Is College a Worthwhile Investment?

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Abstract

This article surveys the existing evidence on the return to a college education and offers new calculations based on recent data. We focus on an individual's decision and outline the standard conceptual framework used by economists to analyze investments in education. We then compare alternative estimates of the value of a college education in the literature and reconcile them with our own preferred estimates. We also conduct a selective review of the literature seeking to estimate the causal effects of college on pecuniary and nonpecuniary outcomes. Finally, we provide additional calculations showing the heterogeneity in returns to college across certain institutional and demographic characteristics, review the related academic literature, and discuss the risk associated with a college investment. We conclude that college is certainly a worthwhile investment on average and likely worthwhile for many subgroups, although not necessarily for everyone.

An investment in knowledge pays the best interest.

Benjamin Franklin

1. INTRODUCTION

In the United States, more than 20 million individuals overall and two-thirds of recent high school graduates are currently enrolled in a postsecondary institution (US Dep. Educ. 2013), with many believing that a college education is required to get ahead. Indeed, the Obama administration has stated that a "post-secondary degree or credential is a prerequisite for 21st century jobs" (**https://www.whitehouse.gov/issues/education**).[1] At the same time, many others are questioning whether the benefits of college justify the cost, given the rise in college tuition and fees outpacing real estate price appreciation even during the housing bubble (Deritis 2011) and total student debt topping $1.1 trillion (Fed. Reserve Bank New York 2014). The popular media also regularly features stories about unemployed college graduates burdened by enormous levels of student debt. Indeed, Theil (2011), who offers young entrepreneurs $100,000 not to go to college for two years, contends that students are being encouraged to invest in college at any cost and without concern about their ability to earn enough to offset the costs.

This article addresses the question, from an individual's perspective, of whether college in the United States is a worthwhile investment. To answer this question, we begin by calculating the returns to a college education based on a simple comparison of discounted earnings profiles by educational attainment and the pecuniary costs of college. We also compare these calculations to ones from a variety of recent policy papers and reports. The calculations of returns differ under alternative assumptions, but all indicate large positive returns to college on average. Nevertheless, these calculations do not address the possibility of selection into college and consequently may be biased. We therefore proceed to review the academic literature on the causal effect of college on both pecuniary and nonpecuniary outcomes. Although there are many concerns about the legitimacy of past strategies used to identify the causal impact of college on earnings and surprisingly little new evidence, the most credible causal estimates are fairly similar to (or even larger than) the noncausal estimates. Consequently, we conclude that college is, on average, a worthwhile investment.

Despite the substantial evidence that college is a worthwhile investment on average, many persist in arguing that there is a so-called college bubble. These arguments are often based on the observations that some college graduates earn less than some high school graduates, that some college graduates work in jobs that do not require a college education, that wages earned in some majors may be too low to justify the cost of college, or that college graduates are struggling to make their student loan payments. These observations by themselves do not necessarily imply that college is a bad investment at the time it is taken. If a young entrepreneur has a great idea, then dropping out of school or not enrolling in college in the first place may indeed be the optimal decision, but this is likely to affect only a very small share of students. While thinking about the more typical case, one needs to consider whether an individual who is near the bottom of the college graduate earnings distribution would have been near the bottom of the high school wage distribution. Studies identifying a causal impact of college attendance on earnings suggest that this is the case, but clearly, more research is necessary to confirm this conclusion across a broader variety of settings.

[1]President Obama also set a goal "that by 2020, America will once again have the highest proportion of college graduates in the world" (**http://www.whitehouse.gov/issues/education/higher-education**). We do not debate the merits of this goal here, although, in our economic framework, the optimal proportion of college graduates should be based on considerations of social costs and benefits and not on comparisons with other countries.

Nevertheless, the evidence that college is a worthwhile investment on average does not indicate that it is a worthwhile investment for everyone. Perhaps a more interesting question is to ask for whom college is a worthwhile investment. This is a much more difficult question to answer conclusively, but we provide evidence of substantial heterogeneity in returns by individual characteristics, such as gender and race, as well as institutional characteristics, such as degree types and college majors. There are certainly some college majors that appear to have substantially lower returns. Moreover, there are almost certainly some individuals who may not benefit from attending college, although it is not necessarily straightforward to determine who they are ahead of time. Many college students learn about whether college is worthwhile to them by actually attending college. Thus, the role of uncertainty in the decision to invest in a college education is extremely important. Although there is growing interest in exploring these issues among scholars, there are many more research avenues left open for further exploration.

The scope of this article is circumscribed in several ways. In addressing the question of whether college is a worthwhile investment, we focus exclusively on evidence from the United States. This is because much of the empirical evidence has been based on data from the United States and because it is not feasible to provide a comprehensive answer for a variety of different countries. Indeed, the answer to whether college is a worthwhile investment may differ widely across countries depending on the specific costs and benefits of a college education. However, the methodology and discussion of our approach to answering this question in the context of the United States are likely to prove useful in answering this question for other countries. Whether college is a worthwhile investment from an individual's perspective may also be different from the perspective of a government that subsidizes postsecondary students and institutions of higher education. [Stantcheva (2014) provides a more complete theoretical discussion of optimal government policies on income taxation and the subsidization of human capital accumulation.] As we argue in the following section, an individual should decide whether to attend college by comparing his or her expected costs and benefits associated with obtaining a college education. However, a government interested in maximizing social gains will also want to include possible spillovers in the benefits of a college education across individuals. These externalities will generally not be considered by individuals in their decision to attend college (see Levin et al. 2007 for a discussion of some of the public benefits of investing in education and an attempt to estimate the public returns to investments in education for African American men). Furthermore, to the extent that some of the benefits from a college education result from the revelation of an individual's private information about his or her own ability rather than the augmentation of human capital, a government may wish to reduce its subsidies for higher education. Yet the individual's decision should not be affected by whether the benefits to college result from signaling or from increased human capital. Accordingly, this article focuses on the individual's decision and sidesteps the issues of signaling and externalities (see Lange & Topel 2006 for a recent discussion of the literature on labor market signaling and externalities in education).

The article proceeds as follows. In Section 2, we outline the standard conceptual framework used by economists to characterize an individual's decision to invest in schooling. This corresponds to the question of whether college is a worthwhile investment for an individual and essentially boils down to a comparison of the costs and benefits resulting from the decision to attend college. In Section 3, we calculate the returns to a college education using discounted earnings profiles by educational attainment and the pecuniary costs of college. We also explore how alternative assumptions affect the calculations offered in a variety of policy papers and reports and attempt to reconcile them with our preferred estimates. In Section 4, we review the academic literature on the causal effect of college on earnings. We describe the different methods used to account for selection bias and offer an interpretation of the resulting estimates. In Section 5, we examine the role of nonpecuniary considerations in the decision to attend college. In Section 6, we provide additional calculations showing heterogeneity in returns to college across different institutions, majors, and demographic characteristics and review some of the related academic literature. In Section 7, we highlight two sources of risk related to the decision to attend college and discuss the challenges of evaluating these risks. Finally, we present our conclusions and suggest some remaining questions for further study in Section 8.

2. A CONCEPTUAL FRAMEWORK

In this section, we describe the standard conceptual framework used by economists to characterize an individual's decision to invest in human capital. We begin by introducing a discrete time formulation of wealth maximization that is used to calculate returns to schooling in Section 3. Then we describe a continuous time formulation of wealth maximization that provides intuition for the optimal choice of schooling and facilitates the interpretation of the regression estimates reviewed in Section 4. Finally, we discuss how a more general formulation in terms of utility maximization can incorporate nonpecuniary costs and benefits into the decision to attend college, as discussed in Section 5.

2.1. Discrete Framework

The simplest formalization of an individual's decision to invest in schooling can be expressed as a discrete sum of discounted pecuniary benefits net of costs over the working life. Thus, in comparing the benefits of a four-year college degree relative to a high school diploma, we can write the net present value as follows:

$$V = \sum_{t=0}^{T} \frac{Y_t^{\mathrm{BA}} - Y_t^{\mathrm{HS}}}{(1+r)^t} - c\sum_{t=0}^{s} \frac{1}{(1+r)^t}, \qquad (1)$$

where Y_t^{BA} represents the earnings at time t of someone who ends up as a college graduate, Y_t^{HS} the earnings at time t of a high school graduate, T the period of retirement, r the discount rate, and c the tuition and other direct costs that are assumed to be constant over s years of schooling. In this setting with pecuniary costs and benefits, the discount rate is often taken to be some market rate of interest.

In this formulation, individuals seeking to maximize the net present value will choose to attend college if the net present value is positive (i.e., $V > 0$). This decision can also be expressed in terms of the internal rate of return (IRR), ρ, defined as a value of r for which $V = 0$. Thus, the choice to attend college will be made if the IRR is greater than the discount rate ($\rho > r$).

Importantly, this formulation ignores nonpecuniary benefits as well as psychic and other nonpecuniary costs of schooling. Moreover, it assumes that all individuals retire at the same time, regardless of their schooling investment. Nevertheless, this is the most common framework used to calculate the net present value of a college education. In Section 3, we review—and attempt to reconcile—a number of different estimates based on precisely this formulation.

2.2. Continuous Framework

Although the discrete time formulation provides a straightforward approach for calculating the net present value of attending college, the analogous formulations in continuous time facilitate an intuition for the optimal choice of schooling level and highlight the potential for bias in estimating returns to schooling due to unobserved ability. If we assume that schooling is a full-time activity and that individuals work for the same number of years after completing their schooling, we can write the net present value for a given level of schooling, s, in continuous time as follows:

$$V(s) = \int_0^T e^{-r(s+x)} Y(s,x)dx - c\int_0^s e^{-r\tau}d\tau,$$

where r and c represent the discount rate and the direct costs of schooling, respectively (as above), and $Y(s,x)$ now represents earnings associated with schooling, s, after x years of experience (as the first term only integrates over time after schooling is completed).[2] It is natural to assume that earnings increase with schooling [i.e., $Y_s(s,x) > 0$], as that provides the rationale to invest in schooling. As in the discrete time formulation, it is straightforward to calculate the net present value of a four-year college degree relative to a high school diploma by taking the difference of V_{BA} and V_{HS} or to calculate the IRR ρ by solving for the discount rate r that sets $V_{\mathrm{BA}} = V_{\mathrm{HS}}$ using numerical methods.[3]

If we assume that the schooling and experience components of earnings are multiplicatively separable, such that $Y(s,x) = f(s)g(x)$, and that there are no costs of schooling, $c = 0$, then the IRR to schooling can be captured by the coefficient on schooling in a standard earnings regression. This is because solving for the IRR to schooling under these assumptions yields $\rho = f'(s)/f(s)$.[4] Therefore, in a simplified Mincer (1958) regression equation of log earnings on schooling that abstracts from the effects of experience, $\ln Y = \alpha + \beta s + \varepsilon$, the estimated coefficient on schooling will be $\beta = d\ln Y(s,x)/ds = Y_s(s,x)/Y(s,x) = f'(s)/f(s) = \rho$. Note that the equivalence between the IRR to schooling and the Mincerian coefficient on schooling depends on all the assumptions mentioned above: Schooling is a full-time activity, individuals work the same number of years regardless of schooling, there are no direct costs of schooling, and the schooling and experience components of earnings are multiplicatively separable. Heckman et al. (2006a) discuss the validity of these assumptions, which are implicit in the regression estimates of the causal returns to college reviewed in Section 4.

2.3. Optimal Choice of Schooling

The continuous time formulation also enables us to solve directly for the optimal choice of schooling by taking the derivative of $V(s)$ with respect to s and equating it to zero:

$$\int_0^T e^{-rx}\frac{\partial Y(s,x)}{\partial s}dx - r\int_0^T e^{-rx}Y(s,x)dx - c = 0.$$

Given the assumption that earnings are multiplicatively separable, such that $Y(s,x) = f(s)g(x)$, we can rearrange the equation above as follows:

[2]The assumption that work life is independent of schooling makes the subsequent expressions more tractable. However, it is possible to assume that all individuals retire at the same age by substituting $T-s$ for T in the upper limit of the first integral, and it is possible to allow working life to vary with schooling by substituting $T(s)$. These alternative assumptions will generally have negligible effects on actual estimates because later periods are heavily discounted (see Heckman et al. 2006a for a more general treatment).

[3]The **Supplemental Appendix** derives an expression for the IRR associated with $s + d$ additional schooling versus just s schooling (follow the Supplemental Material link from the Annual Reviews home page at **http://www.annualreviews.org**). This will be unique so long as the two earnings streams only cross once.

Supplemental Material

[4]Again, the **Supplemental Appendix** provides a derivation. Note that if this relationship holds for all values of s, wage growth must be exponential (or log linear) in schooling such that $f(s) = f(0)e^{\rho s}$.

$$\frac{f'(s)}{f(s)} = r + \tilde{c},$$

where $\tilde{c} = c/f(s) \int_0^T e^{-rt} g(x)dx$ represents the direct costs of schooling as a fraction of the total discounted earnings. This equation provides clear intuition for the optimal stopping rule when investing in schooling.[5] Individuals should choose to acquire schooling up to the point at which the growth rate of earnings from additional schooling is equated to the discount rate plus the (adjusted) direct cost of schooling. If we further assume there are no direct costs of schooling (i.e., that $c = 0$), the equation above reduces to the simple rule derived by Rosen (1977) and Willis (1986): $f'(s)/f(s) = r$. Here, the benefit from additional investment in schooling is captured by $f'(s)$, whereas the opportunity cost is captured by the potential return on forgone earnings, $rf(s)$. Because the IRR to schooling is equal to the growth rate of earnings under these same assumptions, the choice of schooling is optimal when individuals equate their marginal returns to schooling with their discount rates.

This simple continuous time framework shows how heterogeneity in schooling choices and earnings can arise either through differences in the marginal return to schooling $f'(s)/f(s)$ or through differences in the discount rate r, as originally suggested in Becker's (1967) Woytinsky lecture. There may also be differences in the costs of schooling across individuals because of nonpecuniary considerations, although this possibility is usually discussed in a utility framework as presented next.

2.4. Utility Framework

The underlying assumption of the preceding analyses is that individuals seek to maximize wealth by focusing on the pecuniary benefits and costs of education. The wealth maximization framework is applicable if people can borrow or lend at a fixed interest rate and if they are indifferent to the choice between attending school and working. However, Card (2001) notes that individuals may have different aptitudes and tastes for schooling relative to work and therefore introduces a more general utility framework to incorporate these considerations. In particular, Card assumes that individuals maximize utility, $U = U(c(t) - \varphi(t))$, where $c(t)$ is consumption in period t, and $\varphi(t)$ represents the relative disutility of school versus work during periods of schooling. The optimal choice of schooling derived under this framework equates these marginal benefits from schooling with the marginal costs due to forgone earnings, tuition costs, and the disutility of schooling.

Card (2001) uses this framework to further explore the potential sources of individual heterogeneity in optimal schooling choices and to interpret different estimates in the literature. He also distinguishes between the heterogeneity due to differences in the marginal returns to schooling and heterogeneity due to differences in the costs of schooling related to discount rates or the disutility of school versus work. In particular, Card allows the marginal cost of schooling to increase with schooling and parameterizes the marginal return to schooling as a linear function $f'(s)/f(s) = b_i - k_1 S$, where b_i captures the heterogeneity in returns to schooling. This parameterization can in turn be associated with an earnings function of the form $f(s) = e^{a_i - b_i s - (k_1 s^2)/2}$, where a_i represents heterogeneity in individual earnings that does not affect the marginal return to schooling. The heterogeneity in a_i may correspond to differences in the discount rate or the (nonpecuniary) costs of schooling. If we further assume that $k_1 = 0$, we can recover a familiar

[5]Here we implicitly assume diminishing returns to schooling, $\partial[f'(s)/f(s)]/\partial s < 0$, to ensure an interior solution.

Mincer equation in which log earnings are a linear function of schooling but in which the coefficient on schooling, as well as the intercept, differs across individuals (i.e., $\ln Y_i = \alpha_i + \beta_i s_i + \varepsilon_i$).[6] We discuss how such heterogeneity can lead to bias in Section 4.

Although Card's utility framework allows for nonpecuniary costs (or benefits) of schooling concurrent with investments in schooling, it does not allow for nonpecuniary benefits of schooling after schooling is completed. Indeed, the benefits of schooling only arise through the relaxation of an intertemporal budget constraint that relates consumption to income. It is possible to incorporate future nonpecuniary benefits by letting consumption and/or utility be a function of schooling, but these formulations are beyond the scope of this article. However, we review some of the empirical estimates associated with nonpecuniary benefits of college in Section 5.

2.5. Discussion

In the preceding subsections, we introduce a number of explicit simplifications to aid in the analysis. Several implicit assumptions underlie this conceptual framework as well. First, we assume that individuals have access to perfect information about the costs and returns to schooling and therefore do not distinguish between ex ante and ex post returns to schooling. This is an important topic explored by Carneiro et al. (2003) and Cunha et al. (2005). More generally, whereas the optimal choice of schooling is presented as a one-time decision, the decision to accumulate schooling is better characterized as a sequential process with new information revealed at each stage. Altonji et al. (2012) outline such a model in their recent article in this journal and provide valuable references to the related research on dynamic choice models of education. Second, the wealth maximization framework assumes that individuals can borrow and lend in perfect credit markets. Despite the growing availability and use of student loans in recent years, this assumption is unlikely to hold in all circumstances. Lochner & Monge-Naranjo (2012) discuss the role of credit constraints in education in their recent article in this journal. Third, we ignore behavior biases that may lead individuals to stray from their optimal decisions. For example, individuals may exhibit hyperbolic preferences or debt aversion that leads them to avoid college even if it is optimal to do so (Lavecchia et al. 2014). Finally, the underlying source of earnings benefits from schooling remains implicit throughout this discussion. From an individual's perspective, it is not important whether the return to schooling results from increased human capital leading to improved productivity or simply from labor market signaling, which reveals preexisting differences in productivity to employers. Clearly, from a societal perspective, it would be important to distinguish between these alternative mechanisms.

3. NAÏVE ESTIMATES BASED ON PECUNIARY CONSIDERATIONS

The general strategy for estimating the expected financial value of going to college is to use the discrete time accounting exercise described by Equation 1 to determine whether the estimated financial benefits of college exceed the total financial costs. Often implicit in this approach is the assumption that current earnings for individuals of different education levels are a good approximation of the earnings that an individual making the decision today would experience in the

[6]This specification abstracts from the effect of experience because, even if they are multiplicatively separable, we have $\ln Y_i(s,x) = \ln f(s) + \ln g(x)$. Furthermore, this specification assumes that the return to schooling is constant—and not diminishing in schooling as assumed in footnote 5. Consequently, we would need to assume that the discount rate or nonpecuniary cost of schooling is increasing with schooling to avoid a corner solution.

future. Although most studies use cross-sectional data to estimate lifetime earnings paths, a few use longitudinal data on older cohorts of individuals. Regardless of which approach is taken, these estimates may be considered naïve because they do not address the possibility of selection into college associated with the optimal choice of schooling. Before reviewing estimates of the value of college, we describe the direct costs of attendance, the indirect cost of college associated with forgone earnings, and the college earnings advantage.

3.1. The Cost of College and Financial Aid

As has been documented in the press and is well known to students and parents alike, (gross) tuition at most postsecondary institutions has increased rapidly over the past 20 years. For example, based on data from the National Postsecondary Student Aid Study (NPSAS; various years), average gross tuition and fees paid (in constant 2009 US dollars) in public four-year institutions more than doubled from about $3,060 per year to $8,000 per year between 1990 and 2012; over this same time period, annual tuition at public two-year institutions increased from approximately $1,200 to $2,400.[7] That said, less than one-half of undergraduate students (40.9% in 2012) pay the sticker price of gross tuition and fees because nonloan financial aid has also become much more generous over the past few years.[8] As a result, average net tuition and fees—what students actually pay—has increased more slowly between 1990 and 2012, from approximately $2,050 to $4,600 at public four-year institutions and from approximately $735 to $1,040 at public two-year institutions.

However, the cost of attending college includes not only the direct cost in terms of tuition and fees but also the forgone earnings that the student would have earned had he or she worked while in school. Depending on the institution attended, full-time employment during the academic year at the 2013 federal minimum wage (approximately $12,000) easily exceeds the direct cost of attending college.[9] Although the percentage of students working while in school has declined some over time, more than one-half continue to report positive hours worked while in school. According to the most recent data available, 66.0% of college students worked while in school in 2012, compared with 77.2% in 1990.[10] Although working while attending school lowers the opportunity cost of attendance, it has also been associated with increases in other costs: higher dropout rates (Ehrenberg & Sherman 1987), lower grade point averages (GPAs) (Stinebrickner & Stinebrickner 2003), and longer time spent in school (Ehrenberg & Sherman 1987). Most studies taking into account the lost wages while in school assume that students do not work at all while enrolled in school.

[7]The 1990 values were computed by DAS-T Online Version 5.0 using NPSAS:90 data on all undergraduate students attending one institution full time/full year. The 2012 values were computed by NCES PowerStats Version 1.0 using NPSAS:12 data on all undergraduate students attending one institution full time/full year. The equivalent numbers for average tuition and fees available from the Digest of Education Statistics, 2013, are quite similar but do not provide information on tuition and fees net of grants.

[8]As the computation by NCES PowerStats indicates, 59.1% of undergraduates report total grants greater than $0 in the 2011–2012 NPSAS. In 1989–1990, 34.5% of undergraduates report total grants greater than $0 (computation by DAS-T Online Version 5.0).

[9]Economists would not typically include room and board in the cost of education as an individual must pay these expenses whether or not in school.

[10]The 2012 figure is for undergraduates and is based on the percentage of students reporting positive hours worked per week (JOBHOUR2 from NPSAS:12). The 1990 figure is for undergraduates and is based on the percentage of students reporting positive average hours worked per week while enrolled in school (EMWKHR3 from NPSAS:90).

3.2. College Earnings Advantage

There is a well-documented earnings advantage for those who have college experience relative to those who have only a high school diploma or equivalency degree. Using data from the 2013 Current Population Survey (CPS), 22-year-old college graduates earned an average of $33,650 in 2012 compared with average earnings of just under $24,400 for 22-year-old high school graduates (both figures in 2009 US dollars). Furthermore, this gap in earnings grows through the mid- to late forties, peaking at nearly $34,000.[11] We limit our sample to individuals who reported usually working at least 35 hours per week during weeks worked last year and working at least 40 weeks last year so that this earnings advantage is likely driven by higher average wages and salaries; however, some of the difference could be explained by differences in unemployment rates by educational attainment. As of June 2014, high school graduates with no college experience had an unemployment rate of 5.8% compared with 5.0% for individuals with some college or an associate's degree and 3.3% for individuals with at least a bachelor's degree.[12]

3.3. Estimates of the Value of College

Economists and others typically use cross-sectional data to generate naïve estimates of the net value of college. An important assumption inherent to this strategy is that earnings patterns by age or experience within the education category in the future are the same as the patterns existing in the cross section of data used. The researchers then take estimates of future earnings and associated costs of education, calculate their present discounted value (PDV), and subtract the costs from the benefits to get a relatively simple estimate of the potential financial benefits to a college education as described by Equation 1.

Although in principle calculating the net benefit of a college degree is a straightforward exercise, in practice the estimates can vary depending on additional assumptions and the data used. Specifically, one needs to define the number of years over which to sum earnings, choose a discount rate to apply to future earnings and costs (in calculating the net present value), generate estimates of the direct costs of schooling for each year of schooling, and make assumptions about the expected path of future earnings by education level for every year of an individual's working life.

3.3.1. Estimates based on cross-sectional data. **Table 1** presents net benefit estimates of a bachelor's degree relative to a high school diploma or GED using data on 2012 earnings from the 2013 March CPS files combined with National Center for Education Statistics (NCES) data on average tuition and fees for the 2012–2013 school year. We average earnings by age and educational attainment for individuals ages 18–64 and assume that earnings for college graduates are $0 for ages 18–21 (see the **Supplemental Appendix** for more details about how these estimates are derived). Our estimates of the direct costs of four years of college in present value terms range from approximately $47,000 assuming a 5% discount rate to nearly $49,500 assuming a 3% discount rate. Note, however, that these calculations will overestimate the average direct cost to students because they do not take student grant aid into account.

Supplemental Material

The first two rows of **Table 1** present the estimates as described above. The first row applies a 3% discount rate, whereas the second row applies a 5% discount rate. Using a 3% discount rate,

[11]If we use a quadratic in age to fit the difference in average college earnings and average high school earnings for individuals ages 22–64, the maximum fitted value occurs at age 48.

[12]Seasonally adjusted unemployment rates for individuals 25 years and older by educational attainment is from the CPS (July 2014).

Table 1 Naïve estimates of the value of college and the internal rate of return

	Discount rate assumption[a] (%)	Present value of tuition and fees[b] (2009 USD)	Net value of college[c]		Internal rate of return[d]	
			Men (2009 USD)	Women (2009 USD)	Men (%)	Women (%)
Main estimates						
All race/ethnicities, four-year degree	3.0	49,417	444,450	346,232	11.3	11.7
All race/ethnicities, four-year degree	5.0	47,142	235,567	187,314		
Alternative sample						
All race/ethnicities, four-year degree, no full-time/full-year restriction	5.0	47,142	324,482	207,648	16.7	16.3
Alternative educational categories						
All race/ethnicities, two-year degree	5.0	5,825	49,696	58,718	9.2	11.5
All race/ethnicities, at least some college (excluding graduate school)[e]	5.0		185,062	163,577	6.1	6.2
All race/ethnicities, at least some college[f]	5.0		271,189	221,172	8.2	8.4
Estimates by ethnicity (estimated with a Mincer specification)						
All race/ethnicities, four-year degree	5.0	47,142	185,275	135,519	11.0	10.4
Race = "Black only," four-year degree	5.0	47,142	117,902	112,626	9.3	8.8
Race = "White only," four-year degree	5.0	47,142	182,391	129,055	10.8	10.2
Spanish/Hispanic/Latino origin, four-year degree	5.0	47,142	137,127	122,538	10.6	9.8

[a]Discount rate assumption applies to the computation of the present value of tuition and net value of college.
[b]Tuition and fees are the average undergraduate tuition, fees, room, and board charged to full-time students at both public and private institutions provided by the National Center for Education Statistics.
[c]Average lifetime discounted earnings of individuals with a college degree minus average lifetime discounted earnings of individuals with only a high school diploma minus discounted tuition, by sex, using March 2013 Current Population Survey data.
[d]Discount rate needed for the lifetime discounted earnings of an individual with only a high school diploma to equal the discounted earnings of an individual with a college degree minus discounted tuition.
[e]Tuition is weighted between the tuition of the two-year rate for some college and four-year rate for college.
[f]Tuition is weighted between the tuition of the two-year rate for some college, four-year rate for college, and four-year rate for six years for a graduate degree (the cost of a graduate degree is assumed to be at the same annual rate as that of a four-year degree).

we estimate that the overall net benefit of a four-year college degree is approximately \$444,000 for men and \$346,000 for women. The estimates drop by nearly one-half to \$236,000 and \$187,000, respectively, if we use a 5% discount rate. Clearly, estimates are quite sensitive to the choice of interest rate for calculating the PDV of net earnings, making IRR estimates somewhat more appealing. Using these same data, we calculate an IRR of approximately 11% for both men and women. If we instead use all workers, including those who work part time and/or fewer than 40 weeks of the year (which confounds potential differences in preferences and underemployment between education groups), our estimate of the net present value of a four-year degree rises to nearly \$325,000 for men and \$208,000 for women, and the IRRs are around 16% because the PDV of the earnings stream for high school graduates drops by a larger amount than the PDV of the earnings stream (net of tuition) for college graduates.

Many researchers use fitted values to predict earnings for education and age categories to avoid problems with small sample sizes. This is particularly useful for looking at various demographic subgroups for which sample sizes are especially small. In addition, the regression framework allows one to hold demographic characteristics constant over age or time. For estimates in the bottom of **Table 1**, we fit a regression of the natural logarithm of earnings on a constant, age, and age squared for each education group (or demographic-education subgroup) and use the fitted values from this regression as the assumed path for the logarithm of earnings in the future. Using fitted values for log earnings, rather than using average earnings, further reduces our estimates of the net value of a college education to \$185,000 from \$236,000 for men and to \$136,000 from \$187,000 for women. The IRR estimates are slightly smaller using the fitted earnings values at 11% for men and 10% for women.

Table 2 presents net benefit estimates of a bachelor's degree from the literature, which range from \$96,000 to \$1,100,000 (see the **Supplemental Appendix** for even more detail about assumptions used in each study). All estimates have been adjusted to reflect real (2009) US dollars using the personal consumption expenditures chain-type price index. In addition, we list details regarding various assumptions used for the estimates. All but one of these studies relies on data from the March CPS (various years) as the major source of data on earnings for individuals with different levels of education. As a result, differences in estimates across most of these studies will be explained largely by differences in assumptions, although some differences may be attributed to changes in relative earnings or tuition costs over time.[13]

Supplemental Material

The largest estimates of approximately \$1,000,000 (Day & Newburger 2002, Carnevale et al. 2011) are large primarily because they assume a 0% discount rate ($r = 0$) and make no adjustment for the direct costs of schooling in terms of tuition and fees ($c = 0$). Furthermore, these studies ignore the opportunity cost of lost earnings while enrolled in college, as they consider only the earnings for ages 25–64. These assumptions can have relatively large impacts on the level of the estimated value of a four-year college degree. Greenstone & Looney (2011), for example, estimate that the total investment cost for a four-year college degree (tuition plus forgone earnings) is approximately \$102,000 (2009 US dollars), and the PDV of an earnings stream over a 40-year horizon at a 3% discount rate can easily be less than 50% of the value of this same earnings stream if one assumes a discount rate of 0%.[14] As such, these estimates likely overstate the value of a bachelor's degree.

[13]Indeed, our estimates of the net value of a four-year college degree are 33% higher when we use 2008 earnings data and 2008–2009 tuition data (see the **Supplemental Appendix**).

Supplemental Material

[14]For example, the value of \$1 per year from age 25 through age 64 discounted to age 17 with a 3% discount rate is \$18.79 compared with \$40 if one assumes a 0% discount rate.

Erratum

Table 2 Naïve estimates of the value of college relative to high school from the literature

Study	Work life age range (years of age)	Discount rate assumption (%)	Earnings estimation	Sample restrictions	Value of college[a] (2009 USD)	Internal rate of return (%)	Direct cost estimate[a] (2009 USD)
Day & Newburger (2002)[b]	25–64	0.00	5-year age bin averages	Full-time, full-year workers	1,109,618		
Carnevale et al. (2011)[b]	25–64	0.00	5-year age bin medians	Full-time, full-year workers	964,000		
Kantrowitz (2007)[c]	25–64	4.81	10-year age bin averages	Full-time, full-year workers	510,755		
Barrow & Rouse (2005b), estimate A[c]	19–65	5.26	Constant earnings gap	Wage and salary income	338,004		32,025
Barrow & Rouse (2005b), estimate B[c]	19–65	5.26	Averages by age	Wage and salary income	282,050		32,025
Greenstone & Looney (2011)[d]	18–64	5.00	Averages by age	Civilian US citizens, excluding those enrolled in school	468,000	15.2	48,000
Greenstone & Looney (2012)[d]	18–64	5.00	Averages by age		362,012		
Avery & Turner (2012), overall[e]	18–64	3.00	Averages by age	Whites, full-time, full-year workers	417,371		29,005
Avery & Turner (2012), men[e]	18–64	3.00	Averages by age	Whites, full-time, full-year workers	586,628		29,005
Avery & Turner (2012), women[e]	18–64	3.00	Averages by age	Whites, full-time, full-year workers	367,749		29,005

(*Continued*)

Table 2 *(Continued)*

Study	Work life age range (years of age)	Discount rate assumption (%)	Earnings estimation	Sample restrictions	Value of college[a] (2009 USD)	Internal rate of return (%)	Direct cost estimate[a] (2009 USD)
Abel & Deitz (2014)[f]	16–64		Linear regression	Full-time workers		15.0	24,224
Daly & Bengali (2014)[g]	19–67	6.67	Averages by years since graduation[h]	Household heads and partners	95,999		

[a]All published estimates were converted to 2009 US dollars using the chained price index for personal consumption expenditures from the Bureau of Economic Analysis.
[b]Earnings data from the Current Population Survey (various years).
[c]Earnings data from the Current Population Survey (various years). Tuition data from the National Postsecondary Student Aid Study (various years).
[d]Earnings data from the Current Population Survey (various years). Tuition data from the National Center for Education Statistics (various years).
[e]Earnings data from the Current Population Survey (various years). Tuition data for public universities from the College Board (various years).
[f]Earnings data from the Current Population Survey (1970–2013). Tuition data from the College Board (various years) and the National Center for Education Statistics (various years).
[g]Earnings data from the Panel Study of Income Dynamics. Assumes that the net present value of college earnings exceeds the present value of high school graduate earnings 20 years after high school graduation.
[h]Years since graduation plus four for high school graduates. Holds the premium constant from 20 years after high school graduation until retirement at age 67.

Kantrowitz (2007) provides an improvement over the estimates of Day & Newburger (2002) and Carnevale et al. (2011) in that he assumes a positive (4.81%) discount rate. Similar to these studies, however, he considers only earnings for ages 25–64, ignoring the opportunity cost of lost earnings.[15] For the estimate reported in **Table 2**, we net out his estimate of the direct costs to the student of a college degree. Taking account of direct costs and discounting future earnings, Kantrowitz estimates that the net present value of a college degree equals $511,000, roughly one-half the size of the estimates that ignore discounting and direct costs.

Estimates from Barrow & Rouse (2005b), Greenstone & Looney (2011, 2012), and Avery & Turner (2012) are somewhat lower and range from $282,000 to $468,000. The methodology underlying these estimates is similar to the one used for the **Table 1** estimates in that it assumes positive discount rates and takes into consideration the direct costs of college as well as the opportunity cost of attending college in terms of high school graduate earnings. They differ because they use somewhat different assumptions about the path of future earnings and have differences in the restrictions on individuals included in the sample for calculating average earnings. Although these studies also use different sources for information on direct college costs, this does little to explain differences in the estimates of the net present value of a college degree. Barrow & Rouse (2005b) use data on average tuition and fees paid (at all types of institutions) from the 2004 NPSAS; their present value estimate of the cost of four years of college is approximately $32,000 (2009 US dollars). Greenstone & Looney (2011) use data from the NCES on average tuition at public and private four-year institutions (which will be somewhat higher than using all institution types) and estimate that a four-year degree costs $48,000. Avery & Turner (2012) use data from the College Board on average tuition at public universities and estimate that the present value of direct costs is $29,000.[16]

Barrow & Rouse (2005b) use the highest discount rate (5.26%). When they assume a relatively constant earnings difference by education level, they estimate that the net value of a four-year college degree is $338,000 (estimate A in **Table 2**). When they allow earnings by education level to differ by age, their estimate is somewhat lower at $282,000 (estimate B in **Table 2**). Greenstone & Looney (2011, 2012) use a 5% discount rate, and Avery & Turner (2012) use a 3% discount rate, but both use average earnings by education and age. Thus, it is not surprising that Greenstone & Looney's (2012) estimate of a net benefit of $362,000 is smaller than Avery & Turner's (2012) estimate of $417,000. We cannot explain why Greenstone & Looney's (2011) estimate is roughly $100,000 higher than their 2012 estimate, but it seems to be driven by differences in their estimates of the earnings advantage. Based on this higher estimate, Greenstone & Looney (2011) calculate an IRR of 15.2%, which is quite similar to Abel & Deitz's (2014) estimate of 15%, slightly larger than the comparable Heckman et al. (2006a, table 4) estimate for white men in 1990 (including tuition costs not accounting for taxes), and 4.2 percentage points higher than our estimate based on 2012 earnings data.

3.3.2. Estimates based on longitudinal data. Daly & Bengali (2014) use panel data from the Panel Study of Income Dynamics (various years) to generate an estimate of the value of college based on earnings for the same individual over time. Using cohorts of individuals who graduated or would

[15]Kantrowitz (2007) sets averages earnings at each age equal to 10-year age bin averages.

[16]The College Board data are based on the College Board's Annual Survey of Colleges distributed to approximately 4,000 postsecondary institutions. The NPSAS data are based on a survey of a nationally representative sample of postsecondary students attending all types of institutions, and the NCES data for recent years are based on the Integrated Postsecondary Education Data System survey data of more than 7,500 institutions that are mandated to complete the surveys if they participate in federal student financial aid programs.

have graduated from college during the 1990s and 2000s, the authors calculate mean earnings by education group and years since college or high school graduation. The college benefits are the discounted future earnings difference between college and high school graduates, and the costs are the forgone earnings for four years plus the tuition cost. Because the authors do not observe an entire work life for any of these graduates, they make two assumptions about when the present value of earnings minus direct costs for college graduates will just equal the present value of earnings for high school graduates—15 and 20 years after high school graduation—and then solve for the implied cost. If the breakeven point occurs 20 years after high school graduation (age 38) and the discount rate is 6.67% (the average rate on a bond rated AAA over the period 1990–2011), the annual college tuition would equal approximately $20,400 (2009 US dollars). If the breakeven point occurs 15 years after high school graduation, the annual college tuition cost would equal approximately $9,500. Lower discount rates are associated with higher average tuition costs at the same number of years after high school graduation. Any earnings advantage after the breakeven age increases the net present value of the benefit of a college education above zero. Using their estimated earning advantage of $27,525 (2009 US dollars) for every year after the breakeven point at age 38 and a 6.67% discount rate and assuming $T = 49$ (corresponding to age 67), we calculate the net benefit of a four-year college degree discounted to age 18 to be approximately $96,000. The value rises to $157,000 when using a 5% discount rate for the years following the breakeven point.

3.4. Discussion

As illustrated by the estimates presented in **Tables 1** and **2**, naïve estimates of the net value of a college degree can vary quite substantially depending on the underlying assumptions, especially those regarding the discount rate. Although this makes IRR calculation more appealing, one must still choose a benchmark rate of return with which to compare the IRR estimate to determine whether investing in a college degree is more worthwhile than an alternative use of funds. Indeed, some studies have directly compared the return on a college degree with the returns available in the housing market, stock market, or long-term Treasury bills (e.g., Greenstone & Looney 2011, 2012). But once we take this broader asset allocation perspective for evaluating college investment, it becomes necessary to examine the correlation between the earnings premium associated with college and other components of an individual's asset portfolio as well. For low-income students who are unlikely to hold additional assets, evaluating the college investment is substantially more straightforward because we can ignore the potential for correlated risks. However, even in this simple case, the comparison of a risky college investment with stock market returns and Treasury bills can be misleading without explicit consideration of whether these alternative investments have similar levels of risk to investing in a college degree.

However, even if the IRR of a college degree exceeds the rate of return on other similarly risky investments, educational investments are more limited in scale than many financial investments (e.g., people are likely to face diminishing returns to investing in multiple undergraduate degrees, whereas people can double their stock market investment without affecting their expected return), so IRR calculations alone are not always sufficient to determine the best investment choice. When comparing across different educational investments (e.g., two-year college versus four-year college degrees or four-year college versus graduate degrees), it remains more informative to compare the net present value under alternative discount rates.

Importantly, all of these estimates reflect only pecuniary benefits and costs of a college degree, and they do not take into account the endogeneity in the decision to attend college. These issues are not straightforward to address, and we discuss them in the subsequent two sections. Moreover, the use of cross-sectional regressions to estimate returns assumes that current earnings are a good approximation for earnings in the future. Although this is unlikely to hold, it may be the best estimate available to individuals and researchers alike. However, given the availability of tuition data and information on forgone earnings, there seems to be no justifiable reason to omit the direct and indirect costs of college from these naïve calculations of college returns. We suggest that those making the net present value and IRR calculations try to incorporate as much information as possible.

4. CAUSAL ESTIMATES OF PECUNIARY BENEFITS

In the previous section, we present calculations for the net present value and IRR to college based on naïve estimates of the earnings benefits from attending college that do not account for potential selection into college. If those individuals who decide to attend college have different characteristics from those who do not attend, and these characteristics also independently affect earnings, any estimate of the return to college that does not account for differences in these characteristics will be biased. Researchers have typically discussed these differences in terms of unobserved ability, so we continue with that terminology, but it is important to remember that ability can represent any unobserved characteristic that affects both earnings and schooling.

The standard presentation of the potential bias resulting from unobserved ability can be shown in the context of a simplified Mincer regression model in which log earnings are a linear function of schooling and ability, abstracting from experience and other covariates:

$$\ln Y_i = \alpha_0 + \beta s_i + \alpha_i + \upsilon_i,$$

where Y_i represents earnings of individual i, s_i represents schooling, α_i represents unobserved ability, and υ_i represents all other unobserved characteristics that are assumed to be uncorrelated with s_i, such that the error term is $\acute{\varepsilon}_i = \alpha_i + \upsilon_i$.[17] If unobserved ability is (positively) correlated with both schooling and subsequent earnings, then ordinary least squares (OLS) estimates of β_1 that do not adjust for ability will be biased (upward) because individuals who go to college have higher ability and therefore would have earned more, even if not for college.[18]

To the extent that ability is correlated with differences in the discount rate or the (nonpecuniary) costs of schooling, it can simply be represented by the unobserved intercept term α_i. This is because the discount rate and costs of schooling should not affect the growth rate of earnings with schooling, even if they affect the optimal choice of schooling. However, if ability also affects the returns to schooling, this heterogeneity would imply a random coefficient for schooling β_i that differs across individuals:

$$\ln Y_i = \alpha_0 + \beta_i s_i + \alpha_i + \upsilon_i = \alpha_0 + \overline{\beta} s_i + \alpha_i + \left(\beta_i - \overline{\beta}\right) s_i + \upsilon_i,$$

where $\overline{\beta} = E(\beta_i)$ is defined as the mean impact of schooling on earnings across individuals, and the error term is now $\acute{\varepsilon}_i = \alpha_i + \left(\beta_i - \overline{\beta}\right) s_i + \upsilon_i$. Estimates of this mean impact may now be biased because of either a correlation between α_i and s_i or a correlation between β_i and s_i.

Economists have tried to address the problem of selection into college with a variety of empirical techniques. Previous surveys by Rosen (1977), Willis (1986), and Card (1999, 2001)

[17]Note that schooling s_i can be defined as a binary indicator taking a value of 1 for college and 0 otherwise.

[18]If we allow for the possibility that ability is not merely a one-dimensional characteristic and that some individuals may have certain abilities that are better matched to a high school education than college, it is no longer obvious that naïve estimates of the impact of college will always be upward biased (Willis & Rosen 1979).

provide useful summaries of the state of the literature at successive points in time, although they also consider returns to other margins of schooling. Oreopoulos & Petronijevic (2013) offer a more recent review that is focused on the returns to a college education. We include a cursory discussion of some of the studies included in previous surveys for completeness while focusing on a smaller selection of recent studies based on data from the United States. Initially, we retain the simple econometric framework and ignore the possibility of heterogeneity in returns to schooling. It is important to note that almost all of these studies utilize standard Mincer regression models that do not account for pecuniary and nonpecuniary costs of schooling. Therefore, as discussed in Section 2, the resulting estimates do not necessarily recover the IRR to college but only the effect of college on the growth rate of earnings.

4.1. Proxies for Ability

The most straightforward approach to try to address the potential for bias from ability is to include a proxy for ability in a regression of earnings on college:

$$\ln Y_i = \alpha_0 + \beta s_i + A_i + \epsilon_i,$$

where A_i is a proxy for unobserved ability α_i. The main challenge in implementing this approach is finding data sets with plausible proxies for ability. Kane & Rouse (1995) apply this method using the National Longitudinal Survey of the High School Class of 1972 (NLS-72) and the National Longitudinal Survey of Youth 1979 (NLSY-79). Controlling for measures of ability based on standardized tests and family background in the NLS-72, they find that men and women earn approximately 4.6% and 6.2% higher hourly wages, respectively, per additional credit year from a four-year college, approximately 14 years after graduating high school. These estimates are lower than those from regressions that do not include controls for ability and other background characteristics (at 6% and 7.7% for men and women, respectively), which is consistent with the presumption of upward bias in naïve regression estimates. They are also lower than the estimates associated with annual earnings that incorporate differences in labor supply by education. However, these estimates are fairly similar to estimates of the value of each additional credit year at a two-year college.

Castex & Dechter (2014) provide a more recent application of this approach using the NLSY-79 and NLSY-97 samples to show that the returns to education increased between the 1980s and the 2000s. Estimates based on years of schooling are 9.3% per year for men in the 2000s and 7.1% per year for men in the 1980s, whereas corresponding estimates for women are 10% in the 2000s and 8.1% in the 1980s. As in Kane & Rouse (1995), estimates that do not include controls for ability are consistent with the presumption of a positive ability bias, but the size of the bias has declined over time.

Obviously, the main issue with this approach is the strong likelihood that these proxies for ability do not capture all the relevant unobserved factors that could lead to biased estimates. It is tempting to conclude that adjusting for the available measures of ability would bring us closer to the true causal effect of college. However, there are at least two reasons why this may not be the case: (*a*) The upward bias due to unobserved ability may be counteracting some attenuation bias due to classical measurement error, and (*b*) if there are different components of unobserved ability causing bias in different directions, controlling for only a subset of these components may lead to more bias from the remaining unobserved components. As a result, this approach may not fully address the possibility of bias due to unobserved ability or other unobserved characteristics.

4.2. Twin Comparisons

Another approach for trying to deal with the potential bias resulting from unobserved ability is to make use of twin (or sibling) samples. Insofar as monozygotic twins share almost identical genetic characteristics and similar family backgrounds, researchers have tried to difference out the common unobserved ability across twins. These analyses can be implemented either as first-difference regressions in which differences in earnings are regressed on differences in schooling levels between twins or by the inclusion of twin-pair fixed effects in standard regressions of earnings on schooling. For example, consider the following differenced regression:

$$\ln Y_{1p} - \ln Y_{2p} = \beta(s_{1p} - s_{2p}) + (\alpha_{1p} - \alpha_{2p}) + (v_{1p} - v_{2p}),$$

where Y_{1p} and Y_{2p} represent outcomes for twins 1 and 2 of pair p, and the other variables are defined similarly. If we assume that unobserved ability is identical across twins, so that $\alpha_{1p} = \alpha_{2p} = \alpha_p$, then the ability terms in the differenced equations drop out, and our estimates of β will be consistent (assuming no heterogeneity in the effect of college or no selection into college based on expected gains).

Perhaps the best-known study to employ this technique is by Ashenfelter & Krueger (1994). They collect data on the educational attainment and earnings for 149 sets of twins attending a 1991 festival in Twinsburg, Ohio. Although they focus on the impact of schooling more generally, most of the variation in the sample spans the college years. Their differences estimate suggests that an additional year of schooling raised hourly wages by 9.2%, which is slightly higher than the corresponding OLS estimate of 8.4%. However, these estimates become substantially larger (at 11.6% and 16.7% for the cross-sectional and first-difference estimates, respectively) after adjusting for measurement error using reports from one twin as an instrumental variable (IV) for the other's self-report. However, in two follow-up studies using additional rounds of data collection, Ashenfelter & Rouse (1998) and Rouse (1999) estimate that one year of education difference between twins led to 7.5% higher wages (9.5% higher wages after correcting for measurement error), which was smaller than the corresponding OLS estimate of 10.5%.

There are several potential issues arising from this approach for estimating the impact of college on earnings, which were originally raised by Griliches (1979). The fundamental question is why, if twins are so alike, they end up receiving different levels of schooling. Although there may be random shocks leading to differences in education, such differences may also be explained by individual differences in motivation, talents, and other underlying characteristics. Therefore, it may not be sufficient to control for common unobserved family factors, which may even exacerbate bias; this argument is developed more fully by Bound & Solon (1999). Furthermore, as formalized by Behrman et al. (1982), it is possible that twins experience different family environments, despite sharing the same parents and the same home if small differences between twins lead parents to either compensate for or direct fewer resources to the twin with the lower endowment. Finally, if small differences in ability between twins remain, correcting for measurement error using IV methods can also exacerbate bias (Neumark 1999).

4.3. Instrumental Variables

The use of IVs to identify the effect of schooling on earnings and other outcomes is not a recent innovation. One needs a variable Z that is correlated with schooling s but not correlated with unobserved ability α_i. Then one can run the following regression to generate consistent estimates of the causal effect of schooling on earnings:

$$\ln Y_i = \alpha_0 + \beta_1 \hat{s}_i + \alpha_i + \upsilon_i,$$

where $\hat{s}_i$ is the predicted value of schooling from the regression $s_i = \gamma_0 + \gamma_1 Z_i + \vartheta_i$. Whereas early research tended to use IVs based on family background characteristics (e.g., parental education, occupation, experience, religion, and number of siblings), later studies have tried to use more exogenous variables that are derived from institutional or geographic features of the school system.

A prominent example of such research is provided by Card (1995), who uses an indicator for the presence of a four-year college as an instrument for estimating the effect of college on earnings with data from the NLSY-79. The IV estimates indicate that an additional year of college leads to 12–14% higher hourly wages by ages 24–34, which is higher than the OLS estimates that suggest an increase of only 7–8%. Because of concerns that the presence of a nearby college may be correlated with unobserved characteristics associated with higher earnings, Card also considers an alternative IV constructed from the interaction of family background and the presence of a nearby college. The estimates from this alternative instrument are somewhat lower, 9–10% higher wages per additional year of college.

In addition to IV estimates based on the distance to (or presence of) a nearby college, several studies have tried to exploit the sharp increase in educational attainment due to draft avoidance during the Vietnam War (see Angrist & Krueger 1992, 1995, and some of the ancillary estimates in Buckles et al. 2013).[19] Other studies have used local labor market conditions, such as earnings and unemployment rates for individuals at age 17, as instruments for a college education (Cameron & Heckman 1998, Cameron & Taber 2004). The main concern with all of these studies relates to the critical assumption that the instrument is not itself correlated with ability or any other unobserved characteristics that affect earnings. This assumption is generally not testable, and it is often possible to come up with plausible reasons for why it might be violated, even in cases in which it is based on institutional or geographic features of the college system. Moreover, if these IVs are correlated with any relevant unobserved characteristics, the bias can be even larger than in the OLS. The other limitation of IV estimates arises when there is individual heterogeneity in the effect of college on earnings. In this case, the estimates generated need to be interpreted with caution, as they correspond to a local average treatment effect, which is relevant only for the types of individuals who are induced by the instrument to receive more schooling (Imbens & Angrist 1994). We return to this issue of interpretation later in the section.

4.4. Regression Discontinuity

The final approach we discuss uses regression discontinuity (RD) estimates of the impact of college on earnings, which exploit discontinuities in the likelihood of attending college due to specific admission rules for college. The intuition underlying this empirical strategy is to compare individuals just above and below the admission threshold having very similar observed and unobserved characteristics but different probabilities of attaining a college education. This strategy is closely related to the IV approach using institutional features of the school system. Indeed, when implementing this strategy, researchers use the discontinuity as an IV that generates exogenous variation after controlling for a flexible function of the underlying variable that determines assignment (see Imbens & Lemieux 2008 and Lee & Lemieux 2010 for more formal presentations of the RD design).

[19]Angrist & Chen (2011) also estimate the return to a year of college by instrumenting for schooling using draft eligibility but interpret this as the effect of the GI Bill rather than draft avoidance.

Zimmerman (2014) uses an RD design based on the GPA threshold for admission to Florida International University (FIU), which served as the campus of last resort for many students applying to Florida's state university system. He finds that admission into FIU resulted in 22% higher earnings in the 8–14 years following high school graduation for those who just made the FIU GPA threshold relative to those who just missed the admissions cutoff. Unfortunately, it is not straightforward to calculate the effect of an additional year of college because many of those who just miss the threshold do get some college experience by enrolling in a community college. Zimmerman estimates that one year of college at FIU leads to 11% higher earnings if there are no returns to community college. If we instead assume that additional earnings from a year at community college and a year at FIU are similar, as in Kane & Rouse (1995), the boost in earnings of one year of college would be approximately 18% (based on our calculations that attribute the difference in earnings above and below the threshold entirely to the difference in the average years of college enrollment). Thus, it may be reasonable to suppose that the actual effect is somewhere between 11% and 18%.[20]

In our view, these estimates are likely to be the most credible ones currently available in the literature. The validity of the RD design depends on the assumption that all observable and unobservable characteristics that affect earnings (apart from the treatment of gaining admission to college) are continuous around the cutoff. This seems plausible given that the admission threshold was not known to students and therefore difficult to manipulate. Zimmerman (2014) conducts a number of specification tests to show that the frequency density, the likelihood of observing individuals in the earnings sample, and a number of observable characteristics are continuous around the threshold. However, as with IV estimates, the estimates that emerge from the RD design need to be interpreted with care because they may be relevant only for individuals around the discontinuity who are induced to enter college. In Zimmerman's study, for example, the identification applies to students on the margin of attending a four-year college, and not necessarily for the average individual attending college.

4.5. Discussion

The estimated effects of college on wages and earnings vary widely across studies and across different specifications within studies, with relatively larger magnitudes for the IV and RD estimates than for the OLS estimates. Yet almost all the estimates indicate a positive and significant effect. This suggests that there may indeed be a causal relationship between a college education and labor market earnings. However, in the absence of a true experiment, there are always concerns about the validity of the identification strategies used. There are also fairly large standard errors associated with the estimates derived from both the IV and RD designs, raising the possibility that this sample of estimates reflects publication bias (Ashenfelter et al. 1999) and that the true impacts of college on earnings are smaller.

Furthermore, as mentioned above, both the IV and RD estimates correspond to a local average treatment effect when there is heterogeneity in the returns to education. The model of endogenous schooling derived in Section 2 suggests that individuals on the margin of attending college would indeed have higher marginal returns than those already attending college if these schooling differences are driven by differences in the discount rate or by other constraints on the cost side.[21]

[20]In personal communication, Zimmerman notes that he estimates the OLS returns to a year of attendance at FIU at 10–11% compared to 3–4% for community college. This suggests a point estimate near the middle of the range.

[21]Of course, the model also suggests that individuals on the margin of attending college would have (weakly) lower marginal returns than those already attending college if these schooling differences were driven by ability differences.

Thus, if credit constraints prevent individuals with higher potential returns to schooling from attending college and if these individuals are induced to attend college as a result of the instrument, IV and RD estimates would be expected to be higher than OLS estimates. This explanation has, however, been challenged by Carneiro & Heckman (2002), who argue that IV estimates may exceed OLS estimates because of negative selection bias that arises from comparative advantage in a model with multiple dimensions of skills (or simply because of invalid instruments).

In more recent work, Carneiro et al. (2011) employ a marginal treatment effects framework to further explore the heterogeneity of marginal returns to education. They estimate the impact of schooling on hourly wages in the NLSY-79 using many IVs from prior studies, including the presence of a nearby college, tuition costs, and local labor market conditions. But they are also able to simulate the impact of policies that induce expansions in college attendance on margins that differ from those of the instruments themselves. In contrast to many IV estimates from the literature, they find that some hypothetical policies that expand college access among a broad range of individuals may yield very small marginal returns. If we put aside questions about the credibility of these IVs, this analysis suggests that certain individuals have negative returns to schooling and would not benefit from attending college.

An important insight from this discussion is that under heterogeneous treatment impacts, different instruments affect different students on the margin of attending college and may therefore be relevant for different policies. It is instructive to compare the interpretation of the estimates derived using Card's (1995) IV approach and Zimmerman's (2014) RD design. In the case of distance to college, the estimated impact on earnings of attending college is derived from students who are especially sensitive to college proximity and thereby induced to attend college simply because they live near one. In the RD design, the estimated impact on earnings of attending a four-year college is derived from comparing students who do or do not gain entrance because of their high school grades. As a consequence, these two alternative estimates may be relevant for different types of policy levers: the distance to college estimates for a policy of constructing new colleges and the RD estimates for a policy of relaxing the entry thresholds for colleges (although, eventually, relaxing these thresholds may require the expansion of existing colleges or the construction of new colleges).

Overall, the scarcity of credible evidence regarding the causal effect of college on earnings is striking given the voluminous literature on the returns to schooling more generally. Whereas studies focused on the high school margin have been able to take advantage of compulsory schooling laws and school construction as plausible IVs, there have been far fewer opportunities to leverage exogenous variation at the college margin. Zimmerman (2014) provides one approach that could be replicated in other contexts by searching for more discontinuities in the admission thresholds for students on the margin of attending college. This would also provide valuable information about whether the RD estimates from Florida generalize to other settings. However, the open-access nature of the community college system in the United States is likely to limit the ability of researchers to identify impacts of community college on earnings using this type of strategy. Thus, it would also be useful to exploit some of the recent experimental studies that appear to affect college enrollment and persistence and that are perhaps more likely to pertain to community college students who might otherwise not attain any college experience. These include studies that randomize assistance or reminders for filling out the FAFSA (Free Application for Federal Student Aid) forms (Bettinger et al. 2012, Castleman & Page 2015), providing financial aid (Harris & Goldrick-Rab 2012), or offering college counseling for disadvantaged high school students (Avery 2010, Chin et al. 2015). By collecting data on study participants as they enter the labor market, one could possibly utilize the experimental variation in going to college as a first stage to estimate the causal effect of college on earnings.

5. NONPECUNIARY CONSIDERATIONS

The analysis of returns to college in Sections 3 and 4 focuses solely on pecuniary factors. But the potential benefits from college are not limited to pecuniary factors alone. College may affect a myriad of nonpecuniary factors, such health, marriage, crime, and child outcomes, as well as consumption, savings, and migration behavior. In addition, as discussed in Section 2, attending college may result in nonpecuniary costs due to the disutility of school versus work.[22] Incorporating these nonpecuniary considerations could substantially alter the calculation of the overall returns to college. For example, Haveman & Wolfe (1984) conduct a rough marginal willingness-to-pay calculation that suggests that adding nonmarket effects could roughly double the estimated returns to education.

Estimating the impact of attending college on nonpecuniary costs and benefits is also subject to the problem of selection. Furthermore, these types of calculations are complicated by the fact that income could serve as an important mechanism for generating nonpecuniary benefits. If so, there is a danger of double-counting the pecuniary and nonpecuniary benefits. Simply controlling for income in regressions of nonpecuniary factors on schooling introduces potential bias because less educated individuals with higher income are likely to differ on unobservable characteristics from their more educated counterparts. As a result, it is extremely difficult to separate the income mechanism from other independent mechanisms leading to nonpecuniary benefits.

Recent surveys of nonpecuniary impacts of education include those by Grossman (2006) and Oreopoulos & Salvanes (2011), but these two papers are not exclusively focused on the college margin. We focus on the impact of a college education on health and intergenerational outcomes because these outcomes include studies that make serious attempts to address the selection problem. We also discuss the possibility of nonpecuniary costs of schooling.

5.1. Health Benefits

College education is highly correlated with subsequent health outcomes. For example, in 2007, the age-adjusted mortality rate of high school graduates ages 25–64 was more than twice as large as the mortality rate of those with some college or a college degree (Xu et al. 2010). Cutler & Lleras-Muney (2008) also document this positive education gradient for self-reported health status and health behaviors using data from the National Health Interview Surveys. They calculate that their estimates of health benefits serve to increase the total returns to education by 15–55%. One approach for addressing the selection problem takes advantage of draft avoidance behavior during the Vietnam War while accounting for the effects on health associated with veteran status. Card & Lemieux (2001a,b) document the excess educational attainment among cohorts of men induced to enter college in order to avoid conscription. Buckles et al. (2013) build on this observation and use within-cohort variation in induction risk to evaluate the impact of college completion on mortality. They use data from the Vital Statistics Mortality Files from 1981 through 2007 collapsed to the birth state and birth year level. They calculate OLS estimates showing that a cohort with 100% college completion is associated with 102 fewer deaths by 2007 per 1,000 persons compared with a cohort with no one completing college. Given that the mortality rate for noncollege graduates over this period is 171.5 per 1,000 persons, this represents a decrease of almost 60%. Their IV estimates indicate an effect that ranges from 93 to 172 fewer deaths per 1,000 persons, with the preferred specification yielding a magnitude quite similar to the OLS estimate.

[22]It is possible that nonpecuniary costs during periods of schooling are negative if there are consumption benefits to attending college (Lazear 1977). Moreover, there may be nonpecuniary costs to college after schooling is completed given that certain occupations are associated with greater stress.

5.2. Intergenerational Benefits

The effects of college education may also extend to individuals in the next generation. For example, there is consistent evidence of a strong correlation in educational attainment between parents and children and for a positive effect of maternal education on infant and child health. Currie & Moretti (2003) extend Card's (1995) IV strategy by using the construction of new colleges as an instrument to estimate the intergenerational effects of attending college on children's outcomes. This strategy enables Currie & Moretti to compare the outcomes of children whose mothers received less education because they were born too early to benefit from a new college opening with the outcomes of children whose mothers were born in the same county (and who gave birth in the same year) but did benefit from the opportunities afforded by a new college opening. Based on data on birth outcomes from Vital Statistics data, they find that higher maternal education improves infant health, as measured by birth weight and gestational age, with IV estimates that are approximately twice the magnitude of the OLS estimates. There is also evidence that college education increases the probability that new mothers are married and get prenatal care and reduces the probability of smoking during pregnancy. Whereas Currie & Moretti focus on these additional factors as potential mechanisms for explaining infant health, these impacts on infant health may also be important outcomes in their own right when calculating the full returns to college.

5.3. Other Nonpecuniary Benefits

There are certainly other important nonpecuniary outcomes affected by college. These include improvements in consumption, savings, and migration behavior in ways that increase the overall returns to college. Such improvements can lead to greater allocative efficiency, which enables individuals or households to choose a better mix of inputs in trying to maximize production (Grossman 2006). For example, Wozniak (2010) shows that college graduates are more responsive to distant labor market opportunities, and Malamud & Wozniak (2012) confirm that the migration advantage of college graduates reflects a causal relationship using the same draft avoidance IV strategy as in Buckles et al. (2013). College education may also impact happiness and other feelings of well-being, either directly or through these improvements in allocative efficiency. Unfortunately, most research examining these outcomes does not focus specifically on the college margin and has not succeeded in addressing the challenges of selection bias. For other surveys summarizing the impact of education on nonpecuniary outcomes, readers are referred to Haveman & Wolfe (1984), Cohn & Geske (1992), and Oreopoulos & Salvanes (2011).

5.4. Nonpecuniary Costs

The utility framework of Section 2 introduced the possibility of nonpecuniary costs of schooling, also characterized as the disutility of school versus work. Most often, the presence of nonpecuniary costs is invoked as an explanation for why many students do not attend college, despite the high pecuniary and nonpecuniary benefits. If students do not have sufficient information about their nonpecuniary costs until they enroll in college, this may also explain why students drop out of college (although dropping out may happen because of the arrival of new information about expected returns).[23] However, these ad hoc explanations are not entirely convincing without direct

[23]The decision to drop out of college has been formalized by Manski (1989) and Stange (2012), among others. Bound et al. (2010) show that college completion rates differ widely across institutions.

evidence on nonpecuniary costs. Unfortunately, there is relatively little empirical work directly examining the nature and importance of nonpecuniary costs. This paucity likely results from the intrinsic difficulty of measuring nonpecuniary costs, which may be associated with attitudes toward risk, time preference, or leisure preferences. They may also result from behavioral biases and errors in forecasting future benefits. Heckman et al. (2006b) show that certain cognitive and noncognitive skills, which can be related to risk, time, and leisure preferences, can explain schooling decisions. There is related work suggesting that large differentials in noncognitive skills by gender may explain why women are attending college in much greater numbers than are men, as well as work showing that small decreases in the cost of applying to college can have large impacts on enrollment rates (see Jacob 2002 for evidence on noncognitive skills by gender and Goldin et al. 2006 and Becker et al. 2010 regarding their role in explaining gender differences in college attainment; see Pallais 2015 and Bettinger et al. 2012 for two experimental studies that generate large impacts on college enrollment with seemingly small decreases in application costs).

5.5. Discussion

Many open questions remain about the potential for nonpecuniary costs and benefits of a college education. As with our current state of knowledge on pecuniary benefits in the labor market, there are relatively few credible studies establishing a strong causal relationship between college and nonpecuniary benefits. Existing work suggests that such nonpecuniary benefits may represent a substantial fraction of the pecuniary ones and therefore calls for further research. It may well be possible to collect additional information on the individuals in Zimmerman's (2014) RD sample to estimate impacts on health and other nonpecuniary outcomes. Similarly, researchers should explore the possibility of collecting broader outcomes for the subjects of the experimental studies described at the end of Section 4.5. Of course, it will still be necessary to account for the income channel in explaining how college affects these nonpecuniary outcomes so as not to double count the benefits. Finally, it is no trivial matter to monetize the nonpecuniary benefits in order to incorporate them into the overall benefit-costs calculation of a college education. The questions associated with the nonpecuniary costs of college are even more fundamental. We need to know more about what these costs are, how they arise, and how they can be overcome. This research is critical for understanding why it is that young individuals, and especially young men, do not respond to the large estimated returns of a college education.

6. HETEROGENEITY IN THE VALUE OF A COLLEGE EDUCATION

As we note in Section 1, perhaps the most interesting question regarding the value of college is not whether a college degree is worthwhile on average but for whom it is worthwhile. We begin by looking at how the benefits of college differ by individual characteristics and then consider how the benefits of college differ by schooling choices such as college quality and college major.

6.1. Demographic Characteristics and the Value of College

Over the years, researchers have attempted to evaluate whether the relationship between schooling and earnings varies systematically by demographic characteristics such as race, sex, and family background. Kane & Rouse (1995) and Castex & Dechter (2014), for example, estimate that the returns to schooling are higher for women than they are for men by one or two percentage points. **Table 1** presents our own estimates of the net benefits of a four-year college degree and IRRs by sex and race/ethnicity, and **Table 2** provides estimates for men and women separately from Avery &

Turner (2012). For estimates using a 5% discount rate, we find that the net benefit of a four-year college degree is approximately $50,000 higher for men than for women. In addition, our overall IRR estimates are quite similar for men and women, at 11.3 and 11.7, respectively, using average earnings by age. In contrast, Avery & Turner (2012), who limit their sample to whites only, estimate a much larger gap of nearly $220,000 in the net benefit of college between men and women both because they use a smaller discount rate and because they use 2008 earnings data.[24]

Barrow & Rouse (2005a) estimate the relationship between years of schooling and wages by race/ethnicity using data from the NLSY-79. Their main concerns are about systematic differences by race in ability bias and measurement error problems; they are not primarily focused on the value of a college education. Using a sibling sample from the NLSY-79, they find somewhat larger point estimates of the relationship between years of schooling and log wages among African Americans than among nonminority individuals (7–13% versus 5–9%), but the differences are not statistically significant. They also find some evidence that measurement error and selection bias may differ by race and ethnicity but conclude that the increase in wages associated from an additional year of schooling is no different for African Americans or Hispanics than for others.

The bottom section of **Table 1** presents naïve estimates of the present values and IRRs associated with a four-year college degree by sex and race/ethnicity groups. Estimates of the value of college are somewhat higher for whites than for blacks or Hispanics. In particular, the estimates of the net benefit of a four-year degree are $118,000 for black men and $182,000 for white men, with associated IRRs of 9.3% and 10.8%, respectively. This is in contrast to Heckman et al. (2006a), who find higher IRRs estimates for black men than for white men using data from the 1990 US Census, and to Barrow & Rouse (2005a), who find similar estimates of the relationship between wages and schooling for minority and nonminority individuals. Note that our estimates of the net value of a four-year degree for black or Hispanic men and women may be understated relative to whites if selection into work differs by race (Neal 2006).

Finally, Altonji & Dunn (1996) and Ashenfelter & Rouse (1998) examine whether the relationship between years of schooling and wages differs systematically by parental education. Altonji & Dunn (1996) use a sibling sample and ability measures to address ability bias, whereas Ashenfelter & Rouse (1998) use a twins sample with multiple measures of schooling and a three-stage, least-squares IV strategy to address ability bias and measurement error issues. Taking parental education as a proxy for socioeconomic status or family ability, Altonji & Dunn (1996) conclude that the benefits of schooling may be lower for students coming from low–socioeconomic status families, although their evidence is somewhat mixed. In contrast, Ashenfelter & Rouse (1998) find that although individuals from more advantaged backgrounds may invest in more education, they may also receive a somewhat lower marginal benefit. In many ways, this work analyzing the heterogeneity in returns by demographic characteristics is complementary to Heckman's marginal treatment effects estimates based on the distribution of unobservables.

6.2. Two-Year Versus Four-Year College Degrees

Average or median earnings among individuals who hold two-year college degrees are lower than those among individuals who hold four-year college degrees, but the direct and indirect costs for attending a two-year college are also substantially lower than those for attending a four-year college. As discussed in Section 4, Kane & Rouse (1995) estimate that the increase in wages associated with an additional year of college credit from a two-year college is similar to the

[24]We estimate a net benefit gap of $260,000 using 2009 CPS data and a 3% discount rate (see the **Supplemental Appendix**).

estimated increase from a year of college credit from a four-year college. The fourth row of **Table 1** presents estimates of the net value and IRR of a two-year college degree relative to a high school diploma. Whereas the net present value of a two-year college degree is less than one-half the net present value of a four-year college degree, the IRRs for men and women are between 9% and 12%. Thus, a two-year college degree appears to be a good investment, but to the extent that one cannot repeatedly invest in multiple two-year degrees and expect no diminishing returns, a four-year degree is an even better investment. This is consistent with the findings of Heckman et al. (2006a) using 1990 US Census data.

6.3. College Quality

There is a fairly extensive academic literature examining the effect of college quality on earnings, although the findings are not conclusive. Hoxby (1998) calculates the returns to attending a selective college after controlling for aptitude and finds that it has increased over time.[25] Black & Smith (2004) extend this approach using matching techniques and find positive but imprecise estimates for the effect of college quality on earnings using data from the NLSY-79. Behrman et al. (1996) compare across 940 female twin pairs from the Minnesota Twin Registry and find that PhD-granting private universities with well-paid senior faculty and smaller enrollments produce students who have significantly higher earnings later in life. Brewer et al. (1999) use NLS-72 and High School and Beyond data to explicitly model the decision to attend college and apply a Heckman (1979) selection correction to adjust their estimated impacts of college selectivity on later earnings. Using a measure of net costs to help identify the effect of college quality on earnings over time, they find that the effect of college quality increased over time, even after correcting for selection. Hoekstra (2009) employs an RD design to estimate a large positive impact on earnings of attending a large flagship state university, approximately 20% for ages 28–33. Although this study has a compelling design, the findings are somewhat difficult to interpret because there is little information about the educational experiences of those who do not attend the flagship university.

In addition to these standard empirical approaches, Dale & Krueger (2002, 2014) propose a strategy to attempt to account for at least some portion of the selection on unobservables using College and Beyond data collected from a set of highly selective colleges. They compare across students who are admitted and rejected from the same set of colleges and thus control for some of the unobserved factors (to the researcher) used to determine admission into different colleges. Dale & Krueger (2002, 2014) find that attending a more selective college leads to higher earnings only for certain subgroups: black and Hispanic students and students from low-income families. However, an important concern with this strategy is that these estimates will remain biased by the other unobservable factors that determine which college is chosen by the students.[26]

Finally, Deming et al. (2014) and Darolia et al. (2014) use résumé field experiments to study the value of postsecondary experience/degrees from for-profit institutions. Neither study finds statistically significant callback rates by institution type for jobs that do not require a bachelor's degree. In fact, neither study finds an advantage in callback rates for résumés reporting a post-secondary degree relative to those reporting only a high school diploma. In contrast, when limited to job postings that require a bachelor's degree, Deming et al. (2014) find that résumés with

[25]In a related paper, Hoxby (2009) also shows that the stakes associated with choosing a college are greater now than in the past because selective colleges are offering very large per student resources and per student subsidies.

[26]Long (2008) uses data from the National Education Longitudinal Study of 1992 high school graduates and also finds positive OLS estimates, but the results are not robust to alternative estimation strategies.

a bachelor's degree in business from a for-profit online institution are 22% less likely to receive a callback than those with a bachelor's degree in business from a nonselective public institution (although they find no difference in callback rates between degrees from selective and nonselective institutions). These results are suggestive of perceived lower college quality at the bachelor's degree level for for-profit institutions and of no value to levels of college experience below the baccalaureate level.

6.4. College Majors

There is substantial evidence pointing to differences in average earnings across college majors (e.g., Carnevale et al. 2011, Kinsler & Pavan 2015). However, the literature seeking to estimate the causal impact of college majors on earnings has not made much progress in addressing the challenge posed by selection. Several studies have included controls for academic achievement and family background and found that large differences in earnings across college majors remain. For example, in looking at whether changes in the composition of college majors over time can explain the growth of the college wage premium, Grogger & Eide (1995) document large differences in earnings between college majors in the High School and Beyond data. More recently, Hamermesh & Donald (2008) include detailed controls for prior academic achievement, address the issue of survey nonresponse, and also show large differentials in earnings between college majors for a large public university. Finally, Arcidiacono (2004) develops a dynamic structural model to estimate the relative impacts of different college majors on earnings and documents substantial earning differentials by major.

Given that many of these papers have already been surveyed by Altonji et al. (2012) in this journal, we do not expand on them further here. However, we use data from the 2010–2012 American Community Survey to estimate the net present values and IRRs of different college majors. For each major, we assume that average high school earnings are the appropriate counterfactual.[27] The first row of **Table 3** reports the net present values of a bachelor's degree (in any field) as well as our estimates of the IRR separately by men and women to compare these estimates with those using data from the 2013 CPS. Compared with estimates using CPS data (reported in the bottom section of **Table 1**), our estimates of the net benefit of a college degree are a little higher in net present value terms, whereas the IRR estimates are very similar. The other rows in **Table 3** present these same estimates for broad college major categories. Not surprisingly, the net present values and estimated IRRs are highest for computer/information sciences, engineering, and math majors. No majors have negative net values, but education majors have the lowest estimated IRRs of 5.5% for men and 7.6% for women. Estimated IRRs for men majoring in the life sciences and humanities are also below 10%, whereas the next lowest IRR estimate for women is for general studies majors, whose IRR is 9.6%.[28]

Relative to the average earnings of high school graduates and common direct costs of college, there is clearly a wide range of estimates of the value of college depending on the bachelor's degree field. We believe this range may be somewhat overstated to the extent that average high school earnings are an underestimate of counterfactual earnings for individuals who major in higher

[27]One might instead think that individuals who major in relatively low-paying fields would also choose occupations that also pay below average for high school graduates. For example, perhaps education majors would have elected to become child care workers if they had not gone to college.

[28]If we use the more detailed information in the general study area, we run into some problems of very few observations for some combinations of degree, major, and sex. However, we do find negative net values associated with certain majors (e.g., theology and religious vocations).

Table 3 Naïve estimates of the value of college and internal rate of return by college major[a]

College major	Net present discounted value (2009 USD)		Internal rate of return (%)	
	Men	Women	Men	Women
Bachelor's degree in any field	215,725	158,840	11.8	11.5
Computer/information science	341,539	308,192	15.6	16.4
Engineering	325,022	266,987	15.2	15.1
Math	305,010	279,416	13.9	14.9
Business	272,438	206,271	13.3	13.4
Physical sciences	194,914	173,372	10.9	11.9
Social sciences	192,964	129,446	11.3	10.6
Health	162,410	211,406	10.1	12.9
General studies	162,165	105,918	10.3	9.6
Life sciences	116,733	148,994	8.6	10.5
Humanities	77,401	125,185	7.8	10.2
Education	10,456	48,922	5.5	7.6

[a]Estimates are based on earnings data from the 2010–2012 American Community Survey, and tuition and fees data are from the National Center for Education Statistics for the 2011–2012 academic year. Our earnings sample is limited to US citizens who usually work at least 35 hours per week and worked at least 40 weeks in the past 12 months. We also drop observations with allocated earnings.

earning fields of study and an overestimate of counterfactual earnings for individuals who major in lower earning fields of study. In other words, counterfactual high school graduate earnings are likely to be positively correlated with bachelor's degree earnings. However, these estimates suggest that even for some of the lowest earning fields of study, a bachelor's degree is a valuable investment relative to a high school diploma. We have also estimated the net value of a four-year degree by major relative to an associate's degree. For these estimates, we find that the net values of a bachelor's degree turn negative for men majoring in education or the humanities and for women majoring in education.[29]

6.5. Discussion

Investments in standard financial instruments yield similar returns irrespective of one's demographic and personal characteristics. But investments in human capital, such as a college education, depend on further inputs, such as family background, academic preparation, and effort. Therefore, individuals who are considering an investment in higher education would be wise to consider how their own characteristics might affect their future returns. To the extent that this is merely an exercise in prediction, it is not necessary to generate exogenous variation in demographic characteristics. Exploring the heterogeneity in the causal estimates of college returns from well-identified studies, as suggested in Section 4.5, would provide valuable information for

[29]The net discounted value of a bachelor's degree in education relative to an associate's degree (in any field) is approximately −\$79,000 for men and \$45,000 for women.

answering these questions. Our naïve estimates provide some preliminary evidence that returns remain high for different gender, racial, and ethnic groups.

Beyond the impact of college attendance itself on subsequent earnings, the specific choice of college and the choice of major field of study while in college are also likely to affect earnings. Indeed, for many individuals who have already made the decision to attend college, the key decisions are the choice of college and the choice of major. Thus, for example, James et al. (1989, pp. 251–52) argue that "while sending your child to Harvard appears to be a good investment, sending him to your local state university to major in Engineering, to take lots of math, and preferably to attain a high GPA, is an even better private investment." Although we are not able to test this claim directly, we do show that there is substantial variation in returns to major. Nevertheless, almost all of our estimates for the internal rates of return by college major are 7% or higher. The evidence on the returns to college quality is somewhat mixed. But there are also opportunities here to follow up and build on some recent experimental studies (e.g., Hoxby & Turner 2013) that generate exogenous variation in the quality of college attended through low-cost interventions.

7. THE RISK OF A COLLEGE INVESTMENT

As noted in Section 3, it is important to consider the potential risk of a college investment and not simply the average return. However, evaluating the risk of college investments is a difficult undertaking and an area of continuing research. There are two different sources of risk related to an individual's decision to attend college that have been discussed in the literature: (*a*) completion (or dropout) risk associated with the likelihood of actually completing a college degree and (*b*) earnings risk associated with the relative variance of earnings for college versus noncollege graduates. We discuss each of these sources of risk in turn.

7.1. Completion (or Dropout) Risk

Approximately one-half of the students who enroll in college do not complete a bachelor's degree. Some of these students may have aimed only for an associate's degree, which, as shown above, also represents a valuable investment. However, many students also drop out before completing any college degree. To the extent that some exposure to college is valuable, this outcome may be a worthwhile investment even ex post. However, if there is a cost to dropping out of college, and this outcome is uncertain ex ante, then it should be included in the assessment of the risk to a college investment. Why might the possibility of dropping out be unknown ex ante? Students may not have sufficient information about their nonpecuniary costs until they enroll in college, or they may receive new information about expected returns while in college. This suggests that completion risk may be driven by uncertainty in both the costs and benefits of college. Using a life-cycle model with heterogeneous ability, Castex (2011) argues that the (dropout) risk premium of college participation accounts for a nontrivial fraction of the excess returns to college education.

We attempt to address the issue of completion risk in our calculations by estimating the net present value for individuals of getting at least some college education.[30] This goes some way toward accounting for uncertainty by allowing for the full range of potential earnings outcomes regardless of whether one actually completes a degree. The estimates—some of which include

[30]We assume one year of college tuition and foregone earnings for those with some college experience and no degree, two years for an associate's degree, four years for a bachelor's degree, and six years for a graduate degree.

individuals who have graduate degrees and some of which exclude those individuals—are presented in **Table 1**. When we exclude graduate degree holders, we find that the net present value of getting at least some college experience is approximately $164,000 for women and $185,000 for men, with estimated IRRs of approximately 6%. If we also include individuals who go on to receive graduate degrees, our estimates for the value of college are even higher. Thus, accounting for some completion risk by including all individuals with at least some college experience, we continue to find that college attendance pays off, at least on average.

7.2. Earnings Risk

Above we document the heterogeneity of the returns to college by both individual and institutional characteristics. But only wage variance that is not predictable or forecastable by individuals ex ante represents a source of uncertainty that needs to be accounted for when evaluating the risk of a college investment. Cunha et al. (2005) and Cunha & Heckman (2007) estimate that over 50% of the ex post variance in the returns to schooling is forecastable at the time that students make their college choices. In particular, they estimate that the share of variance due to unforecastable components is 45% for high school graduates and 35% for college graduates. Meanwhile, Chen (2008) estimates that approximately 80% of potential wage inequality among college graduates is attributable to uncertainty. Although both Cunha & Heckman (2007) and Chen (2008) show that there is higher overall wage variance for college graduates, Cunha & Heckman's (2007) calculations suggest that wage uncertainty remains higher for college graduates, but Chen (2008) finds that wage uncertainty does not necessarily rise with education.

Evaluating the risk of a college education is further complicated if we consider this investment in the context of a broader asset allocation problem. Then it becomes necessary to examine the correlation between the earnings premium associated with college and other components of the individual's asset portfolio. Numerous studies have examined labor income risk through an asset allocation framework, but these have generally not focused specifically on the college investment decision (see Benzoni & Chyruk 2013 for a recent review of the literature on labor income risk). Of course, this exercise would be even more complex if we accounted for the heterogeneity of asset portfolios across individuals. A related question, once we consider the variance of earnings, is whether the counterfactual high school and college earnings distributions are correlated for individuals. If individuals at the bottom of the college earnings distribution are also at the bottom of the high school earnings distribution, it is unlikely that college graduates with low earnings would have earned as much as the average high school graduate instead. Avery & Turner (2012) explore the estimated return to college under alternative assumptions about the correlation between high school and college earnings.

7.3. Discussion

A comprehensive analysis of the risk associated with college investments is an extremely challenging endeavor. As explained above, neither the possibility of completion risk nor the substantial earnings risk is straightforward to calculate and incorporate into estimates of the rate of return. Moreover, the preceding discussion abstracts from other complicating factors. For example, the existing research on completion and earnings risk does not always address the possibility of selection, which features prominently in prior sections. Furthermore, there is likely substantial uncertainty in nonpecuniary returns to college, something that has not really been explored in the literature. The role of income contingent loans in potentially reducing the uncertainty of the returns to college is also a possibility worth considering in more detail. Finally, in addition to uncertainty about where individuals will end up in the wage distribution, there may be uncertainty about the precise nature of the wage structure in future years. This is closely related, from our perspective, to the assumption underlying the use of cross-sectional data to infer the future returns to college based on the distribution of current earnings. Clearly, a full consideration of these issues would constitute a major research agenda.[31] However, this is an important direction to pursue in further research.

8. CONCLUDING THOUGHTS

As aggregate student debt levels have climbed to new highs, newspapers and magazines have published articles describing college graduates with large student debt levels, barely scraping by, working in positions that do not require a college education and living at home with their parents. Likewise, they have published stories of college dropouts such as Mark Zuckerburg and Bill Gates who have started companies worth billions of dollars. However, when one considers the value of a college education on average or for large subgroups of the population, the pecuniary returns to college appear to be quite large. Despite some legitimate methodological concerns with earlier studies estimating the causal impact of schooling on earnings, the findings from recent studies indicate that college increases earnings, rather than simply reflecting differences driven by selection. Nevertheless, there are surprisingly few convincing causal estimates of the value of college, and researchers should therefore try to take advantage of recent experimental studies that have generated random variation in college attendance and persistence.

Our conclusion—that college is, on average, a good investment—holds up to various decisions about which data to use on earnings and/or tuition and fee costs. In the end, our simple calculations of the net value of college are most sensitive to choices about the appropriate discount rate, suggesting that estimates of the IRR may be more useful. However, we note both that one still needs to choose an appropriate rate of return with which to compare the IRR and that the IRR does not explicitly take risk into consideration. Furthermore, even if the IRR of a college degree exceeds the return on other similarly risky investments, educational investments are more limited in scale than are many financial investments, so IRR calculations alone are not sufficient to determine the best investment choice.

Although the value of a college education is clearly large on average, it is also true that there is substantial heterogeneity in the returns to college. For example, although the estimated IRRs of two- and four-year colleges are quite similar, the net present value of a four-year college degree is more than double the net present value of a two-year college degree. We find much more substantial variation in estimated IRRs for different college majors (assuming tuition costs are the same for all majors and average high school earnings are the appropriate counterfactual earnings), ranging from 5.5% (for men who are education majors) to 16.4% (for women who are computer and information science majors). Notably, however, none of our estimates falls below 5%, which is somewhat surprising given how much overlap there is in the college and high school earnings distributions.[32] Thus, further research is needed to understand how much of the difference in returns to different majors is causal and how much reflects selection into different college majors.

[31] More generally, it may also be fruitful to distinguish between the alternative formulations of uncertainty described by Hansen (2014) and apply them explicitly to the context of investment in education.

[32] To the extent that average high school earnings overstate (understate) the counterfactual earnings for a bachelor's degree in a low- (high-)earning field of study, the range of estimates for the value of a college degree in different majors may actually be too wide.

Differences in estimates of the value of college by individual characteristics are smaller than differences in the estimates of the value of college by institutional characteristics. However, men have higher IRR estimates than do women, and the IRR estimates for whites are higher than the estimates for blacks and Hispanics. If we put aside concerns related to selection, these estimates suggest that blacks and Hispanics have somewhat less incentive to invest in college; however, they do nothing to help explain why women have increased their college going more than men have. Despite some valuable exploratory work, this very much remains an open question for research.

In addition to estimates of large monetary benefits of a college degree, many studies have found evidence of nonpecuniary benefits of education. Any nonpecuniary benefit of more education, such as better health, only further contributes to the benefit of a college degree. Of course, in addition to nonpecuniary benefits, there may also be nonpecuniary costs that explain why more people do not complete a college degree. Researchers have identified poor information and poor academic preparation as potential nonpecuniary costs to completing a college degree. But although improving the information available to students may be a fairly inexpensive policy to reduce potential nonpecuniary costs, poor academic preparation for college is a more difficult challenge to overcome. Education researchers and policy makers have long been working to improve academic outcomes for all children, but 15-year-old students in the United States perform poorly on tests of mathematics and science relative to their international peers (Kelly et al. 2013), even while the United States continues to outspend most other countries on education (OECD 2013). There remains much more to be learned about the nature of nonpecuniary costs in education and the possibilities for alleviating them.

There is also increased concern with levels of student borrowing. Less than one-quarter of students in public four-year institutions borrowed in 1990, but that percentage had more than doubled (to 60.9%) by 2012.[33] At the same time, the average student loan size for bachelor's degree recipients rose as well. According to data from the College Board, the average debt per borrower among bachelor's degree recipients from four-year public colleges and universities rose from $20,800 (2012 US dollars) in 1999–2000 to $25,000 in 2011–2012. Nevertheless, these increasing levels of borrowing do not alter our main conclusions about the value of a college education. As Avery & Turner (2012) point out, there is a strong argument in favor of incurring this debt to finance a valuable college education.[34]

Yet the fact that college remains a good investment on average does not mean that student debt burdens may not be high or even unmanageable for some recent college graduates. Given the dropout risk and earnings risk associated with the investment in a college education, there will undoubtedly be certain individuals who borrow for college but have low pecuniary returns. One approach to reducing the likelihood of excessive student debt burden is a broader adoption of income-contingent loans. For example, using the minimum required income level cutoffs for income-based repayment eligibility, an individual would qualify for loan payment reductions if he or she had a bachelor's degree, student debt of $32,000, and earnings below the 63rd percentile of the bachelor's degree earnings distribution.[35] Thus, rather than concluding that college is a bad

[33]Even more dramatically, the percentage of students who borrowed to attend a two-year institution increased from 5.3% to 36.8% over the same period (data from NPSAS:90 and NPSAS:12). However, these numbers pale in comparison to the percentage of students who borrowed to attend a for-profit institution, which reached 90% in 2008 and fell to 85% in 2012 (up from 65% in 1990).

[34]Indeed, in some instances, students may not be borrowing enough. Cadena & Keys (2013) show that some students turn down interest-free loans to avoid the temptation of liquidity due to self-control problems.

[35]$32,000 is approximately the 75th percentile of debt for a bachelor's degree recipient in 2012 US dollars based on the 2009 Beginning Postsecondary Students Survey.

investment, one might instead conclude that exploring other ways of making college debt more manageable may be good policy. The evidence presented in this article confirms that college is a worthwhile investment, while not necessarily for all, almost certainly for most.

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