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Dynamic rates of return to education in the U.S.

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Received 5 September 1998; accepted 25 September 1999

Abstract

This paper develops dynamic and expected dynamic rates of return to high school and college education for males and females for 1967–95 that take the effects of annual changes in institutional costs and in real earnings within each age group in cross section age earnings profiles into account.

As such they are more comparable to total returns on financial assets. Based on Current Population Survey data, and on adjustments for net “ability” bias from recent studies of identical twins, it is shown that the standard rates of return underestimate the returns to college in 1995 by 3 percentage points for male college graduates and 5 percentage points for females. Assuming that recent trends are based on underlying technical change, globalization, and other factors that are likely to persist, these expected dynamic rates averaged 13.3% in real terms or 11.7% if corrected for ability, family factors, and for measurement error. © 2001 Published by Elsevier Science Ltd.

JEL classification: I21; I22; I28; J24

Keywords: Education economics; Human capital; Education finance

1. Introduction

This paper develops new “dynamic” and “expected dynamic” rates of return to education that capture more information from existing data by taking trends in earnings at older ages into account in the calculation of rates of return. These use microeconomic data on mean annual earnings of individuals from successive Current Population surveys (CPS) reported by education level and age group from 1967 through 1995, together with nationwide data on the direct institutional costs of education.

The resulting expected dynamic rates of return are more relevant to nationwide or statewide decisions to invest in education at different levels or in educational facilities in that they take into account the longitudinal

profile of the earnings of each individual as he or she ages including the trends over time in earnings either upward or downward within older age groups. The expected dynamic rates also use the “full method” reflecting actual institutional costs and net earnings differentials specific to each education level to calculate a pure internal rate of return, rather than the usual return to education given by Mincer earnings functions. They are more comparable than are conventional static cross section rates to standard computations of “total returns” widely used as investment criteria for bonds, stocks, or mutual funds.¹ These computations of “total returns” include capital gains that in turn reflect expected earnings, just as expected dynamic rates reflect expected earnings.

The paper is focused on exploring the longitudinal

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¹ See for example Ibbotson and Associates, 1998, pp. 94–5 for real total returns corrected for inflation.

returns to education over time for given “synthetic cohorts” of workers, including recent graduates, where each cohort is comprised of individuals who graduate in the same year, are of the same gender, and share the same educational attainment. The objective is to calculate pure internal rates of return that are relevant to economy-wide investment decisions. These decisions are continually being made at the state and national levels involving policies, for example to increase college enrollment rates as well as by institutions such as the World Bank (1995) to make education sector loans. These decisions normally apply to the education system, and what is most relevant is the expected rate of return to society on investment in education as a whole that does take institutional costs into account. To do this, we build on prior findings and follow each age cohort that reflects the actual mix of students in the education system as well as changes in institutional costs and longitudinal earnings increments that these graduates experience over their work life.

Most Mincer earnings function studies instead use cross section data to focus on racial differences or on corrections for endogeneity of schooling and measurement error in education. The results of these studies can be very useful, but often have different objectives. In particular, there has been a flurry of activity recently in estimating the returns to education based on large samples of genetically identical twins using Mincer earnings functions while correcting for measurement error to obtain an estimate of the net “ability” bias, such as in Behrman, Rosenzweig and Taubman (1994), Miller, Mulvey and Martin (1995), Ashenfelter and Krueger (1994), Ashenfelter and Rouse (1998), Arias, Hallock & Sosa (2000), Rouse (1999) and Behrman and Rosenzweig (1999). Genetically identical twins who differ in their education but have lived together and share identical genetic endowments and family backgrounds offer the most rigorous controls possible for removal of the influence of innate “ability” and family factors on earnings in order to isolate differences in earnings due to education. Once accounting for measurement error, the resulting estimates of net “ability” bias have a much wider range of practical uses, including the applications in this paper.² Although there is still a range of variation among studies and other sources of possible “ability” bias remain, the more recent studies involving larger samples of US identical twins appear to show greater convergence of the upper and lower bounds to the net “ability” bias. As we discuss further in the paper, these results can then be used to adjust estimates of rates of return to education such as the ones provided here.

Carnoy and Marenbach (1975) were the first to use what we are calling “synthetic cohorts”, but used a quite different approach and did not obtain return estimates for recent periods. They used changes in cross-sectional earnings only for the four census years 1939, 1949, 1959 and 1969 to shift earnings profiles of cohorts growing 10 years older to compute rates of return to education by the “full method”. But they used costs from a single year (1949) and only these decade readings on earnings to compute rates of return for men for 1939 and 1949. Here we use *annual* CPS data for males and for females separately, as well as institutional costs *annually*, to recompute a dynamic or expected dynamic rate of return *each year* from 1967 through 1995. Thus, we obtain more precise measures of the annual shifts in the entire age-earnings profiles during most of a worker’s life cycle for both men and women, more precise changes in the costs of education at each education level, and also expected dynamic rates of return up to very recent years.

We call the dynamic rates of return for each year from 1980 to 1995 “expected” dynamic rates since the remaining years in the age earnings profiles for more recent graduates must be estimated. For these, expected earnings after 1996 are estimated for the older ages not just by observing the current earnings in older age groups (as in standard cross section static rates) but also by using the observable trends over the last 15 years *within each older age groups* to adjust expected earnings either upward or downward to approximate what the more recent graduate is more likely to earn when he/she reaches that age. This way we incorporate trends affecting expected earnings in the middle and later years of the age-earnings profile for recent cohorts. In an analysis similar in spirit to ours, MaCurdy and Mroz (1995) use CPS data to uncover shifts in the age-earnings profiles of various cohorts of male workers. They are not concerned, however, with estimation of rates of return to education.

The results suggest important implications of our approach for the interpretation of the widely used standard cross section rates of return to education. Particularly, we find that the standard cross-section (static) rates of return are misleading (unless adjusted) since they tend to *overstate* the actual returns for graduates when the net earnings trend is downward, and to *understate* it when the trend is upward. The latter is very important for college graduates since about 1980, and especially for women. Trends in the standard cross section static rates are also misleading. There are wider fluctuations in the year to year standard static rates, and much wider fluctuations in both starting salaries and in rates of return based on starting salaries than in expected dynamic rates of return that follow *smoother trends over time*. The latter are more appropriate investment criteria for very long term investments such as those in human capital which have a useful life of over 40 years, the average time an

² These issues including those related to instrumental variables have been surveyed recently by Carnoy (1997), Card (1995, 1998), McMahon (1998) and Bound and Solon (1999).

individual remains in the labor force. Decisions about such long-term investments presumably should not be based on temporary fluctuations. Dynamic rates of return that incorporate information about the growth or decline of earnings in the older age groups do not fluctuate as much as standard cross section rates. There are also very significant implications for the absolute level of rates of return to education. For recent college graduates, we estimate that the rates of return for males may be underestimated by 3 percentage points, and for females by 5 percentage points by conventional methods, an amount that is substantial.

Finally, by way of introduction, the rates computed here are known as social rates of return in the literature, since they do include full institutional costs covered by taxes and other donors. But hereafter we will refer to them as “narrow social” rates since they do not include either non-market private returns from education or most externalities such as those identified and estimated in McMahon (1999). After making an additional qualitative adjustment for these non-market returns and externalities, these dynamic rates are better guides than the standard static cross section rates to whether the current level of public (and private) investment in education at each level is socially efficient.

Section 2 briefly describes the data sources and methods. Section 3 analyzes the behavior over time of real earnings within each education level and age group, the resulting net earnings differential across education levels, and discusses the issue of net “ability” bias. Section 4 uses the resulting dynamic net earnings differentials to compute the dynamic “narrow social” rates of return to education for each year from 1967 to 1975, and the expected dynamic rates of return for 1980 to 1995. The main final results are summarized in Table 2 and especially in Table 3. These final results for the economy-wide dynamic and expected dynamic rates are compared to the standard cross-section static rates (in Tables 2 and 3) and also to inflation-adjusted total returns on financial investments as given by standard sources (in Table 4). Section 5 summarizes the conclusions and comments on their implications.

2. Data sources and methods

2.1. Longitudinal and synthetic cohort data sets

Estimation of dynamic growth factors could ideally be done using longitudinal life histories of earnings data for individuals since they enter the labor market with information on the direct costs of education such as tuition payments and received earnings until retirement. But longitudinal data sets are rare, especially over long periods of time that extend into current years, and even then there will be no information about the future earnings of

current graduates. Even in available longitudinal data sets such as the Panel Study of Income Dynamics, the National Longitudinal Surveys or the NBER-Thorndike sample, the time span is still short so that they cannot fully capture the implications of changes in individuals’ earnings profiles on their rates of return to education over time. In addition, these studies also are affected by censoring as individuals drop out.

The unique feature of this paper is to exploit the available data from annual cross-sectional population surveys to pick up additional information about longitudinal changes in earnings. The CPS data on mean earnings is for a much larger nationwide sample that allows us to focus on a “typical individual” for each new cohort each year, and at each education level. We compute new “dynamic rates of return to education” for each cohort of workers applying a rate of return formula directly each year *from 1967 through 1995* taking into account direct institutional costs by the “full method” as dubbed by Psacharopoulos (1994).

Mincer earnings functions (Mincer, 1974) hinge on strong implicit assumptions that allow the interpretation of the Mincer regression coefficient on education as a “rate of return to education.”³ In particular, this interpretation normally assumes that the payoff to education for a cohort of workers entering the labor market on a given year will be the same as that currently being received by older workers. This is an increasingly unsatisfactory assumption since age-earnings profiles have shifted upward for college graduates during the 80s and 90s, and downward for high school graduates, and no graduate therefore actually received the amount defined by the static cross section age earnings profile that prevailed at the date he or she graduated. Mincer functions also assume that foregone earnings are the only cost of schooling. This is also unsatisfactory since it is well known that institutional costs at the college level have been rising during this same period, even as foregone earnings costs have been falling. These earnings trends are likely to continue given the recent changes in workers unionization, the rapid technical change in knowledge-based economies, continuing globalization, and the increasing education of women entering higher paying fields.

2.2. Earnings

We use mean earnings data from *Current Population Reports* Series P-60, collected through personal interviews by the Bureau of the Census for approximately 60 000 households each March from 1967 to 1995 (U.S.

³ See Willis (1986) for a detailed discussion of the interpretation of human capital earnings functions.

Bureau of the Census, 1967–1995).⁴ Mean earnings (gross of taxes) are annually reported for males and females separately for different age groups and different education levels. We consider the real earnings over time of workers with 8 years of basic education, those completing high school (12 years), 1–3 years of college, workers with a bachelor's degree (4 years of college) and those with more than 5 years of college.⁵

These include all workers with both full-time and part-time jobs at the moment of the survey. This is appropriate when calculating the rate of return to an education system or for a typical individual whose employment status is likely to change over his or her life cycle. Much of the Mincer earnings function literature has a different objective than this, and focuses on the hourly wages of full time workers implicitly assuming that the life cycle pattern of hours is fixed over time. But, as discussed by Weiss (1986, p. 616), in a life cycle context accounting for the endogeneity of labor supply choices is very important for two reasons: (1) future labor supply affects the rate of utilization of the human capital invested and thus the returns to the investment, and (2) past labor supply choices determine the accumulated stock of human capital and therefore the opportunity costs of the investment. Including part time workers both in the net returns and in the costs is clearly relevant to the approach we use here to obtain measures of the rate of return to investment in education economy-wide or for the typical individual. In principle, those persons who are unemployed and have zero earnings also should be included since unemployment episodes are sure to affect returns to education. But the CPS only includes individuals who report positive earnings. However, earnings at the next lower level of education are also reduced by those who are unemployed; if this were by an equal percentage, then the effect on the net earnings differential, which is obtained by simple subtraction of the earnings at lower education levels from the earnings at higher education at

each age is zero. If larger percentages of those with less education are unemployed, which is very likely, then the net earnings differential attributable to more education would be larger and foregone earnings (opportunity costs) lower so that the static and dynamic rates of return we show later in Tables 2 and 3 are slightly underestimated. Labor force participation is especially important for the rates of return to women as more are now choosing to stay full time in the labor market.⁶

Though this is not longitudinal data, the synthetic cohort traces the path of earnings for a typical worker as he or she gets older.⁷ The time series of earnings from successive earnings surveys allows us to generate the age-earnings profile for most of the typical graduate's life cycle without having to assume that earnings are necessarily constant within each age interval as the worker ages as one does with a single cross-section. The experiment is rather straightforward. For each individual we construct the life cycle path of his/her earnings as a member of the synthetic cohort within which he/she ages each year starting in 1967. Fig. 1 illustrates the procedure for constructing the dynamic age-earnings profile of a female college graduate entering the labor market in 1967 at age 22. When this college graduate turns 23 by 1968, her real earnings are given by the CPS reported mean earnings of a typical college graduate of age 18–24 in 1968. As she reaches age 25 her earnings are taken to be the mean earnings of college graduates of age 25–29 in 1970. By 1970 the whole age-earnings profile has shifted upward as shown.⁸ Similarly at age 30, she receives the earnings of his/her cohort in 1975, and so forth. The dynamic path she follows is traced out by the thick line in Fig. 1. It reflects *annual* shifts in the cross-section age-earnings profiles as time passes, and traces out the actual earnings this typical individual will receive. This same exercise is carried out separately for each cohort of male and female workers entering the labor market in later years, and for each education level.

The net earnings differential attributable to any given level of education is obtained by the simple subtraction of the mean age-earnings profile for the lower education

⁴ The sample size fluctuates below 60 000 households and 130 000 to 140 000 individuals during this period. The coverage changes slightly but the Census Bureau staff is of the opinion that the changes do not significantly affect the means (op. cit., 1991, p. C-9).

⁵ Since after 1987 mean earnings of workers with elementary and less than elementary school are reported jointly, after 1987 we take these to be the mean earnings of workers with elementary education. Also, before 1991 the Current Population Report reports mean earnings for more than 5 years of college education without distinguishing between master's and Ph.D. degrees. Thus, for the period 1991–95 we take the earnings of workers with a master's degree as a lower bound. That is, we assume an average time to a master's degree of two years for 5+ years of education. Thus, the rates of return for college 5+ education do not accurately reflect the rate of return to a Ph.D. degree.

⁶ The estimated returns for women are also likely to be affected by the usual (upward) bias caused by self-selection into the labor force. This can not be addressed with the available data. Note that corrections using standard sample selection Heckman-type corrections for the estimation of Mincer functions are increasingly recognized as unsatisfactory due to the sensitivity of the approach to statistical assumptions.

⁷ Individuals are not followed up through each successive population survey. Since the samples are random, one can expect each wave to be representative of a "typical" individual from each education-age group cohort over time.

⁸ As the actual data indicates, these shifts have not been uniformly positive. This is done so only for the purpose of this illustration.

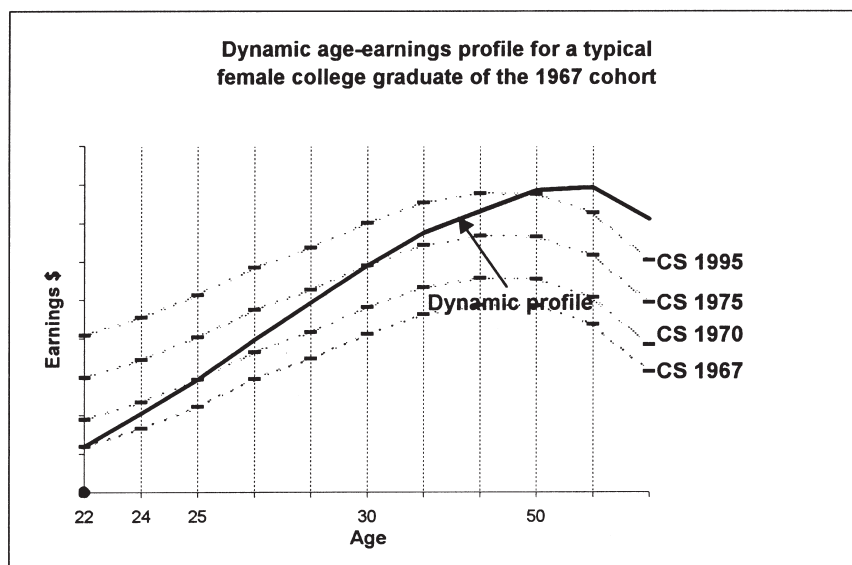


Fig. 1. Dynamic age-earnings profile for a typical female college graduate of the 1967 cohort.

level from the mean age-earnings profile for the higher education level. For example, the difference between the college and high school education profiles for the 1967 cohort yields the net earnings differential that workers with a college degree enjoyed at each age throughout their life cycle over those who entered the labor market with a high school degree.⁹

It is possible to develop the exact age-earnings profiles of cohorts of workers with a high school diploma entering the labor market in the years 1967–75 up to age 46 for the first entrants and up to age 38 for the latest entrants; for those with 1–3 years of college up to ages 48 for earlier entrants and up to age 40 for later entrants; for 4 years of college up to ages 50 and 42; and for more than 5 years of college up to ages 52 and 44.¹⁰ The remaining portion of the earnings profile is estimated as discussed later for each cohort based on recent trends.

⁹ According to the human capital model, some of the observable net earnings differentials may be a result of differences in other forms of human capital accumulated throughout the life cycle such as on the job training which are highly correlated with prior formal schooling. We adhere to the human capital model rather than to explanations of “signaling models.”

¹⁰ An Appendix with a table showing percentage changes in the net earnings differentials based on Table 1 is available from the authors on request. The workers are assumed to enter the labor market at age 20 if they have completed 1–3 years of college, age 22 for four years of college and age 24 for post-college education.

2.3. Net “ability” bias

Significant advances were made recently in studies of identical twins using twins’ cross-reports to control for measurement error in self reported schooling to estimate the net “ability” bias in the returns to schooling. For clarity, we will refer to “net ability bias” as any (normally) upward bias in earnings due to innate ability as distinguished from education after any offsetting measurement error has been netted out. These type of computations were introduced into the literature by Ashenfelter and Krueger (1994) and Behrman et al. (1994) and Behrman, Rosenzweig and Taubman (1994). There is wide agreement that identical twin studies offer probably the best basis for estimating the “pure” returns to education in view of the highly controlled conditions made possible by the identical ability and family background between MZ twins. Recent evidence indicates that “ability” bias may be significant (e.g., Behrman and Rosenzweig (1999, pp. 165–7), and there is also wide agreement that measurement error in an offsetting direction also exists.

In practice, it is the “net ability bias” obtained from identical twins studies in relation to OLS on the raw data without controls for either “ability” or measurement error that is most important and useful. That is because it is seldom possible to fully control for “ability”. Even where test scores such as the widely used SAT and ACT scores are available, they measure achievement and not innate “ability” and other such micro studies often are not replicated annually or representative of the education system. Furthermore most existing national, state, or community

wide data that is representative is based on self-reporting of schooling at some stage and therefore are subject to the same type of measurement error. This is true of the CPS surveys used in this paper, of worldwide labor force surveys of households collecting earnings data now conducted by almost all governments, and of data on enrollment rates at each education level collected by NCES or by UNESCO worldwide since the latter involve self-reporting by governmental units which is also subject to measurement error.

The estimates since 1994 of net “ability” bias based on samples of identical twins are summarized briefly below. The estimates of Mincerian returns to education net of “ability” bias and corrected for measurement error in Col. 2 below as well as of the net “ability” bias in Col. 3 vary widely among studies.¹¹ But, with some judgment, it is possible to get reasonable estimates of the upper and lower bounds of net “ability” bias, which Behrman and Rosenzweig (1999, p. 166) show is significant in OLS estimates, after netting out the *partially* offsetting measurement error.

Particularly, there are reasons for giving the more recent studies in 1998 and 1999 heavier weight, which narrow the range of the estimates considerably. They all involve larger samples with smaller sampling variation, and use actual earnings as distinguished from earnings imputed from Census occupational classifications. Larger samples seem warranted since it has recently been shown by Rouse (1999) that sampling variation led to the large estimate of measurement error in the Ashenfelter and Krueger Study (1994) which then contributed both to their high (corrected) return to schooling and the anomaly seen in row 1 below in the direction of the net ability bias. In the Behrman et al. (1994) study (rows 2 and 3 below), the sample size is also smaller and it seems possible that similar sampling variation could explain the larger net “ability” biases there as well. Furthermore, rows 2 and 3 are based on white males alone who have experienced lower increases in their earnings than females since about 1980 (as will be shown later in this paper) and Row 3 contains a sub-sample for which earnings were imputed from occupation. This may explain in part both their lower returns to education after correction for “ability” and measurement error (“IV Within MZ”) and their larger net “ability” bias estimates (larger differences in the numerator in the computation). Also, the correction for the measurement error in schooling in this study are based on reports of the MZ twins schooling by their eldest child, who are likely to reflect what their parents have told them. So it is possible that a child’s report on his/her father’s schooling is both biased and

less accurate than reports by the father’s twin whose development was parallel to the father’s. Finally, the 80% estimate of “ability” bias is unique in that it appears to be based on a parameter that varies widely across samples (Behrman et al., 1994, p. 1153, col. 5). So although there appears to be some positive reinforcement of endowments in the home, which is a qualification to what follows, the possible sources of upward bias to 80% and its larger implicit standard error warrant that it be given less emphasis, at least until the effect is replicated.

Row	OLS	IV Within given less emphasis, at least until the effect is replicated.	Net bias
1. Ashenfelter and Krueger (1994) <i>n</i> =147 MZ twins pairs	0.084	0.129	–53.6%
2. Behrman et al. (1994) <i>n</i> =141 MZ white male twins pairs (NAS-NRC)	0.094 ^a	0.050 ^b	46.8%
3. Behrman et al. (1994) <i>n</i> =141 MZ white male twins (NAS-NRC)	n.a.	0.039 ^c	80.0 ^d %
4. Miller et al. (1995) <i>n</i> =602 MZ twins pairs	0.064	0.045	29.6%
5. Ashenfelter and Rouse (1998) <i>n</i> =333 MZ twins pairs	0.102	0.088	13.7%
6. Rouse (1999), A&K sample increased <i>n</i> =453 MZ twins pairs	0.105	0.095	6.0 ^d
7. Rouse (1999) <i>n</i> =445 MZ twins pairs	0.111	0.110	0.9% ^e
8. Behrman and Rosenzweig (1999, p. 167) <i>n</i> =720 MZ twins pairs	0.118	0.104	11.8 ^f %

a. GLS, controlling for correlation in the error terms, but close to OLS, from Table 4, Col. 1.

b. Instrumental Variables estimate from Table 4, Col. 4.

c. This is the return (uncorrected for measurement error) used in the Behrman and Rosenzweig (1999) calculation of the 80% (Behrman & Rosenzweig, 1999, p. 1156). It also includes the Minnesota sub-sample, which imputes earnings based on occupation and thereby ignores the returns to earnings within occupations, as the authors recognize (p. 1154).

d. Rouse (1999, Table 2, p. 152).

e. Rouse (1999, Table 4, Cols. 1 (GLS) and 3. This

¹¹ The estimates also vary somewhat within studies depending on the sample and on the precise specification, but in general each authors’ preferred estimate is presented here.

controls for marital status and tenure, unlike the preceding line.

f. This controls for full time work experience, but not marital status, so is probably the most comparable to row 6.

Finally, the Miller et al. (1995) study in row 4 is based on a larger sample of Australian identical twins. It also has lower net returns to education after correction for measurement error. This is probably because it is based on earnings that were imputed from Census occupational categories which ignores earnings variability within occupations (as does the earlier Minnesota study included in row 3 before the twins were re-interviewed) and because of the more equal distribution of income in Australia.¹² After correction for measurement error, their return to education in Australia rises by 2.5 to 5.5 percentage points.

Again, in contrast, the results obtained in the 1998 and 1999 studies, which implement rather rigorous controls for innate ability, family background and measurement error, appear to be converging toward a narrower range. Ashenfelter and Rouse (1998, Table 3, cols. 6, 9–10) find that innate ability and family background account for about 31% of the net returns which is partially offset by the necessary correction for measurement error (which raises the corrected net return by about 28%). The measurement error correction is somewhat less than in Miller et al. (1995, p. 597) but somewhat more than in Behrman and Rosenzweig (1999, p. 166). This results in a “net ability bias” of 12 to 13.7% in Ashenfelter and Rouse (1998) or about a 13% overstatement when the returns to education are based directly on the “raw data”. Behrman and Rosenzweig (1999) estimate this net ability bias with a different sample of twins and totally independently at 11.8%, which is very close. Rouse’s (1999, p. 152) best estimate is 6% to 9.5% and a bit smaller, but close, whereas the 0.9% in her second computation may be affected by the presence of additional covariates (e.g. covered by a union, which is highly significant) and depending on what these covariates do could be a bit on the low side.

Although we are mindful that there are earlier estimates that are both larger and smaller, we conclude that the current best estimates of “net ability bias” results in the net earnings differential overstating the returns to education by somewhere between 6 and 13.7% with a mean that rounds to 10%, very close to the 11.8% obtained most recently by Behrman and Rosenzweig (1999). In his recent survey of the literature, Card (1998) reaches very similar conclusions, which are consistent

with earlier conclusions reached by many others in the field such as Griliches (1977, 1979), Griliches and Mason (1988), Butcher and Case (1992), Ashenfelter and Zimmerman (1997), Kane and Rouse (1993), Card (1993) and Becker (1993) among others.

However, the effect of this 10–12% upward bias on our computation of the return to education by the “full” method is another matter. Since institutional costs (to be discussed next) average about 50% of total investment costs that appear in the denominator of the internal rate of return calculation, then our return to education based on the raw data is upward biased by less than 10–12%. We assume that any “net ability bias” that remains in our rate of return estimates does not change *markedly* over time.¹³

2.4. Costs

The direct institutional costs of education for the secondary level are based on the current expenditures per pupil in public secondary schools for each year from 1967 through 1995 from the NCES (1996). These correspond to the years that each successive CPS cohort was in school. Similarly, for the college levels institutional costs are total current expenditure per full-time equivalent student in 4-year public and private higher education institutions again for 1967 to 1995 from the U.S. Department of Education, U.S. Bureau of the Census (1996, Table 331) and NCES (1996) and NCES (1996) divided by the total number of students.¹⁴ Thus, both public and private costs are accounted for and appropriately weighted.

Total institutional costs for degree completion at each

¹³ Behrman and Rosenzweig (1999) suggest that ability bias may vary somewhat over time. To gain some insight on how large this variation might be, Cawley, Heckman and Vytalil (1998) applied non-parametric methods to NLYS panel data to investigate the possible effect of a rising return to ability in the rising return to education. They conclude that “there is little evidence that the rise in the return to schooling is generated by a rise in the return to ability”. Also the continuing expansion of the higher education system to children from poorer families suggest that the net ability bias may be declining, if anything, at that level. These points offers some support for our assumption. Additional corrections for (non-linear) ability bias are needed when studying the returns to education at a particular school or college campus, given much wider variation in ability among schools.

¹⁴ Current-fund expenditures per student include current operating costs such as salaries, wages, utilities, student services, public services, libraries, scholarships and fellowships, auxiliary enterprises, and independent operations. This excludes capital expenditures which would be erratic, but does include that part of the cost of capital included in O&M. Since it excludes debt service, and possibly some needed repair and rehabilitation, it slightly underestimates the true cost of capital.

¹² As the authors indicate “rates of return to schooling in Australia are lower than in the United States because of (lower) dispersion of the distribution of income” (Miller et al., 1995, p. 597).

education level are obtained by summing the annual expenditure per pupil over the average time to completion of each degree. Although institutional cost data is not obtained directly from the CPS, these are the institutional costs that each “typical” graduate in the CPS survey would have experienced, assuming he/she was not ahead of or behind his/her class, and that relate to the mean earnings within each age group and education level that enters the calculations, so they are very reasonable institutional costs to use.

The foregone earnings component of costs, given by the earnings students forego while completing their education, are assumed in the standard fashion to be the mean earnings for each gender group at each lower education level. For post-college graduate students these are the earnings of 4-year college graduates in the 22–25 age group. For 4-year bachelors and 1–3 years college, these are the earnings of 18–21 year olds with a high school education who are working full time (to be sure that college students working part time are not included). For high school graduates, these are the earnings of all workers age 18–21 with less than a high school education. This latter group is a little older than would be ideal, which may tend to overestimate the foregone earnings costs and result in small underestimates of the rates of return to high school education. Unfortunately mean earnings data for these younger less well educated workers are not available from the CPS mainly because they represent a relatively small group. We believe earnings for those aged 18–21 with less than a high school education are far superior as an estimate of the foregone earnings of those in high school than other alternatives which do not control for education level.¹⁵ Older age groups would have experienced somewhat lower real institutional costs and real foregone earnings costs, which would have the effect of lowering total costs and raising the rates of return somewhat above our estimates, which therefore must be regarded as conservative. All foregone earnings are then multiplied by 0.75 to remove summer earnings, when most students are not in school, and also summed over the average time to completion of each degree. Even though foregone earnings typically account for most of the total investment costs at each education level (about 60%), the contribution of direct institutional costs is still substantial.

Foregone earnings also contain a net “ability” bias that if not removed would leave the denominator too large in a pure internal rate of return calculation and thereby bias

the resulting return to education downward. However this net “ability” bias also affects the numerator in an offsetting direction, so that overall the “ability” bias based on the best that is known at present leads to an overstatement of the rate of return to education of about 6% as discussed above.

2.5. “Narrow social” rate of return computations

Dynamic “narrow social” rates of return to education are computed for 1967–1975, 1980, 1985, 1990 and 1995, for 13 cohorts using annual data for the entire 1967–1995 period. All earnings and costs are expressed in constant 1995 prices using the Consumer Price Index (CPI) as reported in the Economic Report of the President (Council of Economic Advisers, 1996, Table B 59). Successive age-earnings profiles incorporating trends (for the “typical individual” as explained above) are used to compute the dynamic net earnings differentials, which together with the relevant institutional and foregone earnings costs for each cohort are then used to compute the dynamic social rates of return based on the standard internal rate of return formula.

The data was sorted to control for gender, education level and age group. The net “ability” bias or earnings due to innate ability and family factors offset in part by measurement error as has been discussed above. Note that the results will reflect the actual racial mix of the population which is consistent with the objective here. Further controls for differences in the internal rate of return to education associated with race are possible in the CPS data and are of interest for other purposes. The following formulas describe the computation of the dynamic rates of return based on foregone earnings costs, institutional costs and the net earning differentials associated with a “typical” individual of each of the 12 synthetic cohorts:

Let $a = e, \dots, g, \dots, 65$ be the age of the worker, and t the calendar year with $t_e < \dots < t_g < \dots < t_r$, where e = age at school enrollment; g = age at graduation, and retirement age = 65. Denote the real mean earnings for a typical worker of a given gender with age a and education level j at time t by $Y^j(t, a)$ so that $Y^{j-1}(t, a)$ denotes his/her foregone earnings, and $j = 1, 2, 3, 4, 5$ is an education level index with 1=8th grade education; 2= high school education; 3= college 1–3 years; 4= college 4 years; 5= college 5+ years. Also let $C^j(t)$ be the direct institutional cost at time t as defined above. When the value of mean earnings at a given age level for an age-group and a given year is missing (or with a large standard error) it is estimated by interpolating (computing the average) the earnings at that particular age interval between two consecutive years. The *dynamic social rates of return* for a given education level j , R^{j*} then are computed using the standard internal rate of return formula:

¹⁵ Under the presence of self-selection in the schooling decision, these mean measures of foregone earnings may mask considerable heterogeneity in the individual opportunity costs of education, and lead to heterogeneity bias in the estimates of certain types of Mincerian returns to education. See Arias, Hallock and Sosa (2000) for a careful exploration of this issue.

$$\sum_{i=0}^{g-e} [Y^{j-1}(t_{e+i}, e+i) + C^j(t_{e+i})](1+R^j)^i$$

$$= \sum_{i=1}^{65-g} \frac{[Y^j(t_{g+i}, g+i) - Y^{j-1}(t_{g+i}, g+i)]}{(1+R^j)^i}$$

The components in the square brackets on the left are foregone earnings and the direct institutional costs, and the net earnings differential appears on the right. Note that $Y^j(t, a) = Y^j(1995, a)$ for $t > 1995$. The net earnings differentials *after 1995* are adjusted to incorporate the current trends in earnings within each age group to obtain the “adjusted dynamic rates” in Tables 2 and 3, although rates with flat earnings after 1995 without this adjustment are also shown. For the adjusted rates:

$$\tilde{Y}^j(k) = [Y^j(1995, k) - Y^{j-1}(1995, k)](1 + \phi^j(k))^{s-m}$$

where $\phi^j(k)$ is the average growth rate of net earnings differentials during 1981–1995 for a typical worker with education level j and age k , where k is *within each age interval* as defined by the end points s and m . The value of R^{j*} is obtained by solving the above formulas numerically 208 times (4 education levels \times 2 gender groups \times 13 years \times 2 variants, dynamic adjusted and unadjusted) plus 104 times for the standard static cross-section rates.

3. Trends in real earnings and earnings differentials

Freeman (1975, 1980) noted a downturn in the college job market in the 1970s, showing that the real net earnings differential between high school and college graduates declined during 1969–73, so that the rate of return to college education of males also fell. He attributed these developments to a combination of a slackened demand and a growth of the supply of college graduates as baby-boomers surged into the labor market. Projecting this into the future, he posed what came to be the controversial thesis of an over-investment in college by Americans (Freeman, 1976). In retrospect, as suggested by many, it is clear that this dip was temporary as the 1975–76 recession passed and as the surge of baby-boomers into the labor market was assimilated.¹⁶ The demand for college graduates has grown as fast or faster than the supply.

Nevertheless, in the early 1990s the over-investment in college education hypothesis was once again revived by the work of Hecker (1992) and a series of articles

in the popular press which are still widely quoted by politicians. Using data from the Current Population Survey, Hecker (1992) estimated that during 1970–1990 the proportion of college graduates holding “high school jobs” increased from 11% to 20%.¹⁷ The argument was again that the supply of college graduates was growing at a rate too high for the absorptive capacity of the economy, and that this would in turn be associated with a decline in the economic value of college.

Tyler, Murnane and Levy (1995) offer evidence inconsistent with Hecker’s work. Using data from the 1980 and 1990 Censuses of Population and Housing, they show that during 1979–1989 while median real earnings increased modestly for both male and female young 4-year college graduates, they decreased substantially for male high school graduates and leveled for females. This and other evidence led them to conclude that the premium of college relative to high school education continues to be significant.¹⁸ Furthermore, they argue that since 1980 the growth in the supply of college graduates has declined in relation to demand conditions. The analysis presented below provides further evidence inconsistent with the over-investment in college and aggregate over-schooling hypotheses.

3.1. The growth of real earnings

Table 1 shows the annual average growth rates of mean real earnings by age groups for each level of education during the periods 1967–95, 1967–80, 1981–95 and the more recent sub-period 1983–95.¹⁹ The average growth rates at each education level measures the growth of real earnings as a worker proceeds through his/her life cycle.²⁰ When the entire period 1967–95 is considered, while real earnings for females have improved considerably at almost all ages and all levels of education, among male workers only BA graduates were able to increase their real earnings slightly (growing at 0.03% per year), mostly among the more experienced workers.

The big losers have been male workers with a high

¹⁷ Classifications of which jobs are “high school level” are necessarily arbitrary and ignore the likely higher productivity of college graduates in “high school jobs”.

¹⁸ Tyler et al. (1995) rely on an aggregate statistic, the percentage change in median real earnings from 1979 to 1989, based only on end points.

¹⁹ The U.S. Bureau of the Census does not provide the standard errors of mean earnings broken down by age, gender, and education level, although generally they are very small for age and gender categories in part because the samples each year are so large (see US Census, 1993, Table E-3, p. E-5).

²⁰ This is the average of the average growth rates of earnings across ages. For elementary and high school, a weighted average (weight = age interval length/65) was computed to account for the unequal length of the first age interval (18–24).

¹⁶ See for instance Smith and Welch (1978); Rumberger (1980); Witmer (1980); McMahon and Wagner (1982, pp. 154–6) and McMahon (1991), Rumberger (1980), Witmer (1980), McMahon and Wagner (1982) and McMahon (1991).

Table 1

The average annual rate of growth of real earnings at each education level (%)^a

	Elementary (males)				Elementary (females)			
	1967–95	1967–80	1981–95	1983–95	1967–95	1967–80	1981–95	1983–95
Age								
18–24	–2.72	–3.19	–2.31	–1.60	–0.27	–3.07	2.15	2.22
25–29	–0.88	–1.13	–0.66	–0.01	0.69	0.82	0.57	0.12
30–34	–0.12	–0.85	0.51	1.67	0.08	1.01	–0.72	–0.07
35–39	–0.54	–0.87	–0.26	0.60	1.31	1.34	1.29	2.12
40–44	–0.48	–0.32	1.19	1.70	1.25	–0.86	3.07	2.60
45–49	–0.55	–0.71	–0.42	0.47	0.85	0.21	1.41	2.37
50–54	–0.34	–0.32	–0.36	0.92	0.61	–0.96	1.97	1.43
55–59	0.61	–0.13	1.25	2.00	1.34	0.84	1.55	2.16
60–64	0.23	–1.10	1.38	1.82	1.05	0.64	1.41	2.33
Average	–0.43	–0.96	0.03	0.84	0.75	0.00	1.41	1.70
	High school (males)				High school (females)			
Age								
18–24	–1.97	–3.13	–0.97	–0.03	–0.48	–0.08	–0.83	–0.53
25–29	–1.28	–1.44	–1.14	–0.45	0.01	0.42	–0.34	–0.29
30–34	–0.54	–0.14	–0.88	0.04	0.68	0.37	0.94	0.98
35–39	–0.83	–0.59	–1.04	–0.57	0.59	–0.12	1.20	0.70
40–44	–0.67	–0.31	–0.98	–0.82	0.78	0.74	0.82	1.57
45–49	–0.61	–0.43	–0.77	–0.17	0.56	–0.05	1.08	1.08
50–54	–0.53	–0.62	–0.46	0.13	0.99	0.22	1.65	1.82
55–59	–0.04	0.18	–0.23	0.29	0.72	0.41	0.99	0.84
60–64	–0.67	–1.14	–0.26	–0.59	0.55	–0.08	1.10	1.36
Average	–0.79	–0.85	–0.75	–0.24	0.49	0.20	0.74	0.84
	College 1–3 years (males)				College 1–3 years (females)			
Age								
25–29	–1.36	–2.11	–0.70	–0.50	0.29	0.93	–0.27	–0.08
30–34	–0.62	–0.46	–0.77	–0.02	0.62	1.53	–0.17	0.34
35–39	–0.70	–0.71	–0.68	–0.05	0.33	–0.19	0.78	1.01
40–44	–0.72	–0.81	–0.64	–0.69	0.48	0.09	0.82	1.11
45–49	–0.19	–0.22	–0.16	0.37	0.64	–0.12	1.29	1.49
50–54	0.11	–0.01	0.21	1.37	0.63	–0.28	1.42	1.34
55–59	–0.09	–0.01	–0.15	0.65	0.61	0.16	1.00	0.50
60–64	–0.63	–0.80	–0.48	–0.12	–0.45	1.12	–1.81	–1.53
Average	–0.52	–0.64	–0.42	0.13	0.39	0.41	0.38	0.52
	College 4 years (males)				College 4 years (females)			
Age								
25–29	–1.02	–2.38	0.16	0.23	0.86	0.63	1.06	1.35
30–34	0.36	–0.37	0.99	1.45	1.45	0.58	2.21	2.35
35–39	–0.26	–1.16	0.51	1.52	1.40	–0.24	2.82	2.94
40–44	–0.02	–0.56	0.44	1.05	1.24	–0.02	2.34	2.26
45–49	–0.25	–0.40	–0.12	0.21	0.86	–1.15	2.60	2.52
50–54	–0.01	0.23	–0.23	0.46	0.82	–0.70	2.13	3.19
55–59	0.74	1.11	0.41	0.35	0.88	–0.67	2.23	3.65
60–64	0.70	0.11	1.22	1.88	0.60	0.07	1.05	1.73
Average	0.03	–0.43	0.42	0.89	1.01	–0.19	2.05	2.50

(continued on next page)

school diploma (–0.79% per year) or less (–0.43% per year) and male workers who did not complete college (–0.52% per year). On the other hand, women with four years of college (+1.01% per year), elementary school (+0.75%) and post-college education (+0.65%) experienced the biggest increases in real earnings.

It is interesting to note that both male and female workers with only elementary education experienced a higher growth in their real earnings than workers who did not complete college. The market penalizes failure to complete college, perhaps as a signal of lower productivity of those who drop out.

Table 1 (*continued*)

	Elementary (males)				Elementary (females)			
	1967–95	1967–80	1981–95	1983–95	1967–95	1967–80	1981–95	1983–95
	College 5+ years (males)				College 5+ years (females)			
Age								
25–29	–0.34	–2.17	1.24	1.38	0.43	–0.28	1.03	0.86
30–34	0.79	0.48	1.06	1.27	1.34	0.73	1.86	1.95
35–39	0.19	–1.00	1.22	1.80	1.43	0.50	2.23	2.49
40–44	0.09	–0.20	0.34	0.70	1.26	0.02	2.33	2.61
45–49	0.13	–0.24	0.46	1.15	0.30	–0.72	1.19	1.06
50–54	–0.07	–0.72	0.49	0.45	0.42	–0.71	1.40	1.48
55–59	–0.69	–0.73	–0.66	–0.87	0.60	–0.11	1.21	2.06
60–64	–1.01	–0.93	–1.08	–0.48	–0.58	–1.15	–0.09	0.01
Average	–0.11	0.69	0.38	0.66	0.65	–0.21	1.39	1.57

^a Source: Based on Earnings data from Current Population Reports, Series P-60, 1967–199.

In the earlier period 1967–80 only female workers with a college education saw their real earnings decline slightly (–0.19% for 4 year and –0.21% for 5+) consistent with the supply shocks in the mid-70s as baby-boomers entered the labor markets. Females with high school and uncompleted college saw their real earnings grow slightly, but the real earnings of males at all education levels declined significantly from workers with the lowest education levels such as elementary (–0.96% per year) and high school (–0.85% per year) or less (–0.64%), to workers with college (–0.43% per year) and a post-college education (–0.69% per year). These declines also are consistent with the supply shocks in the mid-70s mentioned above, although sorting out whether it is supply or demand factors is not our objective here, but instead the dynamic trends in rates of return for which earnings are one component.

A very different picture emerges when the more recent 1981–95 period is considered. There the real earnings of female workers increased at all education levels and for almost all age groups, especially for the highly educated female workers, i.e., women with 4 years of college (2.05% per year) or with post-graduate education (1.39% per year). As suggested by Ferber and McMahon (1979), this continuing trend in female earnings is consistent with their early earnings expectations and continuing entry into the labor market, especially in the more human capital intensive fields. Male bachelor's graduates also experienced increases in their real earnings (at 0.42% per year) although males with high school education and less than 4 years of college all saw their real earnings decrease steadily (at –0.75% and –0.42% per year, respectively). The real earnings of male workers with post-graduate education rose, especially for the younger cohorts of workers, and decreased for the oldest cohorts. This is consistent with the hypothesis that among highly-educated workers, mainly the older cohorts were affected

by the white-collar restructuring of the late 1980s and early 1990s.

Remarkably, in the last 12 years 1983–95 only male workers with a high school degree continue to face declining real earnings. The real earnings of male college graduates are growing (+0.89% per year) and of female school leavers at all levels continue to grow sharply, especially for more educated females (+2.50% and +1.57% at college and post-BA levels). Both show a clear recovery from the decline in the mid-70s (1967–1980 in Table 1).

In short, these trends indicate that there has been a persistent decline in real earnings for male workers with a high school education and a steady increase in real earnings of all workers with college education, especially since 1980. This table reveals that the foregone earnings costs of college are *falling*, and the net earnings differentials are *widening*, which reveals earnings trends that lie behind the rising wage inequality in the United States.²¹

3.2. Dynamic age-earnings profiles

Given these trends within all age groups, it should be clear that static cross-section age-earnings profiles and the rates of return based on them fail to fully account for growth in the real earnings of college graduates since 1980 or the decline in real earnings of high school graduates in the younger 18–24 age groups. Figs. 2 and 3 illustrate this point by portraying standard cross-section and cohort age-earnings profiles for typical male and female cohorts of workers that entered the labor market with high school diplomas in 1967 (lower 2 lines in each

²¹ See Levy and Murnane (1992) and DiNardo, Fortin and Lemieux (1996) for a comprehensive discussion of the alternative explanations of the rising wage inequality in the U.S.

Age-earnings profiles of the 1967 cohorts of male college and high school graduates

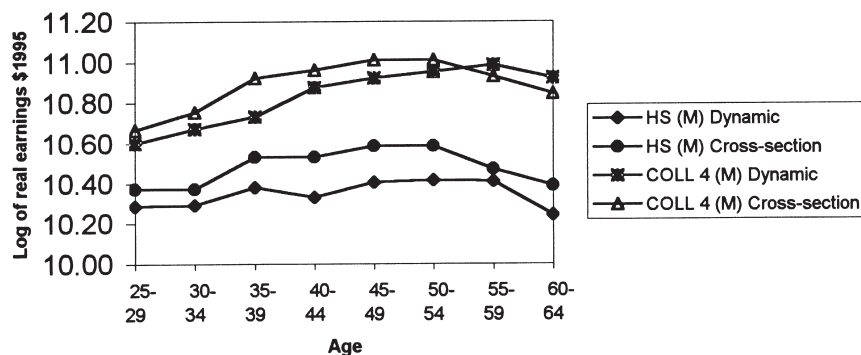


Fig. 2. Age-earnings profiles of the 1967 cohorts of male college and high school graduates.

Age-earnings profiles of the 1967 cohorts of female college and high school graduates

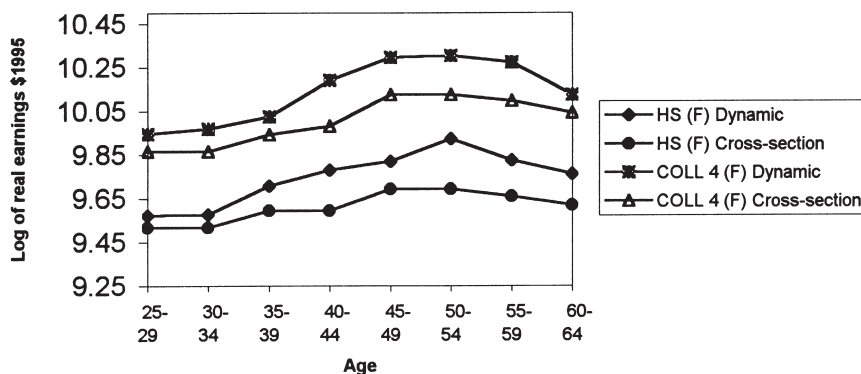


Fig. 3. Age-earnings profiles of the 1967 cohorts of female college and high school graduates.

figure) or a college degree (upper 2 lines). These have been generated using cross-section data on mean earnings for 1967 for the bottom lines in each pair, and then using the successive cross-sections of real earnings to generate the “dynamic” (cohort) age-earnings profile for each gender-education cohort. The latter are therefore the exact empirical counterpart of what was illustrated conceptually in Fig. 1. Since the available earnings data does not allow a full tracing of the 1967 cohort of workers over the last stages of their life cycle, for these ages the real mean earnings in 1995 of older workers are shown corresponding to the “unadjusted” dynamic rates of return in Table 2.

For this oldest 1967 cohort, and for males, it is clear that the 1967 cross-section earnings profiles *overstate* the

path of real earnings. This is consistent with the decline in real earnings following many new entrants during the mid-70s, which affects this and the next few cohorts of workers entering the labor market during this period. In contrast, the cross-section age-earnings profiles for females *understate* the actual real earnings path for both high school and college graduates given the upward trends.

Unfortunately, available earnings data does not allow development of the exact empirical dynamic age-earnings profiles for the more recent cohorts of college graduates since 1980. In this case, the earnings of older workers currently in the labor force must be adjusted by earnings trends within each age group since 1980. From the discussion in the previous section, it is then clear that

Table 2

Dynamic and cross section social rates of return to education in the U.S. (1967–1975)^a

	1967	1968	1969	1970	1971	1972	1973	1974	1975
Panel A: Dynamic rates unadj.									
High school (M)	12.56	12.16	11.57	10.96	10.58	10.17	9.67	8.98	9.59
High school (F)	9.73	10.53	10.49	10.91	10.76	11.17	11.17	11.22	11.18
College 1–3 years (M)	5.43	5.44	5.25	5.14	4.97	4.81	4.58	4.28	4.30
College 1–3 years (F)	5.01	5.27	5.36	5.55	5.08	4.84	4.51	3.53	2.98
College 4 years (M)	8.14	8.05	7.82	7.89	7.81	7.98	7.96	7.92	8.10
College 4 years (F)	7.21	7.12	7.04	7.28	7.51	7.69	7.70	7.59	7.75
College 5+ years (M)	5.57	6.27	6.46	6.55	6.73	6.14	5.70	5.68	5.82
College 5+ years (F)	10.34	11.02	10.87	11.51	11.40	10.31	9.63	8.62	8.27
Panel B: Dynamic rates ^b adj.									
High school (M)	12.53	11.96	11.53	10.90	10.51	10.08	9.56	8.85	9.46
High school (F)	9.81	10.56	10.57	10.99	10.85	11.26	11.26	11.31	11.29
College 1–3 years (M)	5.41	5.39	5.22	5.16	5.02	4.83	4.66	4.39	4.45
College 1–3 years (F)	5.13	5.37	5.46	5.67	5.23	5.02	4.72	3.81	3.30
College 4 years (M)	8.21	8.05	7.83	7.90	7.82	7.99	8.08	8.05	8.24
College 4 years (F)	7.31	7.25	7.20	7.50	7.74	7.96	8.04	7.99	8.21
College 5+ years (M)	5.65	6.37	6.52	6.87	7.13	6.73	6.35	6.45	6.58
College 5+ years (F)	10.30	10.98	10.82	11.46	11.34	10.21	9.51	8.48	7.86
Panel C: Static cross-section									
High school (M)	11.83	11.45	11.71	11.19	11.14	10.86	13.55	14.32	12.44
High school (F)	6.16	7.73	7.68	6.71	13.30	7.86	7.95	10.75	12.36
College 1–3 years (M)	5.65	6.52	8.09	6.70	6.72	5.64	8.87	6.83	5.30
College 1–3 years (F)	4.78	1.64	3.72	6.07	4.02	3.21	5.58	4.84	3.67
College 4 years (M)	8.86	9.39	8.98	9.70	9.63	8.79	7.93	9.57	9.90
College 4 years (F)	6.67	6.41	6.40	8.56	7.77	6.44	6.11	6.18	6.40
College 5+ years (M)	5.94	3.45	8.08	5.31	7.01	7.46	7.99	7.25	8.46
College 5+ years (F)	10.00	12.26	9.58	10.00	10.04	13.34	12.51	11.96	12.28

^a Source: Based on Mean Earnings Data from Current Population Reports, Consumer Income Series P-60, 1967 to 1995, and current fund total expenditure per pupil in 4-year institutions of higher education from the Statistical Abstract of Education (1996), National Center for Education Statistics.

^b Based on projection of net earnings differentials for later stages of the life cycle using their average annual rate of growth within each age-group during 1981–1995.

for these recent cohorts one would expect the dynamic time path to be above the static cross-sections, just as was illustrated in Fig. 1. The rates of return computed based on this earnings profile therefore correspond to the dynamic adjusted rates of return shown in Table 3. Though they follow a different approach and focus on men wages for a shorter time period, the analysis in MaCurdy and Mroz (1995) reveals patterns between cross-section and cohort age-wages profiles of different education groups that are consistent with the findings reported here.

4. Dynamic rates of return to education

Table 2 presents measures of the dynamic (Panels A and B) and cross-section static social rates of return to education in the U.S. for the period 1967–75. The dynamic rates of return apply to each “synthetic cohort” of workers that entered the labor market, the first apply-

ing to the group that entered in 1967, the second to those who entered in 1968, and so forth.

4.1. Dynamic rates of return

To demonstrate that incorporating earnings trends for those reaching the oldest age groups in the years that extend beyond the current data has little effect, Panel A shows dynamic rates with the most recent cross-section data used (in the standard fashion) to represent those years, and Panel B adjusts the last few years in the net earnings differentials using recent trends in earnings within the older age groups. In Panel A dynamic social rates of return at the high school level fall consistently from 12.6% to 9.6% from 1967 through 1975 for high school male graduates and rise slowly for females from 9.7% to 11.2%. The rate of return to 1–3 years of college is lower starting out at about 5% and falling toward 3–4%. It declined about 1 percentage point for males and 2 percentage points for females from 1967 through 1975.

Table 3

Expected dynamic social rates of return to education in the U.S. (1980–1995)^a

	Dynamic rates ^b				Cross-section rates			
	1980	1985	1990	1995	1980	1985	1990	1995
High school (M)	10.79	10.29	9.15	10.23	12.62	10.68	12.00	11.00
High school (F)	13.31	12.48	11.27	12.40	13.38	12.43	11.00	11.00
College 1–3 (M)	5.75	5.93	5.99	7.05	4.47	5.30	7.19	4.50
College 1–3 (F)	3.86	2.92	1.85	1.78	4.74	4.99	6.01	1.01
College 4 (M)	10.89	13.14	12.21	13.20	8.84	10.78	12.87	10.29
College 4 (F)	10.36	12.72	11.23	13.42	5.86	7.97	11.47	8.39
College 5+ (M)	8.73	10.06	11.10	11.11	7.10	7.94	9.63	8.13
College 5+ (F)	8.05	8.30	6.72	5.56	9.56	8.73	10.24	6.87

^a Based on Mean Earnings Data from Current Population Reports, Consumer Income Series P-60, 1967 to 1995. Costs are based on total current fund expenditure per pupil in 4-year institutions of higher education from the Statistical Abstract of Education (NCES, 1996).

^b Projection of net earnings differentials are made for each age-group using the average annual rate of growth of net earnings differentials during 1981–1995.

For college graduates, the unadjusted rates in Panel A decline slightly for males and increase for females but basically hover around 8% for both. The unadjusted rates of return to more than 5 years of college (largely master's degrees) also remain flat at around 6% for males, while for females they first increase from 10.3% to 11.5% from 1967 through 1970 and then decline from 11.4% to 8.3% from 1971 through 1975.

In Panel B the adjusted dynamic rates for 5+ college follow the same pattern, although for females are very slightly lower throughout. It is not surprising that adjustments to the few oldest age groups for trends would lead to very few changes in the estimated dynamic rates of return since earnings in the later stages of the life cycle are heavily discounted in the computation of rates of return. Therefore, the rates of return are little affected by either using or not using real earnings trends to adjust the last few years of the age-earnings profiles.

4.2. Dynamic and standard cross-section static rates compared

We are now in a position to return to the key question addressed by this paper: Do the actual trends in real earnings result in the conventional (static) cross-section rates of return overstating or understating the actual dynamic rates realized for a given cohort?

Table 2 also presents in Panel C the more conventional static cross-section social rates of return to education for males and females computed using the same “full method” (see McMahon, 1991). The public and private costs and earnings data are exactly the same as that used to compute the dynamic rates so that these rates are strictly comparable. Several interesting points emerge.

First, cross-section static rates of return overstate the

actual dynamic returns to education when trends are downward, as for the cohorts of male bachelors (by about 2 percentage points), for male high school graduates and for male college 1–3 school leavers during 1971–75. This is similar to the point noted by Freeman (1976). But the static rates tended at the same time to understate by nearly 2 percentage points the actual dynamic rates for female workers with bachelor degrees and college 1–3 since the trends for them were upward (except for years 1970 and 1971). Similarly, the dynamic rates of return to a high school education for females tend to be significantly understated by the cross-section rates during most of this period.

Second, the behavior of the cross-section static rates of return to education is more erratic than the behavior of the dynamic rates. For instance, the cross-section rates of return to females completing bachelors bounce around a bit from 1967 to 1975, whereas the dynamic rates for females at this level trend relatively more smoothly upward. This may reflect the impact of temporary shocks on the starting salaries of each group of workers. Rate of return estimates based only on starting salaries are even more volatile than the cross-section static rates.

Third, the results also suggest that the extrapolation of trends from a series of changes in cross-section rates of return may be very misleading. For instance, as Table 2 shows, for the period 1967–75 the cross-section rates of return suggest the wrong trend for the returns to high school education of males (a flat then increasing trend, whereas the dynamic rates show it is decreasing), and also for female bachelors (an irregular but decreasing trend, whereas the dynamic rates suggest a more regular slowly increasing trend).

4.3. Expected dynamic rates of return to education, 1980–95

Equally interesting are the implications of this analysis for what has been happening in the 80s and 90s where as suggested there has been a dramatic increase in the real earnings of more skilled workers. This raises another important question that we seek to address in this paper: What are the implications of the current trends reflected in the dynamic rates of return for current graduates and for policies relating to investment in human capital as compared to the alternatives?

In order to address this second question the actual recent data on net earnings differentials is adjusted for growth trends in the earnings within the oldest age groups for the period 1981–95 to project the earnings differentials that recent cohorts are likely to obtain later in their life cycle. “Expected dynamic rates of return” for cohorts entering the labor market in recent years are then computed using the relevant available data together with the estimated life-cycle path of earnings. These are shown in Table 3 together with their cross-section counterparts. It must be stressed again that these rates are not based only on starting salaries and the shifts in age-earnings profiles that they imply; those based on starting salaries are more sensitive to temporary shocks and cyclical downturns. This is because the older age groups tend to have more stable employment than new entrants (e.g., “last hired, first fired”), given that company recruiters scale back acquiring new human capital during recessions, and supply surges affect entry levels the most. Emphasis on starting salaries for computing rates of return is therefore less appropriate for the long-run type of investment in human capital that education decisions involve.

Table 3 indicates that for the most recent 1995 cohort, the expected dynamic rate of return for females at the college level is 13.4%, 5 percentage points above the standard static cross-section rate and also rising above where it was in 1975. Even at the high school level at 12.4% it is 1.4 percentage points above the cross-section rate and about 1% above what it was in 1975. For males at the bachelor’s level, the expected dynamic rate of return is a high 13.2%, 3 percentage points above the conventional static cross-section rate, 2.3 percentage points above 1980.

For male high school graduates, the 1980–1995 expected dynamic rates fall slightly by 0.5 percentage points and for females by .9 percentage points. On the other hand, for the college 1–3 male cohorts their expected dynamic rates of return are about 1–1.5 percentage points higher than during the period 1967–75, though the payoff for females continues to decline substantially.

4.4. Comparisons to inflation-adjusted total returns on other assets

Our final objective has been to obtain a rate of return to investment in the education of cohorts finishing the education system in recent years that is useful and comparable to inflation-adjusted annual total rates of return on alternative classes of investments.

There are aspects and implications of such comparisons that will not be explored here; we only wish to illustrate our objective which is to obtain an internal rate of return to investment in education that in principle is comparable.²² In particular, standard reports on total returns on classes of investments include buyers’ estimates of current and future earnings, and do not report total returns to specific companies (such as within a mutual fund or any other stock market index) even though the composition of the mutual fund changes annually. Such rates of return are meaningful; what has been needed is a comprehensive comparable total return that includes current costs and earnings trends and applies to the education system.

Table 4 shows the inflation-adjusted year-by-year total returns on large company stocks, long-term corporate bonds and intermediate-term government bonds from Ibbotson and Associates (1998, p. 95), a standard source. Since these all fluctuate much more than the expected dynamic rates of return to high school and college levels (which are averaged for males and females from Table 3 and shown in Cols. 4 and 5), they are also each averaged for the preceding four years.

The financial total rates of return, just as the education rates of return, include some tax-subsidies and are before individual income taxes. They do not reflect any existing social benefit or cost spillovers which are assumed to be relatively small in relation to the well known education externalities, and for social costs corporate taxes act as an offset. Total returns are inflation-adjusted and incorporate trends in earnings and production costs.

The overall real returns to investment in human capital formation in the U.S. as shown in Table 4 are both higher and less volatile than most investments in physical capital via these financial assets on the average (although more recent total returns on stocks not shown here have been extraordinary). The recent 13.3% inflation-adjusted expected total return to a typical college degree is the highest.

²² We compute social rates of return which include the full tax costs and earnings before taxes because we want to obtain an estimate of the return to society. Most industries generate fewer externalities than education. More detailed measurement of structural indirect effects is dealt with in *Education and Development: Measuring the Social Benefits* (McMahon, 1999).

Table 4

Inflation adjusted total returns to financial and human capital investments, 1975–1995

	Large company stocks	Long-term corporate bonds	Intermediate government bonds	High school education	College (4-year) education
1975	−3.2%	−2.4%	−1.8%	10.4%	8.2%
1980	7.0	−10.5	−6.4	12.0	10.6
1985	16.1	19.3	13.3	11.4	12.9
1990	7.4	3.3	3.0	10.2	11.7
1995	11.1	8.1	4.7	11.3	13.3
Average	7.7%	3.6%	2.6%	11.1%	11.3%

5. Conclusions

Conventional rates of return based on data from a single cross-section whether they be private or “narrow social” rates and whether they use Mincer earnings functions or the full method do not use all of the information that is available in a series of cross-sections of earnings data in successive years. In this study we exploit the fact that as any one individual enters the labor force he/she will not receive the earnings older workers are receiving when he/she reaches that older age, but will instead receive earnings reported by cross-sections that re-interview the older age groups at later dates. The dynamic rates of return developed here incorporate these growth factors as a typical individual of a given cohort moves through time, and thereby report more accurately the longitudinal rates of return realized by the society on investment in each cohort of individuals as they leave the education system.

This paper shows that the conventional cross-section static rates of return tend to overstate the actual return when the net earnings trend is downward, and to understate it when the trend of the net earnings differential is upward. It also shows that the dynamic rates of return tend to follow smoother trends over time in relation to greater fluctuations in successive cross-section rates, and in relation to the still greater fluctuations in rates based on adjustment of the entire age-earnings profile using only starting salaries. As suggested in the introduction, human capital investments are very long-term investments, with the average individual remaining in the labor force for 40–42 years over which his/her human capital yields returns. Decisions about such long-term investments are best if not based on temporary labor market fluctuations, but instead so long as it remains reasonable to assume that underlying basic forces such as globalization, knowledge-based technical change, and a supply response by women that does not overtake changes in the labor markets are continuing, they are likely to be better if based on these expected dynamic rates of return which incorporate available information about the growth or decline of earnings within each older age group over time.

With respect to specific empirical results, the dynamic rates of returns at the high school level in the period from 1967 to 1980 declined from 12.5% to 10.8% for males, winding up below the static rates, and rose from 9.7% to 13.3% for females, winding up slightly above the static rates. At the college level, dynamic rates of return for males remained low at about 8% through the mid-1970s but then rose to 10.9% by 1980. Female college graduates experienced even lower 7% dynamic rates of return in the late 1960s that rose to 10.4% by 1980.

The dramatic differences are in the period from 1980 to the present. The *dynamic expected rates of return* at the college level that use trends over the last 15 years of available data in only the older age groups to project earnings when recent cohorts reach these older ages are *13.3% for males and 13.4% for females*. These expected dynamic rates take the rising direct institutional costs at public and private universities into account, and yet are *3 percentage points above the standard static cross-section rates for males, and 5 percentage points above the static rates for females* in 1995. This increase occurs of course also in part because *foregone earnings costs are falling*, since those who stop with a high school diploma or less are doing poorly.²³ So unless the supply of workers stopping with high school or less and dropping out of college is reduced, thereby increasing their relative scarcity, and the supply of 2 and 4 year college graduates increased, this factor is likely to influence the widening economic inequality in the earnings of individuals in the U.S. between these groups.

With respect to the extent to which the rates of return to education reported above may be distorted by self selection due to “ability”, endogenous schooling, or family factors, we have sought to show how the recent flurry of studies based on large samples of identical twins are

²³ The cross-section static social rates of return for 1995 at the Associate Degree (2 year) level are considerably better (12% for males and 18% for females) than those for college 1–3. These could not be included in the dynamic rate of return computations because consistent data at the Associate Degree level is not available for the period covered by the study.

beginning to converge toward a narrower range of estimates of “net ability bias” as a correction factor. Although this must be based on judgments which are subject to the qualifications stated above, this begins to permit them to be put to some practical use. This is important because in almost all real world situations the data do not permit any direct controls for (unmeasured) “ability”, family factors, or for self-reporting measurement error, so it is necessary to rely on experiments conducted under very highly controlled conditions. These recent identical twin studies are increasingly precise, but nevertheless generally consistent with earlier conclusions by Griliches (1977) and many others cited. There is an “ability” bias, but when measurement error is taken into account it is partially offset and relatively small, averaging 11% when recent studies with large samples of identical twins in the US are emphasized. Future research will undoubtedly change this estimate somewhat, so it must be interpreted with that in mind. It is noteworthy that the most recent studies of identical twins by Rouse (1999) and Behrman and Rosenzweig (1999) yield a rate of return to education of 10.5% and 11.8, very similar to the static cross section rates we obtain for high school and college graduates in 1995 from the nationwide CPS data ($n=60\,000$) for high school and college graduates by the “full” method for 1995.

If the most recent expected dynamic rates of return to education are adjusted downward by 12%, since the CPS data is representative of the output of the US education system, the most recent rates of return for a 4 year college degree are 11.6% for males and 11.8% for females. These are still notably high, and still distinctly higher by 3–5 percentage points than the standard cross section static rates shown here which are subject to the same bias.

These “narrow social” rates still do not include non-market private returns to education resulting from the use of human capital in the home during non-market hours, or externalities including those generated by delayed feedback effects. A serious effort to measure them has recently been made by McMahon (1999) and Hertog and Oosterbeek (1999) have addressed some of the non-market private return aspects recently in this journal. Wolfe and Zuvekas (1997) earlier tentatively estimated the value of these non-market returns to be nearly equal to the value of the market returns. Considering the new evidence presented here on the market returns, and pondering these externalities, the total returns to both secondary and higher education compare quite favorably to inflation adjusted total returns on comparable alternative forms of investment in the U.S.y

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