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THE PRIVATE RATES OF RETURN TO UNDERGRADUATE EDUCATION BY MAJOR

A Thesis

Submitted

in Partial Fulfillment

of the Requirements for the Designation

University Honors with Distinction

Nick Johnson

University of Northern Iowa

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Ken McCormick, Honors Thesis Advisor

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Date

Jessica Moon, Director, University Honors Program

Abstract

The private returns to undergraduate education are important to understand for high school graduates trying to decide between the work force and college. The IRR method is the best measure of the private returns to education because it allows for important variables to be accounted for and includes the time value of money. Using data from the National Longitudinal Study of 1972, there are large differences in the returns to college by major. This model allows the returns to college to vary by college selectivity and, through ability, within an individual major.

I. Introduction

Economists have discovered that more education leads to higher wages, better fringe benefits, better health (for the individual and his family), better consumer choices, increased savings and charity (controlling for income), increased voting rates, and decreased criminal activity and recidivism [Wolfe and Haveman, 2002, 104-106]. For these reasons, guidance counselors across the nation tell high school students to attend college. Evidence suggests that students are taking their advice. In 1970, only 10.7 percent of the population age 25 or older had a college degree. By 2005, over 27 percent had a college degree [Census Bureau, 2007, 214].

Better jobs and higher salaries seem to be on students' minds as well. In a national survey of college freshman, 71.8 percent agreed that "the chief benefit of a college education is that it increases one's earning power" [Leslie and Brinkman, 1988, 40]. The private returns to undergraduate education, however, vary greatly by major. In fact, "differences in the returns to major are much larger than the differences in the return to college quality" [Arcidiacono, 2004, 343]. In a recent survey, 28 percent of college

graduates might have considered a more lucrative major and 15 percent "absolutely would have" one year after graduation [Marklein and Holeywell, 2007, 6D].

The returns to undergraduate education by major are important to understand for high school graduates deciding between the work force and college. The private rate of return focuses solely on the costs incurred and benefits enjoyed by a college graduate as compared to a high school graduate. Social costs such as government funding for undergraduate institutions and social benefits such as increased tax revenue are not included. The private costs include the direct costs of tuition and the indirect costs of foregone earnings while attending college. The private benefits are the increased earnings college graduates earn as compared to individuals who graduated high school, were accepted by a four-year institution, but chose not to attend. The focus on private returns makes this study useful for high school graduates considering college, not legislators examining the funding of undergraduate institutions.

Using data from the National Longitudinal Study of 1972, economists have found varying private rates of return for undergraduate education. Arcidiacono, while accounting for ability, gender, and school quality, estimated rates of return for several aggregated majors [2004, 365]. He found moderate returns for most majors, but large returns for others (especially for females in business and males in natural science). Only males who majored in education received a negative rate of return. The differences in returns to major dominated the differences in returns to school quality. Math ability, as measured by SAT math score, was a significant indicator of future earnings. Verbal ability was not a significant indicator because business majors had some of the highest earnings, but the lowest verbal scores. High ability individuals, as measured by SAT

math scores, overwhelmingly selected more lucrative fields [Arcidiacono, 2004, 345]. Therefore, math skills played an enormous role in the selection of major which became a main determinant of the rates of return that a student earned for his undergraduate education. Overall, there were large differences in the returns to undergraduate education by major.

II. Background Information

Human capital is the underlying economic theory behind rates of return to education. Human capital is the "energies, talents, skills, and knowledge which can be applied to inert physical factors to produce goods and services and to produce additional human capital" [Alexander, 1976, 85]. Much like a physical asset, investing in the individual can have long term benefits for both the individual and the society. Individuals invest in their own human capital with formal education to increase their productivity and their future earnings streams. Formal education is only one way that an individual, or a society, can invest in human capital, but it has been the focus of much of the research. On-the-job training, apprenticeships, and experience are other successful methods of increasing human capital [Williams and Swail, 2005, 3]. This makes the costs and benefits to human capital very difficult to calculate. Economists have developed several different methods and countless models to try to predict the returns to human capital.

The first method that was widely used to estimate the monetary gains from undergraduate education is called earnings differentials or wage premiums. This method represents the simplest method used by economists and journalists to calculate returns.

For example, in 1999, college graduates earned 1.8 times what a high school graduate earned in an average year [Day and Newburger, 2002, 3]. This information can also be spread out over a simulated life. Over the course of a lifetime, a college graduate can expect to earn $914,289 more in 1999 dollars than a high school graduate [Day and Newburger, 2002, 10]. This method does have a few benefits. It is very simple, easy to understand, and the only math involved is simple arithmetic. In addition, all the data are easily available from census statistics.

Its simplicity is also its greatest weakness as a measure. Earnings differentials fail to take into account several variables that also affect earnings. College graduates would be expected to earn more even without extra education because of their family background, ability, and motivation [Leslie and Brinkman, 1988, 41-42]. The data for earnings differentials or wage premiums consistently use the average or median salary per year instead of analyzing how salaries grow with time. Additionally, the costs of attending college (both direct and indirect) are completely ignored. In effect, this measure completely ignores the time value of money. The magnitude and *the timing* of the cash flows are critical to understanding whether attending college is a beneficial investment in human capital. In order to compensate for these weaknesses, economists began using the net present value (NPV) method.

The NPV method accounts for both the costs of attending college and the timing of the cash flows. It can also be used with data that models the parabolic shape of normal lifetime earnings of individuals. To calculate the NPV of an investment, cash flows are discounted back to the present time at a specific discount rate. The summation of these discounted cash flows gives the current value of the decision. This is based on the idea

that a dollar spent today to purchase undergraduate education is worth more than a dollar earned at some future point after factoring in costs and the time value of money. Economists have estimated the NPV of going to college to be anywhere between $7,000 to $329,000 [Leslie and Brinkman, 1988, 45]. According to the NPV rule, anything with a positive NPV is a beneficial project. The weakness of the NPV method is that a discount rate must be decided upon (i.e. a rate to discount the cash flows). This is a difficult, if not impossible, task because individuals will have different discount rates. Many variables may factor into the discount rate such as school quality, major, gender, race, ability, or motivation. Any variable that affects the risk of the cash flows would affect the discount rate. For example, a business major may be more certain of his cash flows (i.e. the cash flows may have less risk) than a social science major. This would cause the social science major to have a higher discount rate because his future cash flows are more uncertain. The increased discount rate would 'adjust for risk' in order to allow the two NPVs to be comparable. To get around this difficulty, economists calculate NPVs at different discount rates instead of choosing only one. This eventually led to the current method of calculating the returns to education.

Economists calculate the internal rate of return (IRR) in a fashion similar to the NPV. When calculating the IRR, economists set the NPV equal to zero and then solve for the discount rate. The resulting discount rate is known as the IRR. The following is a simple example:

$$0 = -5000 + \frac{1500}{(1+i)} + \frac{2000}{(1+i)^2} + \frac{2500}{(1+i)^3} + \frac{3000}{(1+i)^4} \qquad \text{IRR} = 24.89\%$$

Like the NPV method, the IRR factors in the time value of money as well as the costs of attending college. In order to decide whether a project would be beneficial, the IRR must be greater than the required rate of return. The required rate of return is commonly equal to ten percent because that is approximately the average long run return on investments in the stock market. In other words, the return on funds spent for education is compared to the return the funds would have earned in the stock market. A common error, however, is to directly compare this ten percent return with the rates of return to education. The ten percent is a nominal return on the stock market, while IRRs are typically adjusted for inflation, which makes them real returns. Therefore, it is important to determine if returns are nominal or real and to compare them to the appropriate benchmark rate of return. Leslie and Brinkman summarize several IRR studies and find that the best studies have a nominal return with a mean of approximately 12.2 percent [1988, 47]. This rate of return means that a high school graduate must receive 12.2 percent return annually (e.g. in the stock market) over the next 40 years to equal the return to a college education. This study will continue to focus solely on nominal rates of return. The IRR method best describes the rates of return to education because it is fairly simple, yet is sufficiently complex to control for important variables and includes the time value of money. For the remainder of this study, the term 'rate of return' will be used to describe the IRR method. This will be used to calculate the private rates of return to undergraduate education.

As with any NPV or IRR calculation, the cash flows closest to the present have the greatest impact because they are discounted the least. The costs of undergraduate education are the most important cash flows in the estimation. The private costs of undergraduate education have been separated into two categories; direct and indirect.

Direct costs, or out-of-pocket expenses, are tuition, fees, textbooks and supplies. Room and board are not considered costs to attend college because a person would have to pay for food and shelter even if he decided not to attend college. In addition, 77 percent of students attend state-run institutions that are subsidized with state and federal tax monies [Leek, 2006, 20]. This cost to society is also not included into the calculation because it is a social, and not a private, cost. Individuals who attend a private school typically incur more costs, but this may be decreased by scholarships and higher income after graduation. Scholarships must be subtracted from the costs of attending college in order to obtain the true marginal cost [Leslie and Brinkman, 1988, 59]. For example, suppose a student earns a full-ride scholarship equal to room, board, tuition and fees. This scholarship would eliminate almost all of the direct costs of attending undergraduate education. In addition, the portion of the scholarship that pays for room and board would be a positive cash flow. This scholarship would be treated as ordinary income for the purposes of this study. It is critical to focus only on the costs incurred because of the decision to attend college.

The indirect costs are the forgone earnings a college student loses while in school. Specifically, by attending a four year institution, a student forgoes four years of earnings that could be made with a high school degree. Leslie and Brinkman, however, point out that many undergraduate students earn income even while they are full time students [1988, 59]. This can come in the form of summer jobs, internships, or jobs during the school year. Not including these positive cash flows significantly overestimates the cost of attending schools, which lowers the rate of return. All these issues must be addressed in order to accurately estimate the rates of return.

IRR studies gained popularity in the 1970's as the rates of return to undergraduate education fell. The rates of return dropped because of a large increase in the supply of college graduates. This increase in the supply of college graduates occurred as enrollments ballooned at the end of the 1960's due to the previously high rates of return and the desire to obtain deferments from the draft during the Vietnam War [Boesel and Fredland, 1999, 3]. Deferments were a non-monetary benefit to undergraduate education and therefore more individuals would choose college even if the monetary rates of return were depressed. The large increase in college graduates forced many graduates into 'high school' jobs. Leef points out that the proportion of college graduates working in high school jobs approximately doubled between the late 1960's to the mid-1980's [2006, 29]. This reduced the earnings premiums that college graduates enjoyed over high school graduates which then lowered the rates of return until the 1980's, when the return rose sharply. The sharp increase was due in part to a deceleration in the growth rate of college graduates, but primarily occurred because rapid technological change increased the demand for more educated workers [Boesel and Fredland, 1999, 3]. In addition, the rates of return to undergraduate education increased relative to the return to high school graduates as less skilled workers were hurt when manufacturing jobs moved overseas.

This history illustrates that the rates of return to education depend on the state of the economy and the labor market. As such, there is no definitive rate of return to undergraduate education even if all the important variables are accounted for. When studying rates of return, historical data are used to make calculations. This means economists are calculating rates of return 30 years after students made the decision whether to go to college. In order to calculate present monetary rates of return,

economists would have to forecast future cash flows which would lead to large estimation errors. Using historical data is the best possible estimate of present rates of return, but it must be understood that it is far from perfect.

III. Controlling For Other Factors

There are several factors that must be controlled in order to calculate rates of return to undergraduate education. The most critical factor is the ability of students. Students who have higher ability are more likely to go to college. Therefore, it would be expected that college graduates would earn higher salaries than high school graduates even without the effect of the extra education. Only students that had the option to attend college (i.e. they had been accepted into a four year institution and chose to enter the work force instead) should be included in the calculation. This is an important distinction to make because a student who could not be accepted into college is not making a marginal decision whether to attend college. Therefore, this exclusion helps eliminate some ability sorting by focusing the analysis on the difference between high school graduates who have the option to attend a university and college graduates [Arcidiacono, 2004, 346].

There must also be a variable to sort students' ability during their college careers. Students who choose to attend college have a wide range of ability. In order to sort students, Arcidiacono used SAT math scores as a proxy for ability [2004, 347]. As a result, the returns to undergraduate education are separated from the returns to ability [2004, 344]. If no separation were to exist, then it must be assumed that all students within a major have the same ability. Ignoring ability differences among students would

underestimate the return for high ability students and overestimate the returns for low ability students. Overall, this would cause a distortion in the rates of return to education.

Gender is another factor that must be controlled for because historically there is a significant difference in earnings between the sexes. Daymont and Andrisani found that different preferences between males and females caused them to major in different fields and later to choose different occupations [1984, 408]. For men, earning money was more important in selecting a career. This preference pushed them into higher paying fields such as business, engineering, and other professional occupations. Women, however, preferred the prospect of being helpful to others. This preference pushed more women into lower paying fields such as education, humanities, or health. Overall, college major accounted for approximately 25 percent of the difference in earnings between men and women [Daymont and Andrisani, 1988, 414, 425]. Other economists calculate the rates of return separately for both men and women in order to understand the differences.

Post-tax earnings and unemployment are two other factors that must be included. The earnings that are calculated must be computed after income taxes have been paid. Baum and Payea show that at the median earnings levels for high school and college graduates, there is an additional $5,200 tax burden on college graduates in 2002 [2004, 10]. While this additional tax revenue may be a social benefit of undergraduate education, it should not be included in this rate of return study because it is not a private benefit. On the other hand, high school graduates are more likely to be unemployed than college graduates [Williams and Swail, 2005, 5]. This period of unemployment is already factored into the NLS survey data and no corrections need to be made.

IV. Data

Many studies, including Arcidiacono [2004], Berger [1988], Grogger and Eide [1995], and Daymont and Andrisani [1984], use the National Longitudinal Study completed by the Bureau of Labor Statistics (which surveyed a sample of seniors in high school across the nation in 1972) for their data. Those same individuals were again interviewed in 1973, 1974, 1976, 1979, and 1986 [Arcidiacono, 2004, 345]. The longitudinal survey allows the choice of major to be observed as well as the subsequent experiences in the labor market [Berger, 1988, 420]. Over 40 majors are recognized in the NLS study, but in order to simplify the data for empirical analysis, they are usually aggregated into four or five categories. These broad categories typically include natural science, business, social science and humanities, and education. While these categories are still admittedly broad, they do provide more specific information than a single rate of return for all undergraduate education.

V. Rates of Return by Major

Using this NLS data, the earnings from particular majors can be translated into cash flows over the course of a lifetime and rates of return can be calculated. Arcidiacono completed the first study to combine all of the necessary elements to correctly estimate the rates of return. Other studies have calculated college wage premiums [Grogger and Eide, 1995, 296], but have failed to connect it to the costs of higher education. Berger [1988, 427] and Koch [1974, 683] have connected marginal changes in expected earnings to changes in major choice, but have failed to estimate rates of return. All these studies have also failed to discuss vast differences in ability across

majors. There is an implicit assumption in their studies that the abilities of, say, an education major are the same as any other kind of major. They also assume that the abilities of two education majors are the same. In the real world, this assumption does not hold true.

Arcidiacono's model is the first to take all these considerations into account. His model allows the returns to college to vary by college selectivity and, through ability, within an individual major. Therefore, the model no longer assumes that all undergraduate schools are the same or that students in a particular major have the same ability [2004, 344]. Arcidiacono uses SAT math scores for ability proxies because he found that the ordering of majors by earnings was precisely the same as the ordering of majors by math ability. SAT verbal scores followed the same pattern, with the exception of business majors, who score significantly lower than social science majors, but earn much more on average [Arcidiacono, 2004, 347]. Therefore, SAT verbal scores were not used as an ability proxy because it lacked significance in determining earnings. In order to rate undergraduate colleges, the institutions themselves reported their average SAT math score. The results can be found in the following Table 1.

Table 1
Rates of Return by Major [Arcidiacono, 2004, 365]

	Natural Science	Business	Soc. Sci./Hum.	Education
Male	19.7%	15.9%	9.4%	-1.2%
Female	15.0%	24.4%	13.0%	5.2%
Changes in Premium				
+100 SAT Math	2.1%	1.8%	-0.4%	-2.3%
+100 School Quality	5.2%	-2.7%	4.5%	-0.8%

Students in natural science and business earn the highest rates of return. Males in education earn a negative rate of return indicating that there is a monetary cost (as opposed to a monetary benefit) for obtaining an undergraduate degree. Having higher SAT math scores provides positive rates of return for both natural sciences and business majors, but negative ones for both social science and education. This result does not mean that a college graduate with a higher SAT math score had lower earnings. It does, however, reflect that having a higher SAT math score lowers your rate of return as compared to not going into college at all. Simply put, the returns to higher SAT math scores are positive, but they are higher in the 'no college' sector. Likewise, attending an expensive school to major in business appears to be a poor decision. The returns to attending a better quality school for business are positive, but the costs outweigh the benefits. In the natural science field, however, the returns to attending a high quality school are quite high at 5.2 percent. This study provides the best information because it separates genders and controls for ability within and across majors. Many other studies have put together a few of the factors that are necessary to control for, but Arcidiacono is the first put all of them together in one complete study.

VI. Counterarguments

Several counterarguments have been made against rates of return studies, but many of these arguments lack the necessary evidence. Leef argues that college education is not worth the cost:

> It is more sensible to focus on workers on the *margin*. The right question to ask is this: For high school graduates who might have gone to college but did not, is it the case that their earnings would be significantly higher if they had instead enrolled in college? The answer to that question is no [2006, 26].

Arcidiacono's research studied precisely that by analyzing individuals who had been accepted into four year institutions. By making this distinction, Arcidiacono has focused solely on students on the margin. Leef, however, does make an important point that all individuals, especially mediocre or weak students, may be better off without more formal education [2006, 27]. This is important to understand about rates of returns. They are the average rates of return and not everyone will realize those returns.

It is estimated that over 600,000 students drop out of college each year [Boesel and Fredland, 1999, 2] and in 2004, "almost 20 percent of Americans age 25 to 34 had some college, no degree" [Leef, 2006, 19]. The earnings of students with some college are not much greater than students without any college education. In fact, students with a high school degree earn less than those with two year degrees [Boesel and Fredland, 1999, 2]. The rates of return to undergraduate education are not earned by each individual who enters college, but only those students who go on to graduate. For weaker students, a two year college or vocational school may be a better option. Students who drop out incur almost all of the costs of attending college (depending on how many years until they dropout), but receive very little benefit. A two year degree would certainly be better than the large negative return of dropping out of a four year institution [Leef, 2006, 27]. While undergraduate education has an overall positive return, there are certain students that would be better suited for alternative career paths.

Another counterargument made against IRR studies is that universities do not increase human capital, but only screen students. As Arcidiacono argues, "high math ability individuals prefer both the subject matter and the jobs associated with the lucrative majors" [2004, 345]. Therefore, more difficult majors have higher ability students and

the true effect of higher education is to sort students, not educate them. This argument, however, fails to identify the reason why difficult majors have higher earnings. The supply of graduates majoring in education is much greater than the supply of graduates majoring in actuarial science. Graduates in more difficult majors earn a higher wage because their human capital is relatively rare compared to easier majors. The difference in the supply and demand of the majors in the labor market creates the disparity in earnings, not the screening of universities.

VII. Areas for Further Study

There are several areas in which the data could be improved to enhance the understanding behind the returns to college majors. First, historical data from 1972 is becoming outdated and should be replaced with students entering college in the 1980's. This update in information would give a much better representation of the current rates of return. Longitudinal surveys, however, take large amounts of time, energy, and money to complete. Because of these factors, it may be difficult to get updated information.

The data could also be improved if the majors were not aggregated as severely. In order to have larger sample sizes, Berger [1988, 421] and Arcidiacono [2004, 346] had to aggregate majors. There can, however, be significant differences in rates of return within categories. For example, the natural sciences category includes both engineers and biologists who may have significantly different earnings over the course of a lifetime. The high level of aggregation (i.e. only having four categories) marks an improvement over previous studies that did not differentiate majors, but leaves room for improvement.

While the term 'rate of return' has been used throughout this study, it has focused only on monetary returns. Non-monetary returns, including health insurance, vacation time and retirement savings, should be included. Vacation time would be especially important for education majors because they only work nine months a year while most others work 11 or 12 months. Unfortunately, little or no information is available to clearly show the values of the non-monetary benefits that college graduates enjoy over high school graduates. The type of survey that is necessary to determine these returns would take years and would be costly. When factoring in non-monetary benefits, Leslie and Brinkman predict the benefits to undergraduate education would approximately double [1988, 51]. Therefore, even though male education students may have a negative monetary return, their overall return would most likely be positive.

By using historical data to calculate rates of return, a 'hindsight rate of return' is created as opposed to a present rate of return. Using some form of modeling or regression analysis, it would be possible to forecast the present rate of return. This would require forecasting all the future cash flows including costs of undergraduate education for the next four years and expected earnings of both high school graduates and college graduates as experience increased. The distant cash flows have the least impact on the rate of return estimation. Therefore, even though there could be large estimation errors in the distant cash flows, it would have a smaller impact. This type of study would be a powerful tool for high school seniors to determine if attending college really was the best decision for them. It would also help students realize that different college majors have significantly different returns.

VIII. Conclusion

There are large differences in the rates of return to undergraduate education by major. These differences overshadow the differences in the returns to school quality and ability [Arcidiacono, 2004, 345]. There are large rates of return for business and natural science majors, moderate returns for social science and humanities majors, and low to negative returns for education majors. The presented rates of return are averages for each aggregated major. The returns vary by student ability within the major and by school quality. While not every student will earn these rates of return, it is clear that going to college is a solid investment for most.

High school graduates with the option to enter college should carefully analyze their priorities and make an informed decision about college. A student needs to understand that backwards looking return studies cannot predict the labor market or the economy in the future. The private returns using historical data provide the best possible estimate of the present returns. If a student's main concern is to earn a large salary, then developing math skills and majoring in natural science or business appears to be a safe bet.

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