The Education Premium Puzzle

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1- Introduction

The many studies on the effect of education on labor earnings suggest that the mean monetary return to education could be between 7% and 12%. The conventional approach of computing return to schooling based on its effects on labor income omits non-monetary effects of education, like its effects on life expectancy, health and quality of children, which seems to be an important component of the total return to education.

Becker's seminal work on human capital, household production, marriage, children as consumption goods, and others non-market activities, and his analysis of the role of human capital in these different aspects of economic life of individuals has provided an economic framework and motivation for many empirical studies to estimate the magnitude of the effect of education on those outcomes.

Our goal in this paper is to make some progress in incorporating the effects of education on non-monetary outcomes to the conventional measures of the return to schooling and to establish an order of magnitude of the education premium. Using empirical results from past studies on the effects of education on non-monetary outcomes, and armed with a suitable economic framework we are able to estimate the willingness to pay for education for it effects on life expectancy, health, marriage instability, and quality of children.

We estimate that the gains in life expectancy for going from high school to college alone account for 29% of the value of investment in education as computed by Jorgenson and Fraumeni (1995). These are really big numbers, for comparison, Murphy and Topel (2003) find that the economic value of declining mortality from heart disease during 1970-1990, for which medical advances are known to be significant, for an 18 years individual is $108,000. Our estimates of the value of going from high school to college

due to improvement in life expectancy represent 34% of Murphy and Topel (2003)'s estimates.

When we add our estimates of the dollar value of the effects of education on life expectancy, quality of life or health and marriage instability, the internal rate of return is at least equal to 16%, 70% greater than the monetary return to education. While these estimates could have some problems regarding possible bias on the estimates of the effect of education that we use in our analysis, the magnitude of these benefits appear to be too large to be explained on those grounds.

The average monetary return to schooling have been higher than stock returns and returns on riskless assets. As Table 1 shows, the average monetary return to education in different developed countries is over 6%, and higher than stock returns, except for Germany. The mean of the average return to schooling on the United States, computed from studies for the years 1976, 1978, 1987, and 1991-95, was 8.8%, an impressive 8.2% over the average bond return of 0.6%, and even higher than the stock average return for the period 1947-2000.

Using standard economic theory to estimate risk adjusted returns, Palacios-Huerta (2003) find that the education premium is too large to be explained by riskiness alone. He find that the minimum coefficients of RRA, in a CRRA utility function, that are necessary to reconcile movements in consumption and human capital returns in frictionless economies are implausible high, from 39 to 66 across different demographic groups. He is able to reconcile the empirical evidence by introducing market frictions. But his calculations do not include non-monetary benefits of education that could increase the return to education by more than 70% as we mentioned before. If in fact non-monetary benefits are an

important component of the total return to schooling, as we show in this paper, the puzzle remains unsolved.

The literature on valuing non-monetary outcomes of education is not very extensive. Haveman and Wolfe (1982) proposed a method for estimating willingness to pay for the effects of education on non-monetary outcomes based on a static household production model. Our approach differs from theirs in many respects. First, instead of a static model we use an inter-temporal model that allows us to disentangle the benefits of education over time, and to estimate an age profile of the value of these benefits, which allow us to compute internal rates of return. Since all the effects of education are perceived over different periods in the lifetime, our inter-temporal model allows us to compute those gains in a more accurate way. Second, our estimates of willingness to pay for education are utility-based, using the Value of Statistical Life as our workhorse for the computations, while their approach is based on cost minimization concentrating on the production side of the problem.

The paper is organized as follows. Section 2 discusses the potential effects of education on different non-monetary outcomes. Section 3 concentrates on past estimates of the effect of education on life expectancy, health, marriage instability, and quality of children. Section 4 discusses about the possible sources of bias that could drive an association between education and non-monetary outcomes. Section 5 outlines an economic model based on Rosen (1988) and Murphy and Topel (2003) for valuing the effects of education on non-monetary outcomes. Section 6 presents estimates of the economic value of the gains associated with education using estimates of the effect of education on different outcomes revised in Section 3, and estimates internal rate of

returns to education including non-monetary outcomes. Section 7 concludes and outlines a proposal to extend our study.

2- Effect of education on non-monetary outcomes

Since the pioneer studies on education and on the empirical methods to measure returns to schooling by Becker, Mincer and Schultz in the early 1960's there have been an increasing interest in economics and other disciplines on the role and the effects of education in different aspects of economic and social life of individuals. Studies about the magnitude of the returns on investment in education in the form of higher earnings, and about the accuracy of the different methods to measure this component of the return, have dominated an important part of the economic research agenda in education since the early 1960's. However, most of the estimation methods give similar results of the monetary return to schooling.

As we noted before, the impact of education goes beyond its effects on labor productivity of the individual. T. W. Schultz (1977) enumerates some of the different components of the return of investment in education other than higher earnings, he said:

"All of these achievements [past estimates of the monetary return to education], however, omit the non-market contributions of education in household production, in caring for children, in acquiring and maintaining the health of family member, in being more efficient in purchasing consumer goods and services, in evaluating the quality of education that children receive, and (most important) in determining social competence and the quality of the style of living. None of these non-market values is included in the monetary rates of return to education that are derived from market sector activities."

T. W. Schultz's concerns appear to be listened in part. While in the last 20 years there has been a substantial growth in empirical studies about the potential effects of education on wide a variety of private and non-private outcomes, still there have been little effort in adding in a consistent way these benefits to the total return to education.

Michael (1982), Haveman and Wolfe (1982, 2002), and Grossman (2003) present an extensive review on non-monetary benefits of education. Instead of repeating all the material in the papers just cited, in what follows we will concentrated in the following non-market benefits of education, that we consider as the most important: Life Expectancy, Health, Marriage Stability, and Quality of Children. In the following sections we will revise the empirical evidence regarding these items, and we will measure the dollar value of each item using an economic model.

3- Estimates of the Effect of education on Life expectancy, Health, Marriage Stability, and Quality of Children

3.1- Life Expectancy

The negative relationship between education and health has been documented in many studies in the literature. Grossman and Kaestner (1997) and Grossman (2000) present an extensive review of the literature regarding the relationship between health and education, both studies conclude that education is the most important correlate of good health, whether health level are measured by mortality rates, morbidity rates, self-evaluation of health status, and whether the units of observation are individuals or groups. In reference to these studies Grossman (2003) points out that "The studies reviewed, however, indicate that a significant portion of the gross schooling effect cannot be traced to the relationship between schooling and income or occupation."

Table 2 presents death rates for white male according to age and educational attainment for the United States for the period 1994-1996. The table shows a strong inverse association between mortality and education. In both group of age, the death rate per 100,000 population for high school graduates more than double the death rate for college graduate.

Kitagwa and Hauser (1973) constitute one of the first pieces of empirical evidence on the inverse relationship between education and mortality rates. They constructed life tables for white population, by sex and years of schooling for the United States for the year 1960, based on data generated by the Population Research Center of the University of Chicago using 1960 Census Records. They find that mortality varied inversely with the level of educational attainment, and that the education differential in life expectancy decreases with age. They find that the difference in the probability of dying between age 45 and 65 for white males between high school graduates and people with one year of college or more was 3.53 percentages point. A significant inverse relationship between education and mortality persist after controlling for income. As Table 3 shows the difference in mortality ratios standardized by income level between high school graduate and people with one year of college of more is 0.09 (0.95/0.87).

Since the study by Kitagwa and Hauser (1973) their results have been corroborated by many other studies for the US using different data for different periods and different areas. Feldman et al (1989), Preston and Elo (1995), and Pappas et al (1993) find similar results for the period 1979-1985 controlling for other mortality factors like income. Lange (2003), using Census data from 1940-1990, finds that mortality inequality across education groups have grown significantly during 1960-1990.

Richard and Barry (1998) construct life table by sex, race and education for the United States for the year 1990 using the National Mortality Study, and the National Death Index. According to their computations, the difference in life expectancy between white male high school and college graduate at age 18 was 2.9 years in 1990.

More recently, Rogers, Humer and Nam (2000) estimates the effects of education on mortality using data from the annual National Health Interview Surveys matched with data of the Multiple Cause of Death file for the period 1991-1995. They find a negative and significant relationship between mortality and education. In Table 4 we present some of their regressions results. As the table shows, the education-mortality gradient persists after controlling for income, age, race, marital status, employment status, and health status. Compared with those with College, High School graduates are over 0.132 more likely to die controlling for age, sex, race, marital status and income (See model 4).

Strauss and Shavell (2000) provide another source of empirical evidence on the relationship between education and death rate. They developed a software, Life Expectancy 1.0, for calculating an individual's life expectancy based on a person's age and sex, race, education, lifestyle characteristics (smoking, obesity, etc.), and medical risk factors such as diabetes and hypertension. The software is based on government statistics and published studies in the medical and actuarial literature on the effect of various risk factors on mortality rates. Figure 2 uses their estimates to construct survival probabilities for 18 years old white male by education level. As the figures show, the differences in survival probabilities are important, especially after age 45.

In a recent study Lleras-Muney (2002) explore the causality of the association between education and mortality using Census data. They use a natural experiment in order to

estimate the causal effect of education on mortality. Using state-specific compulsory schooling laws as an instrument in order to obtain consistent estimates of the casual effect of education on mortality, they obtain that an additional year of education reduces the probability of dying in the next 10 years by 1.3 percentage points without using any instrument for education. However, when they perform IV estimates using compulsory schooling as an instrument the effect of an additional year of education on mortality is at least 3.6%. This implies a difference in the ten years death rate between college and high school graduates of the order of 14.4 percentage points.

In order to estimate the dollar value of the difference in mortality due to education we need to compute survival probabilities at different ages for 18 years old white male by education level. We construct two sets of survival probabilities by educational group. We estimate one set of survival probabilities by educational group using estimates of death rates by education from Strauss and Shavell (2000), that we present in Figure 2. We estimate a second set of survival probabilities by educational group combining Rogers et al (2000) odd ratios of mortality by education, life table for white males in the United States, and the distribution of white male population according to their education level . We show these estimates in Figure 1.

As we mentioned before, Rogers et al (2000) report the odd ratios of the effects of education on mortality controlling for other correlates like income. We uses these estimates to compute death rates by age and by level of education in the following way:

$$q(x,e) = \frac{\beta_e}{\sum_i s_{x,i}\beta_i} * q(x, population) \qquad (1)$$

Where q(x,e) is the death rate at age x of people with level of education e, Beta,i is the estimates of the odd ratio of mortality for education i in relation to a reference group, Sx,i is the proportion of people with level of education i among people of age x, and q(x, population) is the death rate at age x of the total population. We use estimates of the proportion of people by education level classified by age for the United States from the Digest of Education Statistics – 2000. Then we compute survival probabilities for age 18 by level of education, e, in the following way:

$$s(18,t,e) = \prod_{j=18}^{t}(1-q(j,e)) \qquad (2)$$

The results are shown in Figure 1. As we can see the gap between survival rate by education level from Roger and Nam (2000) is less than the gap between survival rate from Strauss and Shavell (2000) that we present in Figure 2, since the latter do not control for income.

In order to check if Strauss and Shavell (2000) estimates of the mortality rate by education are too high, we compare these estimates with Lleras Muney (2002) results mentioned before. Figure 3 shows the ten-year mortality rates for college and high school by age using Strauss and Shavell (2000) estimates. As we can see, Strauss and Shavell (2000) estimates of the gap in mortality by education groups appear to be too small compared with Lleras Muney (2002). According to Strauss and Shavell's estimations there is no age at which the ten-year death rate for high school graduates surpass the death rate for college graduates in 14.4 percentage points. This could be suggesting that the relationship between education and mortality is not linear, as the level of education increase the gains from an additional year of education decrease. But this does not mean

that the gains for high education levels are small. In the study by Grossman (1975) all of the individuals in the sample has at least high school, the average level of education was 15 years, and he still find a strong positive relationship between health and education, what suggest that the relationship persist at high level of educations. To some extent Lleras Muney (2002) estimates suggest that the survival rates estimates that we use in our study are not overstating the effect of education on mortality.

3.2- Health

Grossman (1972) constitute one of the most important pieces of evidence regarding the causal relationship between education and health. He report "positive effects of schooling on self-rated health and negative effects of schooling on work-loss days due to illness and injury and on restricted activity days due to illness and injury" after controlling for wage, income, age, and several other variables.

Arkes (2001) uses intra-state differences in unemployment rates during a person's teenage years as an instrumental variable to deal with potential selectivity bias problems in estimating the effects of schooling on adult health outcomes. He estimate that an additional year of schooling reduce the probability of having a work-limiting health condition by 2.6 percentage points and to reduce the probability of requiring personal care by 0.67 percentage points.

de Walque (2003) provides additional evidence on the relationship between health and education. He find that "in Uganda, in the early 90's, at the beginning of the epidemic, more educated women were at greater risk of being infected by HIV/AIDS but that , later, this positive gradient between HIV prevalence and education disappeared, because highly educated individuals were more likely to alter their sexual behavior." In addition, using

retrospective data from the NHIS for the US, he find that after 1950 when the information about the dangers associated with tobacco became available, the prevalence of smoking declined earlier and more strongly among college graduates.

When he include the effect of education in reducing smoking in the US the internal rate of return to education increase by 0.1 and 0.5 percentage point. These low magnitudes could be due to the fact that excess mortality from smoking is concentrated between age 50 and 75, so that these gains are heavily discounted at age 18. In addition, since the value of the benefits of education on life expectancy depends on the Value of Life Year, which positively depends on the discount rate, the fact that he did not adjust the Value of Life Year for changes in the discount rate could understate the real magnitude of the effect on the internal rate of return (i.e., the internal rate of return schooling is 9% and the discount rate to compute the Value of Life Year 3%). These benefits of education could increase in more than 50% when we adjust the Value of Life Year accordingly, we will extend on this point later.

3.3- Marital Instability

According to Becker, Landes, and Michael (1977)'s study on marriage instability "an increase in education has an ambiguous effect on the probabilities of dissolution and remarriage. The reason is that education reduces the division of labor between mates (thus lowering the gain from marriage) while increasing the gain from any given division of labor". An additional force that could drive a negative correlation between schooling and marriage instability is the idea that more educated people are better searcher in the marriage market, forming better matches than less educated people.

Figure 4 and 5 show data on the fraction of first marriage disrupted by duration of the marriage and women level of education and family income respectively. Figure 4 shows a negative relationship between women education and the probability of first marriage disruption. The odd ratio between the less educated and the most educated decrease monotonically with the duration of the marriage. The odd ratio of marital disruption for the first year is 3, while the odd ratio for 15 years is 1.52. Figure 5 shows a similar relationship between marital disruption and family income, which suggest that in order to get a good measure of the effect of education on marriage instability we have to control for income.

Becker et al. (1977), using data from SEO survey 1967, find a week negative correlation between education and marital instability. However, Weiss and Willis (1997), using data from the National Longitudinal Study of the High School Class of 1972, find that schooling is an important predictor of marriage stability after controlling for other variables, including income. In general a higher level of schooling for either the wife or the husband increase marriage stability. They also find that individuals are more likely to marry if they have similar amounts of schooling. In their dataset the correlation of educational attainments of the two spouses at the time of marriage is 0.57.

Table 5, replicated from Weiss and Willis (1997), presents estimates of the direct effect of education on the probability of divorce. The table shows a strong negative relationship between education and the probability of divorce. If a women has a high school degree, acquisition of a college degree by her husband reduce the divorce index by 0.257, while if she is a college graduate the effects is 0.499. According to Weiss and Willis (1997) the five years divorce probability (probability that the marriage dissolve during the fifth year)

is reduced from 23% to 9% if both spouse increase education from high school or less to college graduate or more.

3.4- Quality of Children

Educational Attainment

When parents are more educated, their children tend to receive more education. Many studies have estimated the degree of intergenerational persistence in schooling between parents and children. Couch and Dunn (1997) use intergenerational samples from the US PSID and the German Socio-economic Panel to calculate intergenerational correlations of education in the United States and Germany. They regress schooling of the children on schooling of the parents. For the United States using data of 1984, they find a coefficient of 0.27 for the relation Son-Father, 0.37 for the relation Son-Mother, 0.25 for the relation Daughter-Father, and 0.32 for the relation Daughter-Mother. Mulligan (1997) run similar regressions for a representative sample of the United States, using the SRC portion of the PSID, and he find a coefficient of 0.32 for the relation Son-Father, and 0.33 for the relation Father-Child.

Part of this correlation could be explained by transmission of ability. In order to disentangle the effect of ability from the effect of schooling some studies have used intergenerational sample of families that contains biological and adopted children. This kind of samples provides an effective way to separate biological from environmental influences.

Sacerdote (2002) find that adoptive family income and education have large effects on children's college attendance and marital status and modest sized effects on labor market

income. He also finds evidence that the impact of adoptive family background on test scores does not diminish as children mature.

Using a sample drawn from the NLSY79 he find that each additional year of adoptive mother's education is associated with a gain of 0.22 years of education for the child. The coefficient for the control children is 0.35 and the differences between control and adopted are statistically significant. The coefficient on adoptive father's education is smaller, 0.16, but is also significant at the 5 percent level.

He also run probit regressions where the dependent variable is whether or not the child completed four years of college. He include as right hand side variables a dummy for mother completed four years of college, a dummy for father completed four years of college, and log of family income. The coefficients on adoptive mother's or father's completion of college are quite large at 0.40 and 0.38 respectively, and are statistically significant. This means that children adopted by a mother with a college degree have a 40 percent higher chance of graduating from college themselves when compared to children adopted by a mother without a college degree. The coefficients that they obtain for the control children are not statistically different from those for the adopted children. As the author said "Admittedly, these coefficients may in part be driven by selection bias. However, it is hard to believe that the coefficient is entirely driven by selection bias."

In the same line of Sacerdote (2002), Plug and Vijberberg (2003) use an intergenerational sample of families that contains biological and adopted children…

4- Bias on the Estimations

In this section we discuss some sources of possible bias in the estimates of the causal effect of schooling, and how some of the studies that we use try to deal with this issue. Perhaps the estimates that we use over the study are not as precise as we would like, but the additional evidence that we present accompanying the estimates of the effects of education on different non-market outcomes suggest that in fact education has an important effect on the outcomes that we are interest in. In measuring returns to schooling the precise magnitude of the effect is important, but as we will show even if we use the most pessimistic estimates the total return to education appear to be too large.

The positive relation between education and some non-monetary outcomes in general could be driven by a third unobservable factor. Three hypotheses are worth mentioning:

1- Ability: The relationship between education and some non monetary outcomes could be due to the fact that people with more ability are better at school, or have low school costs, and are better producers of everything else, like health, children.

2- Discount Rate: Education and some non-monetary outcomes could be a negative function of the discount rate. In particular, most patient people (with low discount rate) may have more incentives to invest in both education and activities that improves health, while people with high discount rate has less incentive to invest in both kind of capital. In this case the negative correlation between education and health is driven by its relationship with time preferences.

3- Other unobservable: The relationship could be driven by other unobservable factors, like genetic transmission of intelligence or health, which determines both outcomes. For example, since healthy people has more incentives to invest in human capital it is likely to find in the data a positive relationship between both

variables. In the case of quality of children, if there is strong genetic transmission of ability, parents with more ability are more educated and so are their children.

The aim of most studies about the effects of education is to disentangle the effects of education from these other determinants. In order to obtain a "clean" measure of the magnitude of the effect of education most economist have used instrumental variable methods…

Even if the dispute is not resolved, it is worth to have an idea of the importance of this estimates assigning dollar values to these benefits and measuring its effect on the return to schooling.

5- A Framework for Valuing the Effects of Education on Non-Monetary Outcomes.

As we shown in section 2 and 3, education affects many different non-monetary outcomes. In this section we present a framework to estimates people willingness to pay for education for its effects on non-monetary outcomes. We follow Rosen (1988) and Murphy and Topel (2003) by assuming that willingness to pay is determined by the expected discounted present value of lifetime utility. We write lifetime discounted utility for a representative individual at age 18 with school level So as:

$$U(S_0) = \sum_{t=18}^{\infty} \frac{U_t(C_t, S_0)s(t,18,S_0)}{(1+\rho)^{t-18}} \qquad (3)$$

In (3) s(t,18,So) is the survivor function that depends on the level of schooling of the individual, So.

We assume a perfect and complete annuity market, which means that at each age the lifetime expected discounted value of future consumption must equal expected lifetime wealth:

$$\sum_{t=18}^{\infty} \frac{C_t s(t,18,S_0)}{(1+r)^{t-18}} = \sum_{t=18}^{\infty} \frac{y_t(S_0) s(t,18,S_0)}{(1+r)^{t-18}} \qquad (4)$$

The individual choose an optimal consumption path to maximize (3) subject to (4). The necessary conditions for an optimal consumption is:

$$\frac{U_t^C(C_t,S_0)}{(1+\rho)^{t-18}} = \frac{\lambda}{(1+r)^{t-18}} \qquad (5)$$

The maximum expected value of lifetime discounted utility for a representative individual with level of education So at time t=18 is given by:

$$U^*(S_0) = \sum_{t=18}^{\infty} \frac{U_t(C_t,S_0) s(t,18,S_0)}{(1+\rho)^{t-18}} + \lambda[\sum_{t=18}^{\infty} \frac{y_t(S_0) s(t,18,S_0)}{(1+r)^{t-18}} - \sum_{t=18}^{\infty} \frac{C_t s(t,18,S_0)}{(1+r)^{t-18}}] \qquad (6)$$

We can obtain the dollar value of (6), or the "value of life", dividing (6) by the constant marginal utility of consumption in (5):

$$V(S_0) = \frac{U^*(S_0)}{\lambda} = \sum_{t=18}^{\infty} \frac{[\frac{U_t(C_t,S_0)}{U_t^C(C_t,S_0)} + y_t(S_0) - C_t]}{(1+r)^{t-18}} s(t,18,S_0) \qquad (7)$$

The willingness to pay for an increase in education holding income constant will be given by the marginal value of changing S in (7), that is:

$$V'(S_0)=\sum_{t=18}^{\infty}\frac{[\dfrac{U_t(C_t,S_0)}{U_t^C(C_t,S_0)}+y_t(S_0)-C_t]}{(1+r)^{t-18}}s_{S_0}(t,18,S_0)+\sum_{t=18}^{\infty}\frac{U_t^{S_0}(C_t,S_0)}{U_t^C(C_t,S_0)(1+r)^{t-18}}s(t,18,S_0) \quad (8)$$

$$V'(S_0)=\sum_{t=18}^{\infty}\frac{B_{1,t}+B_{2,t}}{(1+r)^{t-18}} \quad (9)$$

The first term in (8) correspond to the dollar value of the gain in lifetime expected utility from change in mortality due to change in schooling. The term in bracket in the first term correspond to the value of life year. The second term is the dollar value of changes in utility due to change in schooling.

In order to obtain an empirically tractable formulae for valuing changes in different outcomes caused by changes in schooling we make some particular assumption about the form of the utility function. For example, to value changes in quality of life or health, following Murphy and Topel (2003) we will assume that health raises total utility and the marginal utility of consumption by the same proportional amount, so that the second term becomes equal to the sum of the changes in quality of life due to changes in schooling times the value of utility holding mortality fixed.

One of the attractive features of this framework is that it allows us to obtain for each year over the lifecycle the dollar value of non-monetary benefits of schooling. These allow us to obtain a lifetime profile of the benefits of going to school other than the increase in earnings, and to compute its present value. Also it allows us to add up these benefits year by year to the earning profile in order to compare the two lifetime profiles, and to compute internal rate of returns.

5.1- Computing Internal rates of returns that accounts for monetary and non-monetary benefits.

As Becker state in his Human Capital, "rates of return provide the most convenient and complete summary of the economic effects of education". In order to compute returns to schooling that accounts for non-monetary benefits of education, first we compute willingness to pay for additional education for its effects on each particular non-monetary outcome using the framework described in the preceding section.

Once we compute the dollar value of these benefits, it is possible to calculate the internal rate of returns (IRR) to schooling by extending the traditional computation of monetary IRR to schooling in the following way:

$$\sum_{t=S_1}^{T(S_1)} \frac{y(S_1, t-S_1)s(t,0,S_0)}{(1+r)^t} + \sum_{t=S_1}^{\infty} \frac{B(S_1)}{(1+r)^t} - \sum_{t=0}^{S_1} \frac{v_t s(t,0,S_0)}{(1+r)^t} = \sum_{t=0}^{T(S_0)} \frac{y(S_0,t)s(t,0,S_0)}{(1+r)^t} \quad (10)$$

The second term in (10) is the dollar value of benefits associated with education other than earnings. The third term is the monetary and non-monetary costs of education. Notice that we include in the computation survival rates for schooling level So because we would like to include the effects of education on life expectancy.

5.2- Value of Life Year

The major difficulty in applying this approach is determining the Value of Life Year. Most studies derive the Value of Life Year from estimates of the Value of Statistical Life. The many studies of the average value of life of young persons in the United States suggests a range from about $11/2 million to $7 million (see Viscusi, 1993), so we will

assume in our computations an average value of about $3 million for High School graduates.

As we will show, the Value of Life Year inferred from the VSL depends on the discount rate. Since most of our estimates depend on the VLY, in order to compute the internal rate of return we have to adjust the value of life year accordingly. For example, if we assume a discount rate of 3% to compute the value of life year, and the internal rate of return is 12% we will underestimate the effects of this additional benefit on the return to schooling since we will be discounting this benefit at a 12%, while we assumed a 3% to compute its dollar value.

For example, Rosen (1988) using a similar framework shows how the average per period VSL increase from $32,550 to $71,400 when the interest rate increase from 4% to 12%, holding the VSL constant, which implies a discount rate elasticity of the VLY of 0.6. Nordhaus (2003), shows that the value of life year increase from $106,600 to $183,000 when the discount rate increase from 0 to 3%, which implies discount rate elasticity of the VLY of 0.41, using a VSL of $3 million. In the present subsection we show how to adjust the value of life year for changes in the discount rate.

The analog to the VSL computed from risk-wage trade-off in our framework corresponds to the uniform change in income in all periods that is necessary to compensate the individual for a change in the probability of death. That is:

$$\frac{dy}{d\theta} = -\frac{\sum_{t=18}^{\infty} \frac{[\frac{U_t(C_t,S_0)}{U_t^C(C_t,S_0)} + y_t - C_t]}{(1+r)^{t-18}} S_\theta(t,18,S_0,\theta)}{\sum_{t=18}^{\infty} \frac{S(t,18,S_0,\theta)}{(1+r)^{t-18}}} \qquad (11)$$

A simple way to compute the Value of Life Year using (11) is to assume that the Value of Life Year is equal in all periods (consumption is equal to income, and is equal in all periods), in this case the per period value of life is equal to:

$$VLY = -VL * \frac{\sum_{t=18}^{\infty} \frac{S(t)}{(1+r)^{t-18}}}{\sum_{t=18}^{\infty} \frac{S_\theta}{(1+r)^{t-18}}} \qquad (12)$$

Using life tables for High School graduates and assuming a discount rate of 3% we obtain a Value of Life Year equal to $172,000, very similar to the $183,000 find in Nordhaus (2003) since he uses similar assumptions. If we use a discount rate of 7% the Value of Life Year increase to $250,000. These values imply a discount rate elasticity of the Value of Life Year of 0.55, very similar to Rosen (1988). Note that this implies that the value of any benefit of education that is proportional to the Value of Life Year increase by 45% when we change the discount rate from 3% to 7%.

Another way to compute the Value of Life Year is by assuming a particular functional form for the utility function. Murphy and Topel (1999) using a simplified version of Rosen (1988) include non market time on the utility function and assume that the utility function is homogenous of degree g in consumption and non-market time, so that the ratio of utility to the marginal utility value of full consumption, defined as the sum of consumption plus the value of non-market time, is constant. An attractive feature of this approach is that it allows the Value of Life Year to vary over time. Under these assumptions the Value of Life Year can be expressed as:

$$B_t = (y_t^F + C_t^F \Phi) \qquad (13)$$

Where Φ is a parameter that depends on the curvature of the utility function and is equal to (1-g)/g, and yf and Cf are full income and full consumption respectively. In order to compute the Value of Life Year within this framework we have to compute the value of Phi. As they show, one way to compute Φ is to use estimates of the VSL. They compute the value of Phi in the following way:

$$\Phi(r) = \frac{VL * \sum_{t=0}^{\infty} \frac{s(t,a,S,\theta)}{(1+r)^t} - \sum_{t=a}^{\infty} \frac{y_t^F}{(1+r)^t} s_\theta(t,a,S,\theta)}{\sum_{t=a}^{\infty} \frac{C_t^F}{(1+r)^t} s_\theta(t,a,S,\theta)} \qquad (14)$$

Where

$$s_\theta(t,a,S,\theta) = -s(t,a,S,\theta)(t-a)$$

and VL is the value of life computed from tradeoffs between income and job-related mortality. The knowledge of the value of life, and the time paths of full income and full consumption, and mortality rates by age allow us to compute this parameter. As equation (14) shows, among other variables, Φ depends on the discount rate r.

Within this framework, the IRR, including the effects of education on life expectancy and earnings only, computed in a consistent way is given by:

$$\sum_{t=S_1}^{T} \left(\frac{y(S_1, t-S_1) - y(S_0,t)}{(1+r)^t}\right) s(t,0,S_0) + \sum_{t=S_1}^{T} \frac{(y^F(S_0,t) + C_t^F \Phi(r)) s_S(t,0,S_0)}{(1+r)^t} = Cost \quad (15)$$

The IRR will be given by the roots of equation (15). We can perform these same calculations assuming a constant value of life year using (12). In the following sections, we perform this adjustment to the internal rate of return in all the estimations that involve value of life estimates.

In order to obtain a simple expression for Phi we assume that full consumption is equal to full income. Under this assumption Phi is given by:

$$\Phi = \frac{VL * \sum_{t=a}^{\infty} \frac{s(t,a,S,\theta)}{(1+r)^{t-a}}}{\frac{14*7*52}{8*5*52} \sum_{t=a}^{\infty} \frac{y_t}{(1+r)^{t-a}} * s(t,a,S,\theta) * (t-a)} - 1 \qquad (16)$$

Where we made the following assumptions (1) individuals allocate 14 hours per day between market and nonmarket activities, of which 8 hours are allocated to market activities (See Jorgenson and Fraumeni, 1995), and (2) consumption is equal to income in all periods. For example using a value of life estimates of $3 million for a person with lifetime income of $400 thousand and assuming a discount rate of 3.5%, like Murphy and Topel (2003), gives a value of phi equal to 2.33, Murphy and Topel (2003) obtains a value of 2.9 for phi.

6- Estimation.

For the estimations, we use estimates of earnings profiles for White Males with High School graduates and College graduate from Heckman and Lochner (2001) based on the 1990 Census of the United States. For the monetary cost of college we use data on average tuition, room and board of universities for 1990 from the US Department of Education, National Center for Education Statistics.

6.1- Effects of Education on Life Expectancy and Health

As we shown in section 3 higher education levels are associated with reductions in mortality rates and increases in quality of life or health. In order to value the gains in length of life and quality of life, following Murphy and Topel (2003), in (3) we set:

$$U_t(C_t, S_0) = U(C_t)H_t(S_0) \qquad (17)$$

Then (6) becomes:

$$V'(S_0) = \sum_{t=0}^{\infty} \frac{1}{(1+r)^t}[\frac{U(C_t)}{U'(C_t)} + y(t) - C(t)]s_S(0,t,S_0) + \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} \frac{U(C_t)}{U'(C_t)} \frac{H_t^{'}(S_0)}{H_t(S_0)} s(0,t,S_0) \quad (18)$$

Where

$$s(a,t,S) = \exp(-\int_a^t \theta(\tau, S)d\tau)$$

and

$$s_S(a,t,S) = -s(a,t,S)\int_a^t \theta_S(\tau, S)d\tau$$

The first term measure how much an individual with high school education is willing to pay to change his survival function to the one of a college graduate. The second term is the willingness to pay for quality of life or health improvements caused by more schooling.

In this case the value of the per period benefit of education is given by:

$$B_t = [\frac{U(C_t)}{U'(C_t)} + y(t) - C(t)]s_s(0,t,S_0) + \frac{U(C_t)}{U'(C_t)} \frac{H_t^{'}(S_0)}{H_t(S_0)} s(0,t,S_0) \qquad (19)$$

Where the first term in bracket is the gaining in Value of Life Year induced by changes in mortality, and the second term is the gaining in Value of Life Year induced by changes in quality of life.

Estimates of the value of the effect of education on Life expectancy

Figure 6 uses (18) to calculate the willingness to pay for reductions in mortality for going from high school to college education for white males using Strauss and Shavell (2000) estimates of the survival rate by education level. The figure shows lifetime earnings profiles of High School graduates, College graduates and lifetime value profiles of earnings of College graduates plus the value of gaining in life expectancy due to education for College graduate assuming a discount rate of 7%. As the figure show the value of gaining in life expectancy are important, especially after the 40 years of age.

Discounting the gaining in life expectancy at a 7%, equal to the discount rate that we use to compute Value of Life Year, the present value of gains in life expectancy due to education is equal to $37,121. If we assume a constant value of life and a discount rate of 7%, which gives a constant Value of Life Year of $250,000, the present value of the gains in life expectancy due to education is equal to $38,000. When we use our estimates of the survival probabilities based on Rogers et al (2002) estimates the present value of gains in life expectancy decrease significantly to $16,000.

For comparison, Murphy and Topel (1999) estimate that the dollar value for an 18-24 years old male of the increase in life expectancy due to reductions in heart disease between 1970 and 1990 is $108,184 approximately. To highlight the magnitude of the effects of education on mortality rates, Figure 9 compare the difference in death rate between high school and college graduate after controlling for income and other variables with the reductions in heart diseases death rates between 1970 and 1990. As the graph show, the reductions in death rate due to education are on average 20% of the reductions in heart disease death rate. Our estimates of the gains in life expectancy due to education

using Strauss and Shavell (2000) estimates represent 34% of Murphy and Topel (1999)'s estimates.

Estimate of the Value of the effect of education on Quality of Life

Figure 7 uses (18) to calculate the economic value of improvements in health caused by education. We show lifetime earnings profiles of High School graduates, College graduates and lifetime value profiles of earnings of College graduates plus the value of gaining in health due to education for College graduate assuming a discount rate of 7%. We assume a uniform difference of 0.5% in health between College graduates and High School graduates between ages 22 to 40, and 1% thereafter. The present value of gaining in health due to education is equal to $16,400, assuming a 7% discount rate.

6.2- Effects of Education on Marital Instability

Married people invest in many assets, like house, cars, children, from which they derive posterior utility. As stated by Becker (1974), some of these investments are marital-specific, since its value decline if marriage dissolved. "Children, for example, would be a specific investment if the pleasure received by a parent were smaller when the parent was (permanently) separated from their children". To value improvement in marriage stability caused by more schooling we assume that to get utility from your children when they are kids you have to live with them. To impute a value to the utility derived from children we assume an altruistic utility function in which the per-year value of being with your children is equal to the Value of Life Year of children.

In order to value gaining in marriage stability, in (3) we set:

$$U_t(C_t, S_0) = U(C_t)H_t(S_0) + P(M, t, S_0, S_w(S_0))nV_t \qquad (20)$$

Where P is the probability of stayed married conditional on the time since marriage, the level of schooling of the individual, and the level of schooling of the spouse, and n is the number of children, and V is the utility derived from each children.

Then, in (6) we have to add the following component:

$$B_t = \frac{1}{\lambda}\left(\frac{\partial P(M,t,S_0,S_w(S_0))}{\partial S_0} + \frac{\partial P(M,t,S_0,S_w(S_0))}{\partial S_w} S_w'(S_0)\right) nV_t \qquad (21)$$

The length of the benefits will depend on the average age that children leave home, and on the remarriage rate.

Estimate of the Value of the effect of education on Marital Instability

Figure 8 uses (21) to calculate the value of the effect of education on marriage stability for going from High School to College education using Weiss and Willis (1997) estimates of the effect of education on the probability of divorce. We show lifetime earnings profiles of High School graduates, College graduates and lifetime value profiles of earnings of College graduates plus the value of gaining marriage stability due to education for College graduate assuming a discount rate of 7%. Since the average age of first marriage during the early 90's in the United States for males was 26.5, we assume that the individual has their first child at age 29, and that after 5 years the difference in the probability of divorce by education level are such that the survival probability are equal. We perform this assumption in order to account for remarriage. Also, we assume that the Value of Life Year per Children is equal to Value of Life Year of an individual at age 18, and that the individual has one child only.

Under these conservative assumptions, and discounting the gains in marriage stability at a 7% discount rate, the present value of the gains in marriage stability due to education is equal to $8,850.

6.3- Effects of Education on quality of children (Incomplete)

In order to value changes on quality of children caused by more schooling in (1) we set:

$$U_t(C_t, S_0) = U(C_t)H_t(S_0) + P(M, t, S_0, S_w(S_0))nV_tQ(S_0, S_w(S_0)) \qquad (22)$$

Where Q is the quality of children that depends on schooling of the parents. The quality index has different components like health and educational attainment. Then, in (6) we have to add the following term:

$$B_t = \frac{1}{\lambda} P(M, t, S_0, S_w(S_0))V_t(Q_{S_0} + Q_{S_w} S_w'(S_0)) \qquad (23)$$

6.4- Summary of results

Table 6 collect results obtained in this section. It presents present values, using a discount rate of 7%, of the monetary cost of going to college, the difference in earnings between College and High School graduates, and our estimates of the present value gains in life expectancy, health, and marriage instability that we computed in this section. As the table shows, the net present value of investment in education using a discount rate of 7% is large, $93,850. If we use our estimates of the survival probabilities by education level based on Rogers et al (2002) the net present value decrease to $72,550. Non-monetary benefits of education represent 51% of the total benefits of education (41%, using Rogers et al, 2002, estimates).

Jorgenson and Fraumeni (1995) estimate investment in Human Capital in US for the period 1947-1986 based on the flow of human capital services. They recognize the effects of education in activities outside the labor market by incorporating to their estimates the value of time spent outside the labor market. They estimate a value of college investment per student for 1986 of $131,800 in current dollars ($157,173.91 in 1990 $) assuming a discount rate of 4.58% and the same survival probabilities for both educational groups. According to our computations, the value of gains in life expectancy, marriage instability, and health due to education, assuming a discount rate of 7%, represents 40% of the investment in college education, which is close to the contribution of non-monetary benefits to the total internal rate of return to education. Assuming a discount rate of 4.58%, the share of non-monetary benefits on investment in college increase to 57%.

6.5- Internal Rate of Return to Education including Non-Monetary Benefits

In Table 7 we compute Internal Rate of Returns of going from High School to College that include monetary and non-monetary benefits of education, and monetary costs. The first column present computations of the internal rate of return assuming a fixed discount rate of 7% to compute the per period value of life. The second column present computations of the internal rate of return using VLY adjusted for changes in the discount rate using equation (10), that is we assume that the discount rate to compute the per period value of life is equal to the internal rate of return.

The internal rate of return including earnings and tuition only is equal to 9.3%. When we add gains in life expectancy, quality of life or health, and marriage stability using a fixed discount rate of 7% to compute VLY the rate of return increase 33%, it increase to

12.4%. When we adjust the per year Value of Life for changes in the discount rate using equation (11) the rate of return increase by 6.5 percentage points, or 70%, to 15.8%.

These numbers are not as accurate as we would like but they show that the contribution of non-monetary benefits to the return to schooling is significant, and that the rate of return to education is extraordinarily large. The question that poses these results is how could we account for such a large premium on education.

7- Conclusion and Directions for Future Research

In this paper we have quantified the importance of non-monetary benefits of education using a suitable economic model. The share of non-monetary benefits on the total value of investment in human capital could be at least 40%. When we add the value of the effects of education on life expectancy, quality of life or health, and marriage stability the rate of return to schooling increase by 70%. We show that the total rate of return to education is over 15% when we include these kinds of benefits on the computation of the internal rate of return. This is an extraordinarily large rate of return when we compare with other forms of investment. While these estimates could have some problems regarding possible bias on the estimates that we use in our analysis, the magnitude of these benefits appear to be too large to be explained on those grounds.

Our analysis so far has been very preliminary. While we have shown the magnitude of the economic value of education, we have not attempted to explain why the education premium is large using a standard economic model. Regarding our estimations, we can improve the accuracy of our estimations by improving our economic model and by computing the value of the benefits of education using different estimates of the causal

effect of education. In the same line we plan to extend our framework in order to estimate other benefits of education.

Our plan for the future is to refine the economic model in order to have more accurate and precise estimates of the total return to schooling, and to include other non-monetary benefits in our computations. Perhaps the most important part of our research in the future will be to try to explain the large education premium, or at least to show what factors cannot explain such a large premium.

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Tables

Table 1
Returns for Selected Countries

	Mean Real Return			
	Period	Market Index	Relatively Riskless Security	Education for Male	Risk Premium of Education
United States	1947-2000	8.4%	0.6%	8.8% (1976, 1978, 1987, 1991-95)	8.2%
United Kingdom	1947-1999	5.7%	1.1%	10.85% (1975, 1982, 1984, 1987)	9.75%
Japan	1970-1999	4.7%	1.4%	8.03% (1975, 1978, 1988)	6.63%
Germany	1978-1997	9.8%	3.2%	6.6% (1986, 1988)	3.4%

Source: Mehra (2003), Psacharopoulos (2002).

Table 2
Death Rates for White Males according to Age, and Educational Attainment for Selected States
United States – 1994 - 1996

	1994	1995	1996
	Deaths per 100,000 Population		
25-44 years of age			
Less than 12 years	364.9	367.8	329.7
12 years	306.3	311.9	283.1
13 years or more	140.7	137.7	119.1
45-64 years of age			
Less than 12 years	1303.6	1301.9	1297.1
12 years	1115.2	1117	1071.4
13 years or more	509.9	495.9	480.9

Note: Based on Data of 45 States and the District of Columbia.
Source: Centers for Disease Control and Prevention, National Center for Health Statistics.

Table 3
Mortality ratios by years of school completed (standardized for age and income level), for white family members 25-64 years of age, by sex: United States, May-August, 1960

Years of School completed	Ratios standardized for age and income level	
	White males	White females
Family members 25-64 years	1.00	1.00
0-7 years	1.05	1.21
8 years	1.04	1.05
High School, 1-3 years	1.05	.93
High School, 4 years	.95	.90
College, 1 year or more	.87	.89

Source: Kitagwa and Hauser (1973)

Table 4 – Roger and Nam (2002)
Odds Ratios Showing the Effect of Socioeconomic Status on Mortality, US Adults Age 18 and Over, 1991-1995

Covariates	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Education								
0-8 years	1.94*			1.53*	1.69*		1.44*	1.44*
9-11 years	1.85*			1.49*	1.61*		1.39*	1.39*
High School graduate	1.60*			1.37*	1.44*		1.30*	1.30*
13-15 years	1.41*			1.28*	1.30*		1.22*	1.22*
16 years	1.25*			1.21+	1.19		1.16	1.16
17 years or more	ref			ref	ref		ref	ref
Controls								
Income		x		x		x	x	x
Employment Status			x		x	x	x	x
Age	x	x	x	x	x	x	x	x
Sex	x	x	x	x	x	x	x	x
Race	x	x	x	x	x	x	x	x
Marital Status	x	x	x	x	x	x	x	x
Health Status								x

*5% of significance.
+10% of significance.

Table 5
Effect of Education on Probability of Divorce

	Wife's Education		
Husband's Education	High School	Some College	College Graduate
High school	...	−.124	−.135
		(−1.985)	(−1.443)
Some college	.080	−.221	−.184
	(−1.385)	(−4.517)	(−1.709)
College graduate	−.257	−.334	−.499
	(−3.214)	(−4.761)	(−7.233)

NOTE.—Probit coefficients are drawn from table A1, panel G, col. 1; *t*-statistics are in parentheses.

Source: Weiss and Willis (1997)

Table 6
Present value gains of going from High School to College assuming a discount rate of 7%

Item	Present Value (r = 7%)
Earnings	$59,500
Monetary Cost of College	$28,000
Life Expectancy	$37,100
Health	$16,400
Marital Instability	$8,850
Net Present Value	$93,850

Table 7
Internal rates of return of going from High School to College

	With discount rate = 7%	Adjusting the discount rate
Earnings + Tuition	9.3%	9.3%
Earnings + Tuition + Gains in Survival	11.0%	12.0%
Earnings + Tuition + Health	10.3%	10.8%
Earnings + Tuition + Marriage Stability	10.0%	10.3%
Earnings + Tuition + Gains in Survival + Health + Marriage Stability	12.4%	15.8%

Figures

Figure 1
Estimated Survival Probabilities for age 18 by Education for High School and College Graduate – White Males – 1991-1995

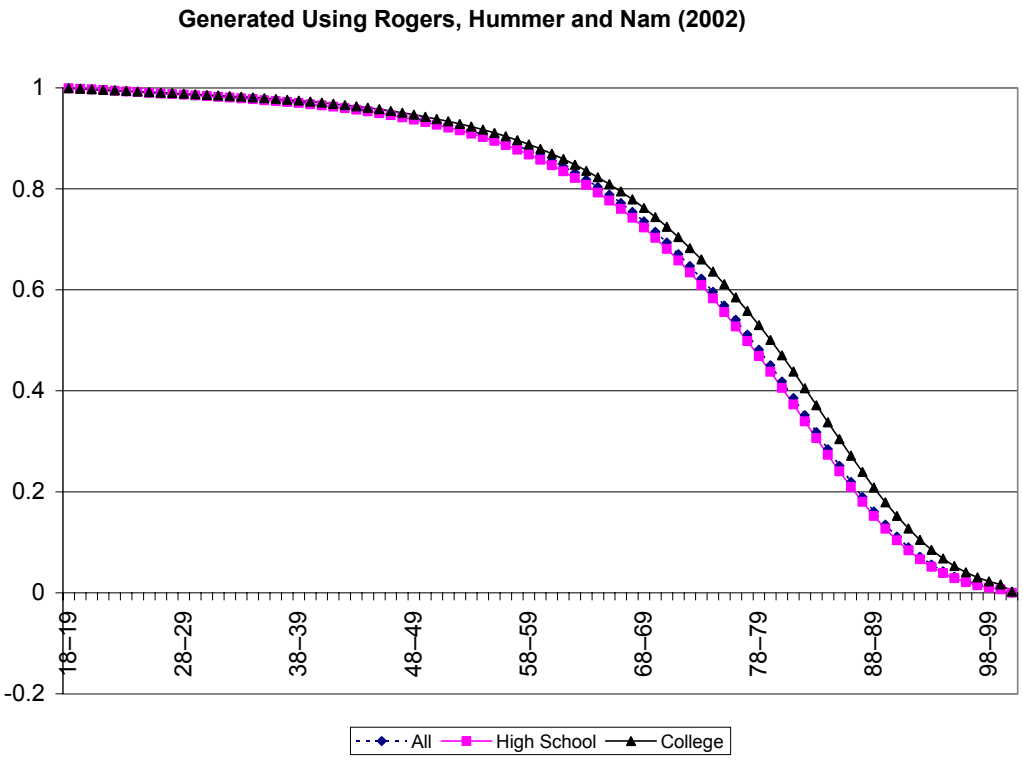

Figure 2
Estimated Survival Probabilities for age 18 by Education for High School and College Graduate – White Males - 1990

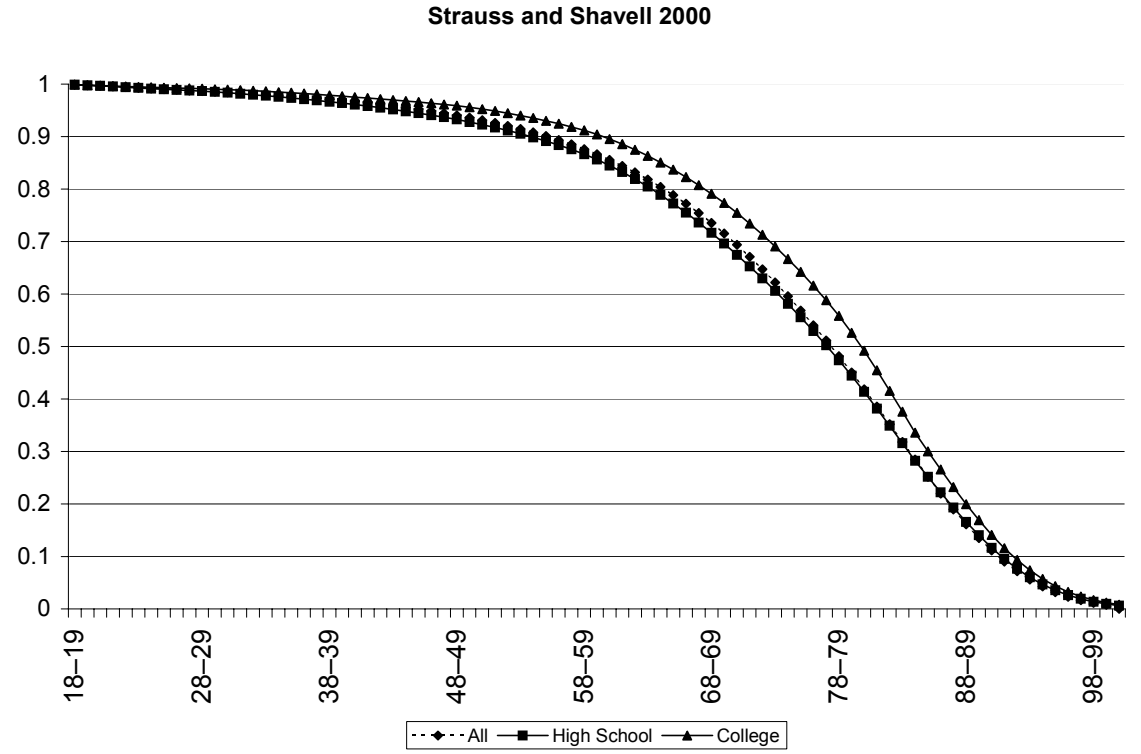

Figure 3

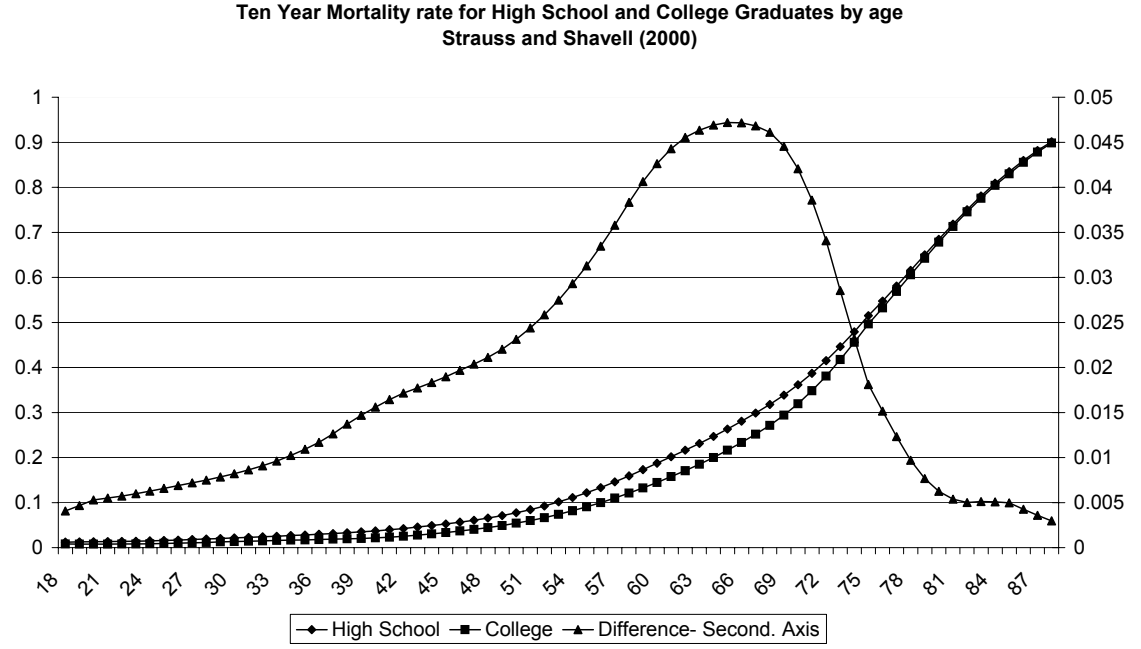

Figure 4

Probability of first marriage disruption by duration of marriage and Women level of Education: Non-Hispanic white women 15–44years of age. United States, 1995

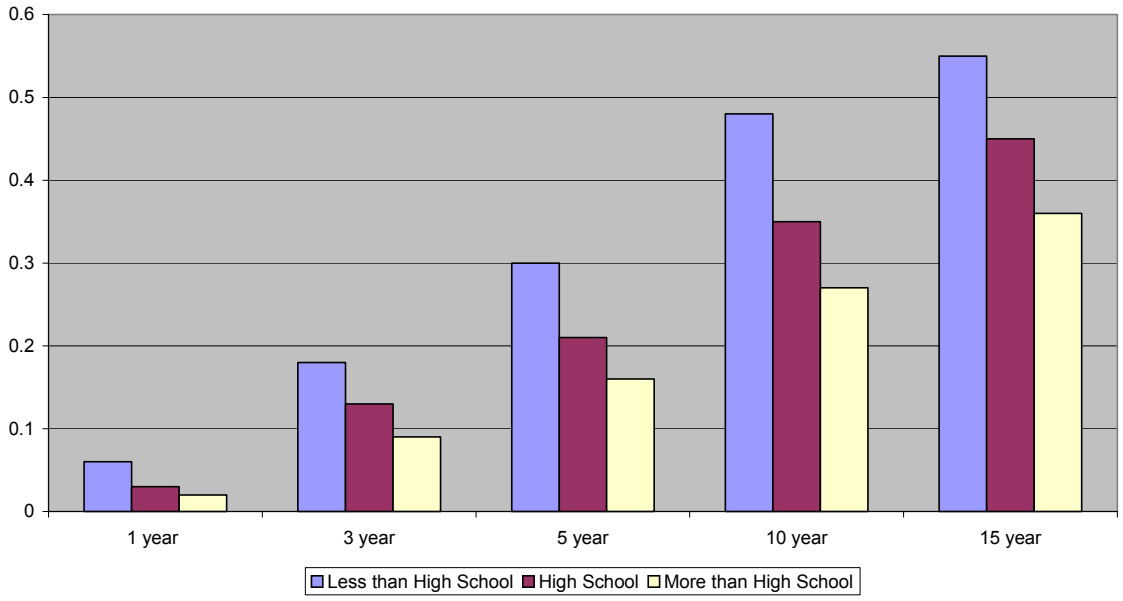

Figure 5

Probability of first marriage disruption by duration of marriage and Family Income: Non-Hispanic white women 15–44years of age. United States, 1995

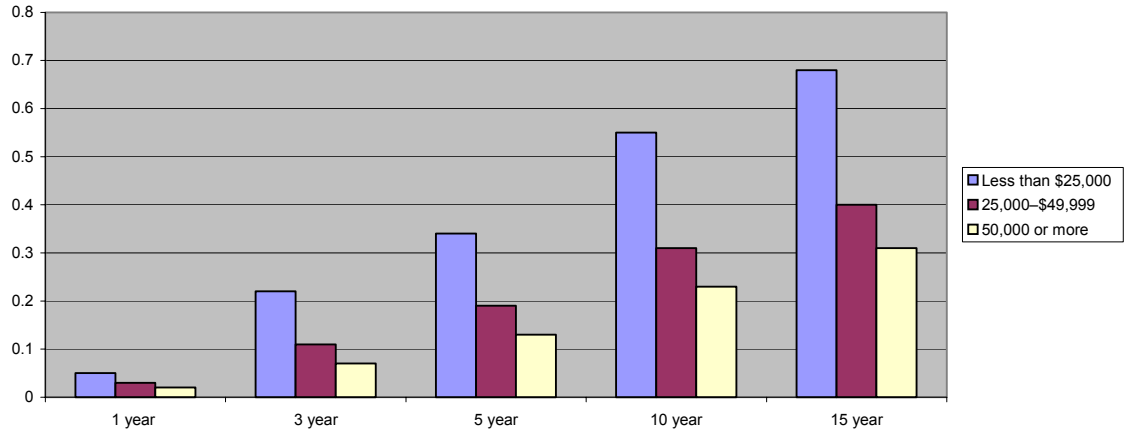

Figure 6

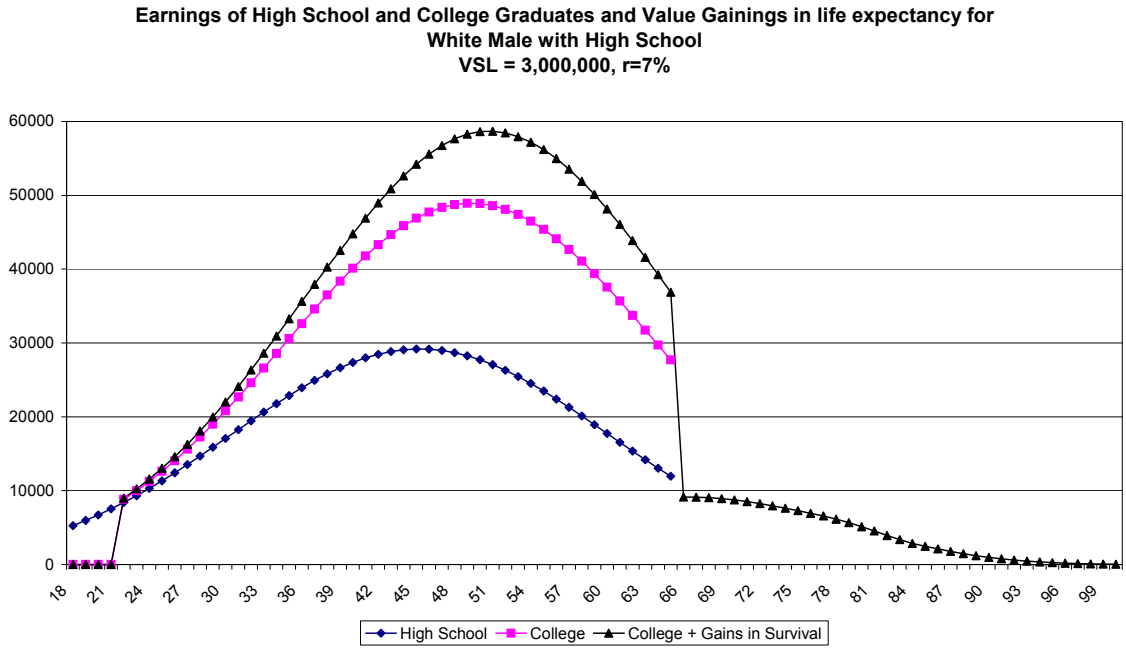

Figure 7

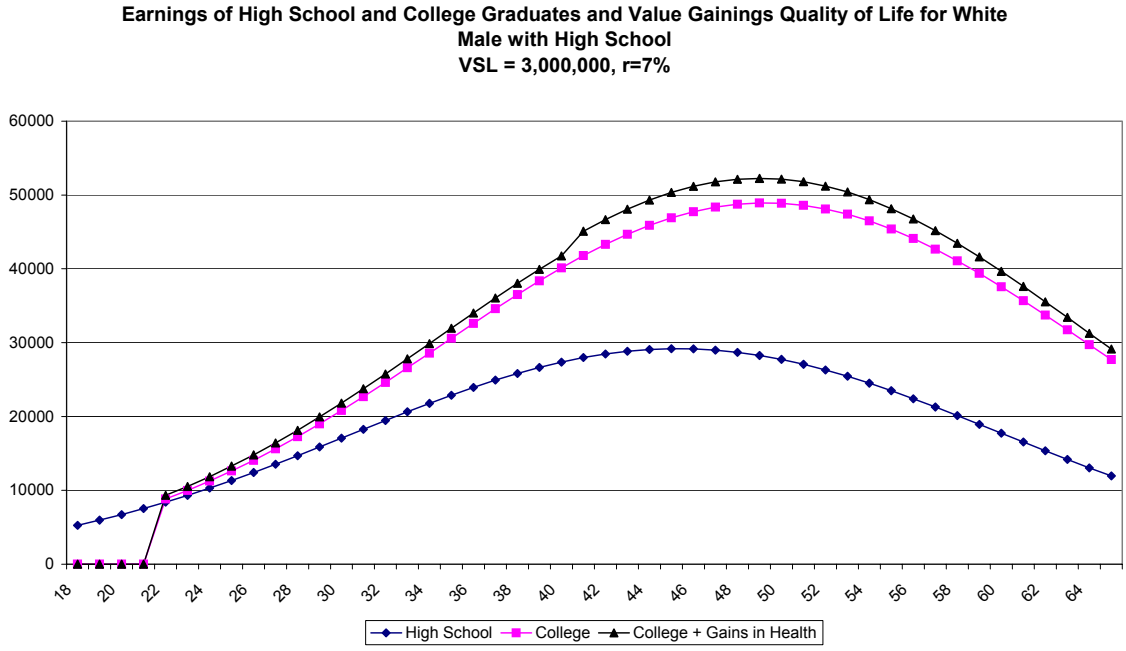

Figure 8

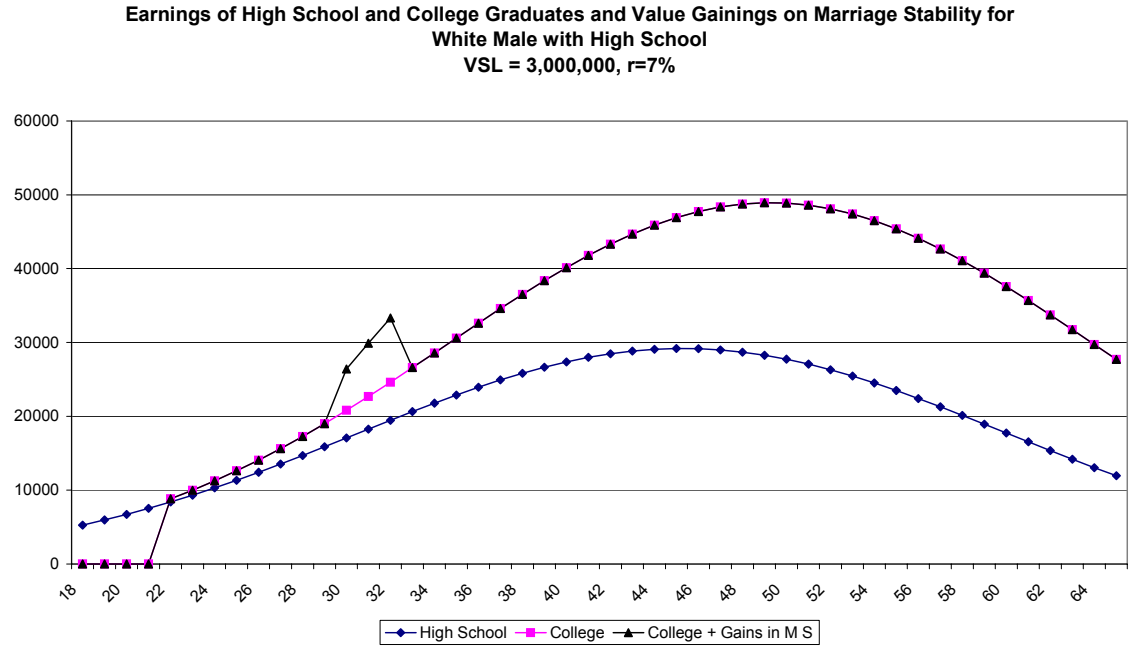

Figure 9