3% to 1.7%, depending on the assumed depreciation rate (see the the fourth bar in Fig. 5).[23]

The precise impact, then, of the business cycle on the aggregate human capital stock in the above simulation depends on the measure of the cyclical component. However, we can firmly conclude that at any point in time during the business cycle there is significant substitution between human capital investment and competing economic activities.[24] In 1982 when the unemployment rate stood about 1.9 points higher than in the previous year, the worsening in aggregate economic conditions was associated with college enrollment that was higher by about 232,000. This number reflects movements into the education sector of 18- to 22-year-old high school graduates only but is, nonetheless, substantial when contrasted with the (net) change in total civilian employment observed between October of 1981 and October of 1982 of about 1.163 million.

A natural question to ask next is whether this represents substitution by individuals in education across time also. Does the cycle affect the level of a particular individual's human capital temporarily or permanently? Unfortunately, we cannot answer this question satisfactorily since we do not have longitudinal data. We note,

[23] The Cochrane measure of the cycle has an average very close to zero so it would not predict any effect on the human capital stock as opposed to GNP growth, which was positive on average.

[24] We confirmed this using the GNP growth rate. In this case the magnitude of the response was lower but still substantial. The growth rate of GNP would be the appropriate measure for the simulations if youths respond to the rate at which the economy grows (i.e. its vigor) rather than its current level.

however, that, other things equal, the expected probability of enrollment of a 19-year-old is about five points lower than that of a 18-year-old. The corresponding difference is nine points for 20-year-old, 12 points for 21-year-old, and 22 points for 22-year-old. This indicates that youths that substitute away from college education in a boom year are less likely to go to college later on when economic activity falls. The increase in college enrollment during a subsequent recession seems to come from increased participation of new cohorts of high school graduates. This indicates that for some individuals the effect of cyclical fluctuations on their level of human capital is persistent.

3.2.2 *Is there a change after 1978?* After examining the series of enrollment rates as well as that of the year coefficients it seems that their behavior changed dramatically around 1978. Before 1978 there seems to be a downward trend in enrollment which reverses itself to an upward trend after that. At the same time the variability of the series seems to have dropped substantially. Indeed, we can reject the null that the coefficients on the trend terms and the unemployment rate did not change after 1978.[25] The responsiveness to the unemployment rate was considerably lower after 1978. The marginal effect of the unemployment rate fell from 1.44 (with a standard error of 0.21) to 0.59 (0.20).

What could be underlying this change in trends and in volatility? It is easier to offer explanations for the change in trends. One explanation could be the changing behavior of the college 'wage premium'. It has been documented (see Katz and Murphy, 1992, among others) that this premium fell steadily throughout the 1970s. The 1980s, however, brought a reversal of this trend and large increases in the returns to education. Another explanation involves the steady decreases in the net direct cost of college education in the 1970s followed by increases in the 1980s (Kane, 1994, documents this trend as do other studies). Finally, the size of the cohort of high school graduates had been increasing until 1981. After the last baby boom cohort the number of high school graduates was trending downward. Stapleton and Young (1988) argue that the cohort size should be negatively related to educational attainment.

3.2.3 *Are there differences across gender, race and ethnicity?* We now turn to exploring whether there are differences in the time variation of individual enrollments by gender, race, or ethnicity. As may be seen in Table 3, the degree of enrollment cyclicality is roughly similar for males and females.

The same table also provides evidence that there are some differences across ethnic groups in the cyclicality of enrollment. In particular, the propensity to enroll for minority individuals is less cyclical than that of whites. In fact, in separate results (available upon request) we found that there is a break in 1978 with the

[25] The estimates presented in Table 2 and the associated tests were not sensitive to shifting the break point one year earlier or later.

Table 3 Probit results by gender and race: individual enrollment data

	Males	Females	Whites	Non-whites
Unemployment rate	0.021 (0.005)	0.021 (0.005)	0.022 (0.004)	0.015 (0.009)
	0.0083 (0.0019)	0.0075 (0.0019)	0.0083 (0.0017)	0.0054 (0.0034)
Pseudo-R^2	0.076	0.142	0.112	0.099

Notes: The number of observations is 93,961 for males and 108,636 for females. The number of observations is 24,571 for non-whites (blacks, Hispanics, and other minorities) and 178,026 for whites. The first line for each entry contains the estimated coefficient, the second line the marginal effect. Robust standard errors (corrected for clustering/group aggregation) are in parentheses. The specification also includes the following variables: AGE, AGE^2, gender race interaction dummies, SMSA dummy, two dummies for Hispanics living in the West and in the South, a dummy for blacks living in the South, marital status dummies, state dummies, and linear, quadratic, and cubic trends.

propensity to enroll displaying strong countercyclical patterns before that year but no cyclicality after it.

3.2.4 *Looking at multinomial choices* Young people contemplating whether to enroll in college or not are faced with more options than two.[26] There are three distinct and economically quite different alternatives to enrolling: become employed, become unemployed, or drop out of the labor force. We now examine briefly whether explicit modelling of this multinomial choice alters our results on the cyclical behavior of enrollment.

Table 4 (panel A), which contains the results of the multinomial logit, shows that when the unemployment rate increases individuals are more likely to enroll in college, become unemployed, or drop out of the labor force, and less likely to become employed. It is interesting to note that the degree of enrollment countercyclicality estimated from a multinomial logit is very close to the estimate from a simple probit (see Table 2). An increase in the unemployment rate by one point leads to an increase in the probability of enrolling by 0.87 points. It seems, then, that our analysis of cyclical behavior was not compromised by the simplicity of the probit.

Another interesting choice that young individuals are faced with is whether to enroll part- or full-time (or not at all). Drawing on our results from panel A of Table 4, we will now abstract from modelling the choice to become employed, unemployed, or drop out of the labor force separately and lump all three into the choice of not enrolling. Panel B contains the results of this trinomial logit.

Both full-time and part-time enrollments are countercyclical. However, an increase in the unemployment rate by one point is associated with a much higher increase in the probability of enrolling full-time (0.60 points) as opposed to part-time (0.17 points). This fact coupled with the observation that on average

[26] We would like to thank the anonymous referees for prompting us to examine these issues.

Table 4 Multinomial choice results: effect of the unemployment rate

	Coefficient	Standard error	Marginal effect on probability
(*A*)			
Enroll	0.0065	0.0025	0.0087
Become unemployed	0.1057	0.013	0.0071
Become employed	−0.0511	0.0093	−0.0170
Drop out of the labor force	–	–	0.0012
(*B*)			
Full-time enrollment	0.031	0.007	0.0059
Part-time enrollment	0.054	0.012	0.0019
Not enrolled	–	–	−0.0078
(*C*)			
Four-year enrollment	0.017	0.009	0.0019
Two-year enrollment	0.063	0.010	0.0043
Not enrolled	–	–	−0.0062

Notes: Each panel refers to a separate multinomial logit estimation. Only the effect of the unemployment rate variable is displayed. The specifications also include the following variables: AGE, AGE^2, gender race interaction dummies, SMSA dummy, two dummies for Hispanics living in the West and in the South, a dummy for blacks living in the South, marital status dummies, state dummies, and linear, quadratic, and cubic trends, whose estimated coefficients are not reported. The number of observations is 202,597 for panels (A) and (B) and 179,182 for panel (C). Valid observations for four-year versus two-year enrollment exist only for the years 1970 to 1988. The standard errors are robust and corrected for clustering/group aggregation.

full-time enrollment in college is much higher than part-time enrollment suggests that the cyclical behavior of enrollment is driven by the full-time margin.

Finally, we examine a young individual's decision of whether to enroll in four-year or two-year college again lumping all other decisions together as before. We have information on this margin starting in 1970 only. Enrollment in four-year institutions of higher education is overwhelmingly larger, the ratio being about seven to three over the 19 years examined here. An interesting fact that comes out of panel C is that enrollment at two-year colleges is much more countercyclical than that for four-year colleges. The marginal probability effect of an increase in the unemployment rate by one point is 0.43 and 0.19 respectively.[27] This result complements the finding of Betts and McFarland (1995) that aggregate enrollment at public two-year colleges in the US during 1969 to 1985 were strongly countercyclical. Furthermore, it shows that the cyclical behavior of total enrollment is not driven completely by the two-year margin. Since average enrollment in four-year

[27] An anonymous referee prompted us to look into the relative cyclicality of these two margins guessing, correctly, that counter-cyclical enrollment will be stronger for two-year enrollment. An explanation the referee gave is that students are unsure of the length of a recession and might not want to enroll in a four-year college if there are fixed costs to entering or exiting higher education.

colleges is much larger the contribution of the two margins to cyclical movements is roughly equal.

Before concluding this sub-section let us briefly comment on two other variables, 'learning ability' and the 'socio-economic background' of the parents. Learning ability is certainly an important determinant of the enrollment decision. Unfortunately, we do not have a measure of prior attainment such as test scores in the Current Population Survey. How does this omission affect the coefficient on unemployment in the probit? That depends on whether a recession increases individuals' propensity to enroll by roughly the same amount independent of their ability. If this condition holds (roughly, that ability has a fixed effect) and the population distribution of abilities does not change systematically over the business cycle (which seems reasonable to assume) then the coefficient on unemployment should not be affected much (despite the non-linearities of the probit).

If, however, a recession increases individuals' propensity to enroll more (or less) depending on learning ability then we may be over- or under-estimating the coefficient on unemployment with no clear sense of which is more likely.

The above discussion of the implications of omitted 'learning ability' applies also for omitted 'socio-economic background' of parents. Unfortunately, the main microeconomic data sets in the US, such as the Current Population Survey or the Decennial Census, lack any family background data. More specialized data sets such as High School and Beyond cover only a narrow range of cohorts and are not as suitable for the study of the effect of the aggregate business cycle on enrollment.

3.3 Economic factors and the enrollment decision

In the theoretical section of this paper we argued that certain economic variables should influence enrollment decisions. In this subsection we test the role of some of these. Where possible we use data at the individual or state level so as to take advantage of additional variation between states at a given time period. The unemployment rate, the cost of tuition, and average weekly earnings in manufacturing are state-specific. Table 5 contains the results and we will concentrate on the second specification (see Table 6 for details of the explanatory variables).

The coefficient on unemployment is significantly positive. An increase in the state unemployment rate by one percentage point increases the average probability of enrollment in college by 0.28 percentage points (with a standard error of 0.1). The significance of the unemployment rate even when controlling for other cyclical variables may be due to a number of reasons. Increases in the unemployment rate increase expected unemployment insurance payments and, therefore, the benefit to pursuing activities competing with employment. In addition, it may be the case that the current unemployment rate contains information about future wages and interest rates not contained in the contemporaneous values of these variables.

Another variable related to local labor market conditions is earnings while employed, which is a competing activity. The estimated sign is, as expected, nega-

Table 5 Probit results: individual enrollment data

State-level variables				
Unemployment rate	0.0092	(0.0025)	0.0074	(0.0026)
	0.0035	(0.001)	0.0028	(0.001)
Average weekly earnings in manufacturing			−0.0005	(0.0002)
			−0.0002	(0.0001)
Tuition			−0.000018	(0.000027)
			-6.7×10^{-6}	(10.2×10^{-6})
Economy-level variables				
Real interest rate			−0.0084	(0.0021)
			−0.0031	(0.0008)
Log of high school graduates (18–22)			0.326	(0.358)
			0.124	(0.136)
Individual-level variable				
Log of College 'earnings differential'			0.852	(0.109)
			0.323	(0.041)
$-logL$	121,239.07		121,171.75	

Notes: The number of observations is 202,524. The first line for each entry contains the estimated coefficient, the second line the marginal effect. Robust standard errors (corrected for clustering/group aggregation) are in parentheses. The specification also includes the following variables: AGE, AGE^2, gender race interaction dummies, SMSA dummy, two dummies for Hispanics living in the West and in the South, a dummy for blacks living in the South, marital status dummies, state dummies, and linear, quadratic, and cubic trends.

tive and significant. An increase in the average weekly real earnings in manufacturing by $40 (roughly a $1 rise in the hourly real wage measured in constant 1983 US dollars) is associated with a decrease in the average probability of enrollment by 0.8 points (with a standard error of 0.32).

The real interest rate has a significantly negative impact. An increase of the real interest rate by one point is associated with a decrease in the average probability of enrollment by 0.31 percentage points (with a standard error of 0.08). This conforms to the theory in Section 1. Much of this association is due to the negative values of expected real interest rates in 1976 and 1977, years when the propensity to enroll fell whereas observed enrollment rates remained steady (see Fig. 3).

We also included in the probit a variable, called 'college earnings differential', intended to measure the differential in expected lifetime earnings in the post investment phase, in other words, the return to college education. We constructed this variable for each individual following closely the methodology in Pissarides (1982) and Leslie and Drinkwater (1999). The coefficient is significantly positive and indicates that an increase in the differential by 1% increases the probability of enrollment by 0.32 points, or about 0.8% (since the average enrollment rate is 40% over the whole period). This elasticity estimate is quite high.

Two other variables turn out not to have significant effect: the size of the cohort of high school graduates, and tuition costs. Thus, we do not find evidence in the data of the hypothesis, discussed in the end of the last subsection, by Stapleton and

Table 6 Means of explanatory variables

	Full sample	Whites	Non-whites	Males	Females
White	0.870	1.000	0.000	0.878	0.862
Non White	0.130	0.000	1.000	0.122	0.138
Male	0.468	0.472	0.438	1.000	0.000
Female	0.532	0.528	0.562	0.000	1.000
Age	20.069	20.063	20.108	20.088	20.053
SMSA	0.545	0.520	0.711	0.544	0.547
Black in South	0.058	0.000	0.187	0.052	0.063
Hispanic in the West	0.017	0.000	0.138	0.017	0.018
Hispanic in the South	0.013	0.000	0.087	0.013	0.012
Married	0.222	0.231	0.162	0.148	0.287
Widowed	0.010	0.010	0.008	0.005	0.014
Unemployment rate	6.614	6.596	6.734	6.641	6.591
Earnings in manufacturing	363.973	365.527	353.616	364.522	363.491
Tuition costs	1041.606	1047.600	1001.661	1045.092	1038.545
GNP growth rate	0.026	0.026	0.027	0.026	0.026
Cochrane measure	−0.002	−0.002	−0.004	−0.003	−0.002
Real interest rate	4.515	4.473	4.795	4.500	4.528
College earn. differential	3.155	3.133	3.304	2.977	3.312
Log HS graduates	16.490	16.488	16.498	16.492	16.488

Notes: The full sample consists of all high school graduates between the ages of 18 and 22 (inclusive) observed over the years 1968 to 1988. Average weekly earnings in manufacturing and tuition costs are in constant 1983 US $. 'Non-whites' refers to race categories other than white, e.g. black, or Hispanic. SMSA is equal to one if individual lives in a Standard Metropolitan Statistical Area.

Young (1988) that the cohort size should be negatively related to educational attainment.

In summary, our findings indicate strong responsiveness of high school graduates to the opportunity costs (variables capturing local labor market conditions), the return to, and the financing costs (the expected real interest rate), of college education. There seems to be, however, lower responsiveness to the direct costs of college education. The latter result, however, might be due to our state-specific measure of tuition costs not capturing correctly the direct cost of education for the marginal individual.

4. Conclusion

Macroeconomic theory suggests that people respond to changing cyclical conditions by engaging in intertemporal substitution of activities. During recessions individuals are thought to redirect activities away from work toward leisure (Kydland and Prescott, 1982) and home production (Benhabib *et al.*, 1991). In Hall's (1991) framework labor is redirected from production to the formation of organizational capital. In this paper we have suggested an alternative substitution activity, namely schooling. We provided evidence that young individuals' propensity to

enroll in college is strongly countercyclical. Severe recessions may have been associated with increases in college enrollment of up to 400,000 by some measures. The precise impact of cyclical economic activity on educational attainment does depend on the measure of its amplitude used. None the less, it is large for all the measures that we have employed. Our finding is important. It suggests the need for dynamic general equilibrium models of the economy, such as Real Business Cycle ones, to incorporate substitution between human capital accumulation and other economic activities. This may modify the predictions of these models regarding the nature of cyclical fluctuations. It may also clarify the importance of a potential link between short run fluctuations and long run growth: that of human capital accumulation.

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Appendix

1. Variable definitions

Enrolled: All those attending grades 13 through 16, full-time or part-time, at a four-year or two-year institution of higher education.
Unemployment rate: The total civilian population unemployment rate for the US.
Contraction: Takes the value 1 in years when the unemployment rate increased.
GNP growth rate: The first difference of log real GNP.
Cochrane measure of the cycle: Measures the cyclical component of real GNP. See Cochrane (1994) for a description of its construction.

Expected real interest rate: This measure is meant to capture the opportunity cost of financing the college education. Constructed as the difference between the nominal yield on new home mortgages and the expected inflation rate calculated as the average of the inflation rates in the previous 12 months. This is the method suggested in Gordon and Veitch ('Fixed investment in the American business cycle 1919–83', in Robert J. Gordon (ed.) *The American Business Cycle: Continuity and Change*, NBER, **25,** University of Chicago Press, pp.267–335) and is widely used in studies of physical investment. An alternative would have been the Livingston survey of expected inflation. The correlation between the two series is 0.75.
Tuition costs: Tuition and fees charged of in-state students in four-year comprehensive public universities. This is used as the price relevant for students on the margin of enrolling in college. See Kane (1994) for a discussion and justification of using this measure.
College 'earnings differential': This is intended to measure the differential in expected lifetime earnings in the post investment phase, in other words, the return to college education. We constructed this variable for each individual following closely the methodology in Pissarides (1982) and Leslie and Drinkwater (1999). See especially the discussion in the latter of caveats to constructing and using this variable. A brief description of the construction follows. We extracted a sample of high school graduates of all ages and divided it into four groups by gender and race. For each group: (1) we estimated conventional Mincer regressions of log hourly earnings, (2) predicted a smooth age-earnings profile for college graduates as well as for non-college graduates, (3) obtained separate non-parametric estimates of age-related employment probabilities for college graduates as well as for non-college graduates, and (4) constructed the differential in the expected present discounted value of real earnings from age 22 to 65 of college graduates versus non-college graduates. The real discount rate used was 6% but using 4% or 8% did not change the nature or significance of the results.