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Educational Attainment Model for a Minor Child: The Next Generation

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Abstract

An ordered probit educational attainment model, used to predict the lost earning capacity of a wrongfully injured minor child, was created by Spizman and Kane (1992) and updated by Kane and Spizman (2001). This paper re-estimates the educational attainment model using the latest round of interviews from the National Longitudinal Survey of Youth-1997. The model specification has been updated to reflect recent findings on the determinants of educational attainment. We also examine the legal framework in which econometric techniques have been accepted and have become standard tools in litigation.

I. Introduction

Spizman and Kane (1992) proposed a procedure for estimating the earning losses of an injured minor child. An updated version appears in Kane and Spizman (2001). In this procedure, an ordered probit estimation technique models an individual's choice among alternative levels of education. This model is then used to estimate the probabilities of alternative levels of educational attainment for a minor child, based upon family background characteristics. A forensic economist then estimates the present value of lifetime earnings at alternative levels of educational attainment. The estimated earnings projection is constructed by weighting each of these earnings projections by the estimated probability of observing it.

The original Spizman-Kane (SK, 1992) study was estimated using data from the *National Longitudinal Study of the High School Class of 1972*. Gill and Foley (1996) re-estimated an extended version of this model using data from the *National Longitudinal Study of Youth-1979* (NLSY79). This data set provided information on high school dropout probabilities that could not be directly derived in the SK 1992 model (since the earlier sample consisted only of high school seniors). Gill's and Foley's model also included a wider set of family background variables than those used in the original study.

The data used by Gill and Foley only contained observations measured between 1979 and 1992. Kane and Spizman (2001) re-estimated the Gill and Fo-

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ley variant of this model by including updated educational attainment data through 1998. Gill and Foley also used, tested, and replicated the original Spizman/Kane model. More recently, Kane, Spizman, Rodgers and Gaskin (2010) used an expanded version of this model to estimate the effect on a child's future earnings when one or both parents are absent.

The literature described above indicates that the specification adopted in Spizman/Kane (1992) has been quite robust, generating very similar predictions and forecasts when estimated using alternative data sets and alternative model specifications. Most of the estimates, however, have been generated using samples of individuals born in the 1950s and 1960s. It is quite likely that the determinants of educational attainment for individuals born in recent decades will be somewhat different than for individuals born in the mid 20th century. Some of the household human capital investment proxy variables introduced by Gill and Foley, such as the presence of a library card, household newspaper, or magazine subscriptions, are becoming increasingly less likely to serve in their intended role as proxies for unobserved household investments in human capital due to the widespread access to information on the internet.

In the current paper, the ordered probit model is re-specified to take into account more recent research on the determinants of educational attainment. The set of variables is altered to better reflect the factors that influence educational attainment for youth who make educational decisions in the 21st century. This updated model is then estimated using a younger cohort that more closely reflects the experiences of today's youth.

Before addressing the proposed re-specification of this model, it will be helpful to address the legal framework in which the model is applied.

II. Legal Framework

The ordered probit econometric technique used by Spizman/Kane (1992) and replicated by six additional studies seems to meet the legal standards of admissibility. The authors could find no court challenge to the SK model. Any discussion on the admissibility, or inadmissibility, of scientific testimony must necessarily begin with an analysis of the standards set forth by the Supreme Court in *Daubert v. Merrel Dow Pharmaceuticals.* In *Daubert*, the court outlined specific guidelines for determining the admissibility of expert testimony under rule 702 of the Federal Rules of Evidence, which states:

> A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:
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> (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
> (b) the testimony is based on sufficient facts or data;
> (c) the testimony is the product of reliable principles and methods; and
> (d) the expert has reliably applied the principles and methods to the facts of the case.

A judge, prior to any expert testifying, must make an "…assessment of whether the reasoning or methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue." (*Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 1993, p. 592-593)

The court is thus required to act as a "gatekeeper," its objective being "…to ensure the reliability and relevancy of expert testimony." (*Kumho Tire Co., Ltd. v. Carmichael*, 1999, p. 152) The court's duty "…is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field." (p. 152)

The reliability of econometric and regression analysis data under the *Daubert* standard is well established and unquestionable.[1] An exhaustive search of both Federal and State statutes and judicial opinions revealed no instances of the methodologies of regression analysis or econometrics being barred under the *Daubert* standards or any other. Rather, when opinion testimony based on regression analysis or econometrics has been disallowed, it is often due to problems with the qualifications of the particular witness, the inclusion of irrelevant variables, or the omission of relevant variables.[2] There is even an instance in which a Federal Court, while excluding an expert's testimony which was not based on regression analysis or econometric modeling, went as far as to imply that the testimony would have been more likely to be admitted had econometric data been relied upon. (*Zenith Electronics Corp. v. WH-TV Broad. Corp.*, 2005)

Econometric and regression analysis-based testimony is not confined to any one particular type of case; it is accepted in a wide array of cases with a multitude of different applications.

In an anti-trust suit, claims of price-fixing were made against various defendant carpet manufacturers. (*Polypropylene Carpet Antitrust Litig.*, 2000) The Plaintiffs offered a witness who sought to testify based on an econometric model designed "…to forecast competitive prices during the time period at issue, and identify any difference between the actual prices of polypropylene carpet and the forecasted competitive prices during that period." (p. 1351) The Defendant raised objections to the admissibility of the testimony, attacking its reliability because it was based on certain assumptions, allegedly did not count for major factors affecting the dependent variable, and the data used was questionable. (*Polypropylene Carpet Antitrust Litig.*, 2000) The court was not swayed and admitted the testimony.

In a securities fraud case brought against the University of Phoenix, investors claimed that the Defendant artificially kept its stock prices high through fraudulent methods. (*Apollo Group Inc. Sec. Litig.,* 2007) The Plaintiffs offered in support of their claims expert testimony based on a multiple regression

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[1]See e.g. In re *Polypropylene Carpet Antitrust Litig.*, (2000) "Regression analysis is a well-worn statistical technique used in a variety of contexts to examine the nature of the relation, if any, between two or more variables." (p. 1359); *City of Tuscaloosa v. Harcros Chemicals, Inc.*, (1998) "regression analysis [is] a methodology that is well-established as reliable." (p. 566)

[2]See e.g., *Zenith Electronics Corp. v. WH-TV Broad. Corp.*, (2005), In re *Polypropylene Carpet Antitrust Litig.* (2000), quoting Peter Kennedy, *A Guide to Econometrics* 69 (2d ed.1985).

analysis aimed at identifying what factors determined salary for specific employees of the Defendant. (*Apollo Group Inc. Sec. Litig.,* 2007) The court admitted the testimony over objection, ruling that the expert's "…methodology and opinions are reliable and relevant to this case." (p. 963)

Claims of bid-rigging were brought to Federal Court by the State of Colorado against two contractors; econometric modeling was offered showing what competitive bids would have been without rigging. (*State of Colo. v. Goodell Bros., Inc.,* 1987) The State offered the testimony to show the impact the rigging had on prices by calculating the difference between the bids projected by the econometric model and the actual bids made. (*State of Colo. v. Goodell Bros., Inc.,* 1987) The court admitted the testimony and ruled that it was "…reasonable and valid." (p. 3)

Precedent also supports the use of economic and statistical analysis being used to calculate damages in personal injury and wrongful death cases. "…[T]he task of projecting a person's lost earnings lends itself to clarification by expert testimony because it involves the use of statistical techniques and requires a broad knowledge of economics." (*Hughes v. Pender*, 1978, p. 262) "When properly utilized, such expert testimony can provide a rational basis for the jury's determination of an individual's future earnings, and can thus minimize the risk of jury speculation present whenever future earnings must be predicted." (p. 263) Such testimony frequently uses independent variables to project what future income would have been in comparison to what it is or is not, as in the case of wrongful death after the injury. "In a case such as this, involving a person who had not yet made his choice of livelihood, future lost earnings must be determined on the basis of potential rather than demonstrated earning capacity." (p. 263) "That potential must be extrapolated from individual characteristics, such as age, sex, socio-economic status, educational attainment, intelligence and dexterity." (p. 263)

Testimony based on the use of an ordered probit model will be reviewed by courts that have the power to be flexible when determining its admissibility.[3] As there is ample case law to support the reliability of econometric modeling and regression analysis-based testimony, both in a general sense and in an array of specific applications, the use of the ordered probit model is surely found to be reliable.

A federal case mentioned the study by Kane/Spizman et al., in a ruling excluding a forensic economist from testifying about the lost earnings of a minor child due to the death of her father. The specific problem that the court had with the offered testimony was that it relied on speculation and was not grounded in sound econometric evidence. (*Kallas v. Carnival Corp.*, 2008)

A 2011 case specifically discusses issues with respect to the earning capacity of a minor child. (*Musick v Dorel Juvenile Group*, 2011) The district court allowed expert opinions on earning capacity loss based on facts specific to the minor child. The court said that "statistical evidence alone is too speculative and cannot form a sufficient basis for such damages." (p. 960) The court further defined statistical evidence as "generalized employment and earnings statistics about the population at large, and not on facts specific to the plaintiff." (p. 961)

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[3]See *Natchitoches Parish Hosp. Serv. Dist. v. Tyco Intern., Ltd.*, 2009. ""The test for the admissibility of economic testimony is a flexible one with the touchstone of reliability." (p. 1097).

These generalized employment and earnings statistics that the court rejected are often the basis for a minor child's estimate of lost earning capacity.

An example of using such general statistics is when an economic expert claims a minor's future earnings is based on the average earnings of a high school graduate (or college graduate) for all individuals of the same gender as the child. The court further said in defense of the plaintiff's expert that "Instead of only using statistical averages to calculate lost earning capacity, the plaintiff's experts combined facts personal to the plaintiff with national data that corresponds to the individualized evidence." (p. 962) This is precisely what the model in this paper accomplishes using econometric models.

III. Why an Update?

The Kane/Spizman (2001) study used the National Longitudinal Survey of Youth (NLSY79) which started in 1979. The survey respondents in this sample were between the ages of 14 and 21 in 1979 and would be 48-55 years old in 2013. While this data set offers the advantage of providing a sample in which virtually all participants have completed their educational attainment, individuals in this sample made educational decisions in an environment that differs increasingly from the conditions facing current youth.

In 1997 the *National Longitudinal Survey of Youth* (NLSY97) started tracking a new cohort of youth from a nationally representative survey of 8,984 men and women born between the years of 1980 to 1984 (see http://www.bls.gov/nls/nlsy97.htm for a full description of the survey). This cohort was first interviewed in 1997 when they were between 12 and 16 years old as of December 31, 1996. In this study, we rely on data from the base year (1997) through the 14th follow-up interview in 2010. At the time of the most recent interview, cohort participants were between the ages of 25 and 29. The sample population was born between January 1, 1980 and December 31, 1984. The educational experiences and constraints facing individuals who participated in the NLSY97 sample are likely to be much more representative of current youth than would be true for the prior generation that participated in the NLSY79 sample.[4]

A few of the variables included in our prior study are not available in the NLSY97 data. Specifically, the following variables are not available: parents' occupations, the presence of library cards in the household, and the presence of newspaper and magazine subscriptions in the household. While a measure of parental occupation might be helpful as a proxy variable for unobservable parental human capital investments, we now have more direct means of measuring this. With the ubiquitous presence of the internet, the availability of library cards and print media in the household is likely to no longer be a very useful measure of household investment in a child's human capital. While the new data set includes data on the availability of computers in the household, computers in 1997 were quite different from the computers that most people keep in their backpacks, on their desks, or in their pockets today. Any such

[4]While not all of the participants in the NLSY97 sample will have completed the very highest levels of educational attainment, we believe that the risk of understating completed educational attainment is sufficiently offset by the more recent vintage of this sample.

measure becomes obsolete very rapidly and would not serve as a very good long-term proxy variable.

The NLSY97 data, though, offers the advantage of providing several variables that were not reliably measured in the NLSY79 data set. The household income for 1997 is reported by the head of the household and by all working recipients. This measure is expected to be more reliable than the youth respondent reported income in the NLSY79 data. In the current study, we use a direct measure of household income (the ratio of gross household income to the poverty level) which is likely to serve as a much more direct measure of the human capital stock of the household head(s) than the less direct measures used in the earlier studies.[5] This measure is also one that can be easily estimated by forensic economists applying this model.[6]

Recognizing that the parents of minor children involved in litigation may not be legally obligated (or willing) to provide income tax records, we also re-estimate a model (Model II) that does not include the income-to-poverty ratio.

The NLSY97 data set also provides data on the biological mother's age at first birth. This variable has been shown in a variety of studies to be an important determinant of educational outcomes.[7]

IV. The Model: Estimating the Probability of Obtaining Different Educational Levels.

A large number of econometric models have been developed that examine the determinants of a child's eventual educational attainment based on family background and demographic characteristics. Most of these studies have fo-

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[5]A growing body of evidence, beginning with Easterlin (1974), indicates that individual decisions are influenced by relative, not absolute, income. This is one argument for the use of an income to poverty ratio variable instead of just a real income measure. A second advantage of this approach is that it eliminates the need to convert current incomes into 1997 dollars when applying this model.

[6]The income-to-poverty ratio is the family income divided by the poverty level for the prior year. Poverty levels for the 48 contiguous states and the District of Columbia depend on the number of persons in the household. In 2012, for example, the poverty levels were:

- $11,170 for a one-person household,
- $15,130 for a two-person household,
- $19,090 for a three-person household,
- $23,050 for a four-person household,
- $27,010 for a five-person household,
- $30,970 for a six-person household,
- $34,930 for a seven-person household,
- $38,890 for an eight-person household (for more than 8 people add $3,960 for each additional person), (Federal Register/Vol. 77, No. 17/ Thursday, January 26, 2012 Notices p 4035).

Family income as defined by the Census Bureau's measures of poverty includes earnings, unemployment compensation, workers' compensation, Social Security, Supplemental Security Income, public assistance, veterans' payments, survivors benefits, pension or retirement income, interest, dividends, rents, royalties, income from estates, trusts, educational assistance, alimony, child support, assistance from outside the household, and other miscellaneous sources. It is before taxes and does not include non-cash benefits such as food stamps and housing subsidies, as well as excluding capital gains or losses (see www.census.gov/hhes/www/poverty/about/overview/measure.html).
For practical purposes it would be line 22 (total income) from the parents' Federal 1040 Individual Income Tax Returns.

[7]See, for example, Fryer and Levitt (2004).

cused on binary choices such as whether or not a particular student will complete high school, will attend college, or will acquire a graduate degree. In the discussion below, we will focus on the process of jointly estimating the probability of alternative levels of educational attainment.[8]

The ordered probit educational attainment model of Kane and Spizman (2001) is one method of predicting the educational attainment of a minor child. The ordered probit specification is modeled as:

$$Z_i = X_i\beta + \mu_i.$$

The benefits and/or costs of different levels of educational attainment are represented by the unobservable variable Z_i. Family background and demographic variables that influence Z_i are represented by the vector X_i. An indicator variable is used to show the actual educational level for each individual in the sample because Z_i is unobservable. It is assumed that individual i acquires:[9]

less than a high school degree if $Z_i \leq \theta_1$
GED if $\theta_1 < Z_i \leq \theta_2$
High School diploma $\theta_2 < Z_i \leq \theta_3$
an Associate's degree if $\theta_3 < Z_i \leq \theta_4$
Bachelor's degree if $\theta_4 < Z_i \leq \theta_5$
a Master's degree if $\theta_5 < Z_i \leq \theta_6$
a Ph.D. degree if $\theta_6 < Z_i \leq \theta_7$
an MD, JD, or DDS degree if $Z_i > \theta_7$.[10]

The ordered probit estimated coefficients are then used to determine the probability of the minor child obtaining each different educational level as his or her highest level of educational attainment.[11]

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[8]Recent papers on this topic in the forensic economic literature are Jepsen and Jepsen (2001), Kane and Spizman (2001), and Kane, Spizman et. al., (2010). The reference sections of these papers list earlier papers in the forensic economics literature and papers in the general economics journals.

[9]This specification follows that used in Kane, Spizman, et al. (2010) and slightly differs from that used in Spizman and Kane (1992) and in Kane and Spizman (2001). The initial threshold value is specified as θ_1 instead of zero. This alternative specification is becoming more common in the literature and has been adopted by Stata, the statistical package that was used to generate the results appearing. The two alternative specifications are equivalent. The specification used in this study does not contain a separate constant term (the estimated value of θ_1 is the negative of the constant term in the earlier specification).

[10]While a PhD degree is a higher academic rank than an MD, JD, and DDS degree, these professional degrees are placed higher in this ordering on the grounds that medical schools, dental schools, and at least some law schools are more selective than are most PhD programs. Further, graduates of professional programs generally receive higher salaries and more social status than is received by PhDs.

[11]For a more complete discussion of the ordered probit model, see Marcus and Greene (1985), Zavoina and McElvey (1975), and Spizman and Kane (1992).

Table 1
Probabilities of Alternative Levels of Educational Attainment

Outcome	Probability
Less than high school degree	$\Phi(\hat{\theta}_1 - \hat{Z})$
GED	$\Phi(\hat{\theta}_2 - \hat{Z}) - \Phi(\hat{\theta}_1 - \hat{Z})$
High school diploma	$\Phi(\hat{\theta}_3 - \hat{Z}) - \Phi(\hat{\theta}_2 - \hat{Z})$
Associate's degree	$\Phi(\hat{\theta}_4 - \hat{Z}) - \Phi(\hat{\theta}_3 - \hat{Z})$
BA or BS degree	$\Phi(\hat{\theta}_5 - \hat{Z}) - \Phi(\hat{\theta}_4 - \hat{Z})$
Master's degree	$\Phi(\hat{\theta}_6 - \hat{Z}) - \Phi(\hat{\theta}_5 - \hat{Z})$
PhD degree	$\Phi(\hat{\theta}_7 - \hat{Z}) - \Phi(\hat{\theta}_6 - \hat{Z})$
Professional degree (DDS, JD, MD)	$1 - \Phi(\hat{\theta}_7 - \hat{Z})$

Where: $\Phi(\cdot)$ is the cumulative density function for a standard normal random variable.

Table 1 describes how to calculate the probability of reaching each different level of educational attainment. The economist would have to determine the total earning for each educational level and then weigh each outcome by the probability of each educational level.[12] Adding these together would provide the estimated lost earnings of the minor child.

V. Data

The variables and the sample means of these variables used in the estimation are described in Table 2. Minority groups were oversampled in the NLSY97, so to correct for this, sample base year weights were used to estimate population means in Table 2.[13] Most of these variables have been described in Kane and Spizman (2001).[14] The main differences in the current specification are:

dropping outdated measures of human capital investment such as library card ownership and newspaper and magazine subscriptions;

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[12]From an applied perspective, if using an excel spread sheet the normdist function is used for Table 1. Z_i is the sum of all the demographic variable (1 or 0) multiplied by the estimated coefficient for that variable.

[13]While a weighted mean estimator is used, the ordered probit equation was estimated using an unweighted procedure. The rationale for this is that the ordered probit equation is assumed to hold for all individuals in the population. The use of weighted estimator would induce heteroskedasticity, and could be justified only if the ordered probit equation would have different parameters for different subsamples of the population. If this were the case, the estimation of a single equation would be inappropriate.

[14]The high value for the mean number of siblings in cross-sectional samples often surprises people that have not examined such data. The basic issue is that families with no children have a 0% probability of having a child included in a cross-sample survey of adolescents. Families with 10 children have 10 times the probability of having a child in the sample compared to households with a single child.

Table 2
Description of variables and sample means

		Sample means			
		Model I		Model II	
Variable	**Description**	**Males**	**Females**	**Males**	**Females**
Highest Level of Educational attainment					
Less than high school	= 1 if the respondent does not report a HS degree or GED	0.0918	0.0862	0.0943	0.0820
GED	= 1 if the respondent reports a GED degree	0.1020	0.0715	0.0992	0.0696
HS	= 1 if the respondent reports a high school degree	0.4813	0.4064	0.4801	0.4086
Associate's	= 1 if the respondent reports an AA or AS degree	0.0744	0.0814	0.0681	0.0830
Bachelor's	= 1 if the respondent reports a BA or BS degree	0.2058	0.2843	0.2120	0.2882
Master's	=1 if the respondent reports a Master's degree	0.0365	0.0515	0.0368	0.0561
PhD	= 1 if the respondent reports a PhD degree	0.0016	0.0034	0.0015	0.0030
Professional Degree	= 1 if the respondent reports a PhD, JD, MD, or DDS degree	0.0067	0.0152	0.0082	0.0153
Demographic Variables					
Hispanic	= 1 if the respondent reports a primary racial/ethnic identification as Hispanic or Latino	0.1051	0.0981	0.1069	0.0994
Black	= 1 if the respondent reports a primary racial/ethic identity as Black	0.1097	0.1173	0.1140	0.1214
Urban	= 1 if the respondent reports living in the central city in a Metropolitan Statistical Area	0.2187	0.2395	0.2229	0.2420
Rural	= 1 if the respondent reports living in a rural area	0.2914	0.2929	0.2856	0.2872
Parent's Education					
Mother's years of schooling	= number of years of schooling for mother	13.2769	13.2103	13.3046	13.2364
Father's years of schooling	= number of years of schooling for father	13.3824	13.2094	13.3942	13.2491
Both biological parents	= 1 if both biological parents were present in the household when the respondent was 12 years old	0.5888	0.5597	0.5970	0.5659
Mother's age at 1st birth	= the age of the mother at the birth of her first biological child	23.5820	23.6013	23.6084	23.6337
Religion raised					
Baptist	= 1 if the respondent reports being raised as a Baptist	0.1914	0.2137	0.1927	0.2121
Protestant	= 1 if the respondent reports being raised as a non-Baptist Protestant	0.3752	0.3953	0.3799	0.3935
Catholic	= 1 if the respondent reports being raised as a Roman Catholic	0.3620	0.3121	0.3553	0.3161
Jewish	= 1 if the respondent reports being raised in a Jewish religion	0.0144	0.0113	0.0161	0.0123
No religion (atheist, agnostic, or no religion reported)	= 1 if the respondent reports being raised as an atheist, agnostic, or with no religion	0.0283	0.0386	0.0262	0.0363
Other (non-agnostic and non-atheist)	= 1 if the respondent reports an alternative religion	0.0275	0.0282	0.0284	0.0288
Other household variables					
Number of siblings	= number of siblings reported in 1997	3.8031	3.7901	3.8000	3.8066
Income-to-poverty ratio	= gross household income / poverty level income	3.4488	3.4647	-	-

dropping the very broadly defined parental occupation dummy variables used in earlier studies;
including a direct measure of household income to replace the human capital proxy variables used above;
replacing a dummy variable representing an "only child" with a quantitative variable representing the number of siblings;
including a measure of mother's age at first birth.

VI. Changing Educational Levels

Table 3 contains statistics on the gender distribution of degrees awarded between 1975 and 2009. An examination of this table illustrates the need for an updated study. In recent years, female respondents have become more likely than males to receive all levels of college degrees except for professional degrees. Female professional degrees have also increased over most of this period, dropping slightly as a share in the last three years of data. These changes reflect the rather dramatic rise in female college enrollments over the last several decades. The increase in college degrees for females adds to their human capital and enhances their expected lifetime earnings. The data from the more recent NLSY97 cohort reflects the increase in female educational attainment more accurately than the older NLSY79 cohort.

Table 3
Number of Degrees (in thousands) by Degree and Gender

Year	Percent of all degrees held by males	Associates Degrees		Bachelor's Degrees		Masters' Degrees		Professional Degrees		Doctoral Degrees	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1975	56.0	191	169	505	418	162	131	49	7	27	7
1976	55.7	210	181	505	421	167	145	53	10	26	8
1977	54.7	211	196	496	424	168	149	52	12	25	8
1978	53.3	205	208	487	434	161	150	52	14	24	8
1979	52.1	192	211	477	444	153	148	53	16	24	9
1980	51.1	184	217	474	456	151	147	53	17	23	10
1981	50.3	189	228	470	465	147	149	53	19	23	10
1982	49.8	197	238	473	480	146	150	52	20	22	10
1983	49.6	204	246	479	490	145	145	51	22	22	11
1984	49.6	203	250	482	492	144	141	51	23	22	11
1985	49.3	203	252	483	497	143	143	50	25	22	11
1986	49.0	196	250	486	502	144	145	49	25	22	12
1987	48.4	191	245	481	510	141	148	47	25	22	12
1988	48.0	190	245	477	518	145	154	45	25	23	12
1989	47.3	186	250	483	535	149	161	45	26	23	13
1990	46.6	191	264	492	560	154	171	44	27	24	14
1991	45.8	199	283	504	590	156	181	44	28	25	15
1992	45.6	207	297	521	616	162	191	45	29	26	15
1993	45.5	212	303	533	632	169	200	45	30	26	16
1994	45.1	215	315	532	637	176	211	45	31	27	17
1995	44.9	218	321	526	634	179	219	45	31	27	18
1996	44.2	220	336	522	642	179	227	45	32	27	18
1997	43.6	224	347	521	652	181	238	46	33	27	19
1998	43.2	218	341	520	664	184	246	45	34	27	19
1999	42.7	218	342	519	682	186	254	44	34	25	19
2000	42.6	225	340	530	708	192	265	44	36	25	20
2001	42.4	232	347	532	712	194	274	43	37	25	20
2002	42.2	238	357	550	742	199	283	43	38	24	20
2003	42.1	253	380	573	775	211	301	42	39	24	22
2004	41.8	260	405	595	804	230	329	42	41	25	23
2005	41.6	268	429	613	826	234	341	44	43	27	26
2006	41.3	270	443	631	855	238	356	44	44	29	27
2007	41.2	275	453	650	875	238	366	45	45	30	30
2008	41.2	283	468	668	895	246	379	46	45	31	32
2009	41.3	298	489	685	916	260	397	47	45	32	35

Source: U.S. National Center for Education Statistics,
Digest of Education Statistics, annual.
Statistical Abstract 2012, Table 299

Table 4
Ordered Probit Equation

Variable	Model I		Model II	
	Males Coefficient (t-ratio)	Females Coefficient (t-ratio)	Males Coefficient (t-ratio)	Females Coefficient (t-ratio)
Demographic Variables				
Hispanic	-0.1542 (-2.24)**	0.0475 (0.66)	-0.2233 (-3.56)	0.0529 (0.80)
Black	-0.0829 (-1.19)	0.2134 (3.11)***	-0.1287 (-2.05)**	0.2127 (3.44)***
Urban	-0.0438 (-0.81)	0.0407 (0.76)	0.0364 (-0.74)	0.0269 (0.55)
Rural	-0.0094 (-0.18)	0.1489 (2.68)***	-0.0067 (-0.14)	0.1275 (2.48)**
Parent's Education				
Mother's years of schooling	0.0190 (3.11)***	0.0736 (7.03)***	0.0297 (5.12)***	0.0804 (8.37)***
Father's years of schooling	0.0199 (3.98)***	0.0610 (6.41)***	0.0268 (5.61)***	0.0646 (7.41)***
Both biological parents	0.4269 (8.91)***	0.4333 (9.01)***	0.4368 (10.12)***	0.4522 (10.38)***
Mother's age at 1st birth	0.0345 (6.76)***	0.0258 (4.88)***	0.0398 (8.60)***	0.0249 (5.24)***
Religion raised				
Baptist	-0.0775 (-1.21)	-0.1249 (-2.01)**	-0.0231 (-0.39)	-0.1377** (-2.40)
Catholic	-0.0163 (-0.30)	0.0983 (1.69)*	-0.0014 (-0.03)	0.0692 (1.29)
Jewish	0.3472 (1.73)*	0.1952 (0.84)	0.4540 (2.58)***	0.3634 (1.78)*
Other (non-agnostic and non-atheist)	0.3812 (2.56)***	0.0965 (0.65)	0.3084 (2.29)**	0.0954 (0.70)
No religion	-0.3259 (-2.32)**	-0.2173 (1.73)*	-0.3111 -(2.36)**	-0.1449 -(1.23)
Other household variables				
Number of siblings	-0.0119 (-1.55)	-0.0011 (-0.15)	-0.0164 (-2.32)**	-0.0025 (-0.35)
Income-to-poverty ratio	0.0563 (6.36)***	0.0443 (4.65)***	-	-
Thresholds				
$\hat{\theta}_1$	0.1982	1.2693	0.3846	1.2256
$\hat{\theta}_2$	0.7211	1.6900	0.8936	1.6387
$\hat{\theta}_3$	2.2012	3.0674	2.3604	3.0143
$\hat{\theta}_4$	2.4518	3.3176	2.5881	3.2645
$\hat{\theta}_5$	3.6178	4.5623	3.7430	4.4675
$\hat{\theta}_6$	4.3556	5.2312	4.4327	5.1802
$\hat{\theta}_7$	4.4295	5.3034	4.5045	5.2524
N	2,475	2,380	2,947	2,823
x^2	514.23***	582.70***	571.68***	621.74***

* significant at the 0.1 level
** significant at the 0.05 level
*** significant at the 0.01 level

VII. Empirical Results

Table 4 contains the estimated coefficients for the ordered probit model. The religion variables, in general, seem to be less important in this younger cohort than they were in studies of earlier cohorts. Jewish males, Catholic females, and males of other religions are the only religious groups that, *ceteris paribus*, appear to have higher levels of educational attainment than would otherwise be expected.[15] A large share of the "other religious group" consists of Muslim, Hindu and Buddhist individuals. Given the emphasis placed on male education in Middle Eastern and Asian cultures, the positive coefficient on this variable is not very surprising.[16]

The parental income and education variables have the expected signs and are highly significant for both males and females. As found by Fryer and Levitt (2004), mother's age at first birth is also a significant determinant of educational attainment. As found in Gill and Foley (1996), Kane and Spizman (2001), Kane, Spizman, Rodgers, and Gaskin 2010), Spizman and Kane (1992), Jespen and Jespen (2001), and to some extent Bruce and Anderson (2005), the presence of both biological parents has a substantial positive impact on educational attainment.[17]

The negative sign on the coefficients for black and Hispanic males is consistent with the relatively lower levels of educational attainment for these groups as found by Cameron and Heckman (2001), McDaniel, DiPrete, Buchman, and Shwed (2011), and Jasinski (2000). Black females, on the other hand, tend to acquire more education than their white counterparts. This is probably the result of the higher and more continuous labor force participation realized by this group (relative to black males and white females).

In general, though, the results of this estimation are very consistent with the findings of earlier studies.

VIII. Example

One method used by forensic economists to estimate the earning capacity loss of a minor child is to assume the child would have either earned a high school degree or a college degree. Sometimes an economist will assume the attainment of an associate's degree. That is, the economist uses broad statistical evidence without any personalization of the minor child's familial characteristics. Both scenarios make it an either/or situation. The expert may either leave it to the trier of fact to choose an earning capacity loss based on the broad statistical evidence or the expert will simply take the average of the two scenar-

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[15]More precisely, given the nonlinearity of the normal distribution, all we can say is that this model suggests that a positive coefficient indicates that an increase in the level of the variable results in a lower probability that the individual will become a high school dropout and a higher probability that the individual will acquire a professional degree. The probabilities of other categories of educational attainment may rise or fall in this case.

[16]A similar result is found in Sander (2010).

[17]While other variables such as quality of schools, teacher quality, class size, expenditures per pupil might also affect educational attainment, this data is not available in the current data set (or any other large longitudinal data set). Also in the case of minor preschool injured children, even if this data were available, assumptions about these variables by forensic economists would be speculative.

ios. The economic expert might provide demographic characteristics such as the child's parents' educational levels. The economist will then justify the child's educational attainment on the basis that the child will follow the parents' footsteps and also graduate high school or attend college. The economist does not provide any probability of this occurring.

When an economist presents the earning capacity loss for only a high school degree, he/she are claiming with 100% certainty that the child will obtain a high school degree. When the same economist presents the earning capacity loss for only a college degree he/she also claim with 100% certainty that the minor child will obtain the degree. If the economist or trier of fact takes the average lost earning capacity of the two educational levels, the economist is essentially saying there is a 50% probability of attaining a high school degree and a 50% probability of attaining a college degree. Yet the economist should have the skills and tools necessary to utilize family demographic variables in determining the probability of a minor child attaining all education levels, not just two outcomes.

The convenience and simplicity of using this two educational average earning capacity loss methodology always assumes a 50/50 probability for every child, no matter what the family background characteristics. If both parents are highly successful and educated, the expert might only provide earning capacity loss assuming the minor child gets a Bachelor's degree, in essence claiming with 100% certainty that the minor child will obtain a Bachelor's degree. In all the studies estimating educational probabilities, though, there are no statistical combinations of family background characteristics that will provide any outcome of educational attainment with 100 percent probability.

While the model in this paper requires more effort to estimate the earnings loss (since all earning capacities must be calculated for every educational level) it is statistically more accurate than assuming there is a 50/50 probability of getting a Bachelor's degree and high school degree, or some equally weighted average of different educational combinations. The model examines facts personal to the minor child and combines those with national data that also corresponds to the child's individual evidence. This paper provides the statistical methodology to make the probability statements for each level of education. The economist will have to estimate each educational level earning capacity; however, with data sources such as *Full-Time Earnings in the United States "Expectancy Data,"* it is relatively straightforward.[18]

An example will help provide insight into the process of estimating the probabilities of attaining different educational levels based on specific demographic characteristics. For the purpose of this example, we make the following assumptions: the child is white, lives in central city of a Metropolitan Statistical Area, has a mother with 14 years of schooling, has a father with 16 years of schooling, both parents are in the household, the mother was 28 years of age at the birth of her first-born child, the child was raised in a Protestant religion, has one sibling and the family income is five times the poverty rate.[19]

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[18]We make no judgment on how the earning capacity loss should be projected; that is, using age earning profiles or not, or the rate of growth and discount rate where appropriate. Each expert will have his/her own methodology that has to stand up to vigorous cross examination.

[19]In this example we assume tax returns of the parents were provided. If they are not provided then model II without the income to poverty ratio can be used.

Table 5

Education Level	Male Model 1		Female Model 1		Male Model II		Female Model II	
	Probability of attaining this level of education	Cumulative Probability	Probability of attaining this level of education	Cumulative Probability	Probability of attaining this level of education	Cumulative Probability	Probability of attaining this level of education	Cumulative Probability
Less than High School Diploma	2.25%	2.25%	1.56%	1.56%	2.11%	2.11%	1.75%	1.75%
GED	4.67%	6.92%	2.59%	4.15%	4.29%	6.40%	2.76%	4.51%
High School	43.01%	49.92%	31.95%	36.10%	41.39%	47.79%	32.99%	37.50%
Associate degree	9.90%	59.82%	9.70%	45.79%	9.05%	56.84%	9.77%	47.27%
Bachelor's Degree	32.32%	92.14%	41.47%	87.27%	33.94%	90.78%	39.90%	87.17%
Master's Degree	6.29%	98.43%	9.20%	96.47%	7.04%	97.81%	9.59%	96.76%
Ph.D. Degree	0.27%	98.70%	0.53%	97.00%	0.35%	98.16%	0.49%	97.25%
Professional Degree	1.30%	100.00%	3.00%	100.00%	1.84%	100.00%	2.75%	100.00%
$\hat{Z}_i=$	2.2031		3.4232		2.4158		3.3330	

Table 5 shows the probability of each educational level for males and females with the above demographic characteristics. The *Z* scores are shown at the bottom of the table and are used in the formula in Table 1. Females in both models have a higher probability of attaining a Bachelor's degree and above. Model 1, which includes the income-to-poverty ratio, shows that males have a 32.32% probability of receiving a Bachelor's degree while females have a probability of 41.47%. Model 2, which does not include the income-to-poverty ratio, shows males have a 33.94% probability of attaining a Bachelor's degree while the female probability is 39.90%. The earning capacity loss for each educational level is weighed by the probability for each educational level in Table 5. The trier of fact is thus presented with one estimate of lost earning capacity that examines the demographic characteristics of the child. This determines the child's probability of attaining each level of education.

While this model is useful in establishing a benchmark, the judge or jury can rely on other experts to tailor individual case-specific data to adjust this benchmark. For example, a vocational expert or medical doctor might be used to estimate how the age-earning profile post injury should be adjusted to account for different levels of cognitive impairments of each child. Thus, the vocational expert or medical doctor might opine that post-injury earnings would be reduced by a specific percentage for a child with neurological damage. The economist may adjust the earnings estimates derived from the model presented herein to make adjustments based on the vocational expert's evaluations.

IX. Conclusion

The results of this estimation are very consistent with the results in earlier variations of this model. The revised model takes advantage of more recent findings concerning the determinants of educational attainment. It is also based on variables that are less likely to be rendered obsolete than some of the human capital proxy variables used in earlier studies.

Since a large share of the NLSY cohort are still in the process of completing their education, the estimated probabilities derived from this model will understate the actual probabilities of educational attainment, especially for graduate level attainment. Thus, the lifetime income stream estimates derived from this model should be treated as a lower-bound estimate of expected income. As more waves of the NLSY97 survey become available, though, more precise estimates of lifetime educational attainment will become available. The aging of the NLSY79 cohort used in earlier studies, though, results in predicted educational outcomes that are based on experiences very different from those encountered by current youth. We propose that it is time to use the results from the more recent NLSY 97 cohort in generating forecasts of educational attainment for youth today.

Future research in this area can examine the new literature that is emerging that relates health status to educational attainment (see Stoler and Melzer 2013, and Oster, Shoulson and Dorsey 2013). That is, unhealthy people have lower rates of return to schooling because of higher risks of morbidity or mortality.

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