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Dimensions of Ability and Educational Attainment: The Theory of Comparative Advantage Re-Examined

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ABILITY AND ATTAINMENT

To the extent that the level of schooling attained by a person is subject to rational choice, there must be a weighing of benefits and costs. Many sociological models of schooling can be thought of as focusing on the "psychic costs" (Spence 1974) of schooling, interpreted loosely to include the feedback and normative expectations of others (Sewell, Haller and Portes 1969; Sewell, Haller and Ohlendorf 1970; Sewell and Hauser 1975). Economic models have focused on the monetary returns to schooling, with the cost of schooling largely represented by foregone earnings (Becker 1964; Mincer 1974).

Both of these models place a central focus on a person's ability. In the human capital model, ability is assumed to be a major input into the human capital production function. In the sociological model, ability is assumed to help form the basis for normative judgements about appropriate social positions. In each case, the cost of schooling must rise to exceed the marginal benefits at a level of schooling which is higher for those with a higher level of ability. The challenge of economic research on human capital, in particular, has been to identify the factors acting along with ability, which make for a production function which has this property. Such factors may include ability to pay for schooling, uncertainty about achieving returns and others (see Willis 1986).

A novel way of explaining the sorting process involved in schooling has been proposed by Willis (1986; Willis & Rosen 1979). Rather than conceptualizing ability as a single dimension, Willis proposes that persons sort themselves into educational paths towards occupational opportunities appropriate to a vector of abilities which they possess. Willis shows that a model based on this assumption can reproduce most of the desirable features of the more traditional human capital and can help describe a number of features of the labor market. Most importantly, it provides a shift in rationale from one focusing on the costs associated with years of schooling to one focusing on choice of appropriate opportunities.

Sociologists have not explored the possibility that a number of dimensions of ability influence attainment outcomes. Willis and Rosen (1979) have tested the proposition from an economic point of view, as will be discussed below. Meanwhile, psychologists have long explored the concept of multiple dimensions of mental ability, reaching a conclusion generally opposite to that of Willis and Rosen.

The purpose of the present paper is thus threefold. First, I want to test the effects of multiple dimensions of ability using a somewhat flexible framework that allows for sociological as well as economic ways of viewing the process. Second, Willis has noted the lack of replication of their findings, due largely to the absence of appropriate data. I will apply the Willis-Rosen model to data from the 1979-1988 National Longitudinal Survey of Youth. Third, I want to examine the plausibility of the model from the psychometric point of view.

The results presented below indicate that different measured abilities have effects that can be distinguished from that of "general" ability, but these effects are not large. The residual correlations in the model of education and earnings show no evidence that there are unmeasured abilities which are particularly rewarded in careers pursued by those without college education.

ATTAINMENT IN RELATION TO MULTIPLE-APTITUDE MEASURES

Willis and Rosen were concerned with how anticipated gains in earnings affect the decision to continue a person's education. Their sample of aviation training applicants from World War II provided results from several different tests in the Army Air Corps aptitude battery. Their analysis showing differing influence on earnings for the different tests is shown in Table 1.

Three effects stand out from this analysis. First, different tests have different effects on earnings. Second, the tests vary in their effect on earnings across the two categories of educational attainment. Third, several of the coefficients are implausibly negative, significantly so in the case of the mechanical ability test. Willis and Rosen attribute this to possible weaknesses in the construction or application of the test.

In contrast to Willis and Rosen's concept of multiple types of talent and intelligence, the psychological literature has failed to establish consistent evidence for a defined set of intellectual talents. A number of researchers have produced evidence favoring a single over-riding dimension of intelligence, which they label "g" (for general intelligence), (see Jensen 1980; Gottfredson 1986). Other researchers have produced theories and evidence on multiple dimensions of intelligence, but these dimensions tend to vary from one theorist to another, with no compelling evidence to link them together in a single framework (Anastasi 1988, 373-402)

More important, in the current context, is whether different types of intelligence, as measured in typical multiple-test batteries, have differential outcomes in terms of job performance. In a standard textbook on aptitude testing, Anastasi (1988, p.395) writes:

> About a dozen multiple aptitude batteries have been developed for use in educational testing, counseling, and personnel classification. These instruments vary widely in approach, technical quality, and amount of available validation data. A common feature, however, is their disappointing performance with regard to differential validity.

This point is confirmed by Hunter and Hunter (1984) and Hunter (1986) in an analysis of numerous validity studies of aptitude tests and batteries.

A clear example of this type of failing occurs with military testing programs, such as the army test examined by Willis and Rosen, and the armed services test analyzed later in this paper. Several published reviews of the armed services tests repeat this same criticism (Cronbach 1979; Murphy 1984; Jensen 1985). Analyses performed by Department of Defense analysts show that many tests or groups of tests designed to predict performance in particular military training programs do little better (or often worse) than a single composite designed to measure general academic ability (see, for example, McLaughlin et al. 1984).

UNMEASURED ABILITY AND ATTAINMENT

Although psychologists have tested whether different aspects of intelligence have differential validity in predicting performance on different jobs (measured as training success and/or supervisor ratings), there has been less attention paid to whether different aspects of intelligence have any impact on social attainment in general. A key difference is that a broader range of mechanisms may be at work in producing overall success, as compared to the more controlled environment of job training and advancement. Fortunately, Willis and Rosen's approach is able, at least partially, to account for unmeasured factors that contribute to success in different career paths.

The basic idea is this. Start with a regression of the probability of college attendance on a set of family/social background factors. Students who go to college despite a low predicted probability of doing so are likely to score high on unmeasured factors which predict success in careers which require college education. Willis and Rosen term these factors "unmeasured abilities," though, clearly, other aspects of the attainment process, such as personality, cultural capital, cultural environment, and the like, might just as easily play a role. If these unmeasured abilities play a role, they will influence both earnings and college attendance. The residuals of equations predicting college attendance and earnings in college careers would be positively correlated.

The prediction Willis and Rosen made about non-college careers is slightly more interesting. They reasoned that if there are special abilities that favor careers open to those with only a high school degree, then the correlation between college attendance and earnings in high school-type careers would be negative. That is to say that after taking measured background factors into account, those most likely to attend college would be those who would earn less in "high school" type careers. Those most likely to not attend college would be those who could expect to earn more in the non-college careers.

Willis and Rosen's findings supported their hypothesis. They found that higher earnings capacity conditional on college attendance is associated with higher probability of attending college, as one might expect. At the same time, higher earnings capacity conditional on completing only high school was associated with lower probability of attending college.

Willis and Rosen interpreted these findings as showing that persons have unmeasured talents or other factors that favor undertaking particular roles. Those with the most talent for careers requiring college education are not necessarily those with the most talent for other types of careers. In other words, people aren't really sorted along a single dimension of occupational rankings, but, rather, occupy "niches" in which they enjoy the advantages of specialization. This they label "comparative advantage" in labor markets, parallel to the theory of comparative advantage in international trade. Willis and Rosen's evidence on both measured and unmeasured factors influencing earnings supports this theory.

HYPOTHESES

The above discussion has produced two dimensions along which we can examine the question of multiple dimensions of ability. The first involves the range of dimensions of ability, which may include those measured and unmeasured by standardized tests. The second involves the relationship of these abilities to attainment, either affecting overall attainment or particular occupational-educational directions. The models I will develop below will not be able to account for both categories of abilities (measured and unmeasured) in both contexts; however there are three hypotheses which can be tested.

Hypothesis 1. There exists more than one ability factor affecting the overall educational and earnings attainments of young men.

Hypothesis 2. Some measured ability factors will have a different effect on earnings if one pursues college education (and the occupational paths thus implied) than they do if one does not.

Hypothesis 3. Unmeasured determinants (which include unmeasured ability) of earnings to be expected if a person does not pursue college education will be negatively correlated with the probability of attending college, while unmeasured determinants of earnings to be expected if one does attend college should be positively associated with this probability.

DATA

This paper analyzes data from the National Longitudinal Survey of Youth (NLSY). NLSY is a large national panel survey based on interviews of 12,686 persons between the ages of 14 and 22 in 1979, with annual follow-up through 1988 and beyond. The data were gathered according to a complex design intended to represent the U.S. national youth population; however, several population subgroups were deliberately over-sampled to allow for comparison between groups. Oversampling was done of blacks, hispanics, low-income whites and youth in the military.

The current analysis is based on a subsample of the NLSY respondents. The analysis uses a representative sample of non-black males who had completed high school, and thus were eligible to make the decision to attend college. After eliminating respondents who did not fit the profile or had missing data on earnings or aptitude test scores, the sample was reduced to 1,487, which is the sample used in Part 2 of the analysis. For some of the analyses, non-high school graduates were added back in, producing a sample size of 1772.

Total initial 1979 NLSY sample:		12686
Males		6403
With valid aptitude test scores		5951
Who have graduated from high school		4386
Not in oversamples:		
poor white	415	
hispanic	401	
military	625	2945
With valid income data, not enrolled in school		2224
Non-blacks		1487

Table 2 lists the variables used in the second part of the analysis. What follows is a brief description of the variables and their derivation.

Dependent Variable: College Attendance.

For this paper, a respondent is recorded as having attended college if he reported attending grade 13 by age 24.

Dependent Variable: Earnings.

Earnings are calculated from the total of self-employment and wage and salary earnings for each individual in the second and third years following school completion. This earnings measure implicitly controls for years of labor market experience since completion of schooling. For a similar approach, see Hauser (1979). The next step in calculating earnings is to take the mean of the earnings in years two and three.

In most analyses of earnings, the logarithm of earnings is used as the dependent variable. In this research, the overriding concern was with maintaining approximate normality, as the model outlined above depends on the assumption of normally distributed errors. Based on the lower level of skew and stronger correlations with other variables, the square root of income was chosen as the dependent variable for this analysis.[1]

Mental Ability.

In spring and summer of 1980, 11,914 NLSY respondents were administered the Armed Services Vocational Aptitude Battery (ASVAB) (see Bock and Moore 1986). The ASVAB consists of 10 separate subtests, measuring verbal skills, math skills, coding speed, general and technical knowledge. The common approach to analyzing a multiple-aptitude test battery such as the ASVAB is to conduct a factor analysis. Several such analyses have been conducted on the ASVAB (Bock and Moore 1986; Andberg et al. 1988). Four factors are generally found, similar to the ones described below.

Given that there are four factors, one can use either an oblique or orthogonal rotation to represent the data. The advantage of one over the other is a matter of descriptive convenience. Table 3 shows how the ten ASVAB tests load on orthogonal and oblique factors. The oblique factors clearly relate to the underlying concepts chosen to describe them. The orthogonal factors have the advantage of avoiding problems of multicollinearity in regression equations. However, this advantage is paid for in a slightly less well-defined correspondence to underlying concepts.

The names given to the four dimensions of ability are verbal ability, technical knowledge, speeded test scores and mathematical ability. These dimensions are loosely associated with what psychologists consider basic aspects of intelligence. The mathematical factor affects arithmetic reasoning and mathematics knowledge, and is probably related to the Horn-Cattell Gf factor. The verbal factor is associated with scores on general science, word knowledge and paragraph comprehension tests, similar to the Horn-Cattell Gc. Both of these factors are probably related to Vernon's v:ed factor. The speeded test factor affects ability to work quickly on repetitive tasks (Horn-Cattell Gs). Technical knowledge affects scores on auto & shop information, mechanical comprehension and electronics information, probably related to the Horn-Cattell Gv and Vernon's k:m. (For a discussion of factors of this type in a similar setting, see Gustafsson 1984. For more on the psychometric properties of the ASVAB tests, see Bock and Moore 1986.)

Other background variables.

Several family background variables are included in this analysis. One is a measure indicating whether at age 14 the respondent did not live with both natural parents. Another is the respondent's number of siblings. Mother's education is measured as actual years completed. Father's socio-economic status is taken from occupational codes and transformed into 1980 values of socioeconomic status. Parents' income was measured for those living with parents in the first year of the survey, 1979 (a dummy variable was used for those with missing data or not living with parents).

Young men graduating from high school in different years would be expected to have different outcomes. The year of graduation was directly observed, or imputed when necessary. Local and national labor market conditions are expected to only affect earnings. NLSY has recorded the unemployment rate of the local labor market (SMSA or balance of state) for each respondent for each year of the sample.

MULTIPLE DIMENSIONS OF ABILITY MODEL

In this section of the paper I explore the measurement of dimensions of ability and their relation to overall education and earnings. The question to be examined is whether the dimensions of ability found in the ASVAB test battery add to prediction of these outcomes beyond their contribution to "g," the general ability factor.

Before I proceed with the description of results, I'd like to add a caveat. The heart of the Willis-Rosen model of attainment is the idea of self-selection. If persons select educational paths based on unmeasured personal attributes, then traditional attainment models are misspecified. I will examine a traditional attainment model in this section, despite the potential for specification error. I do so because I have an interest in overall attainment, and because in the present context I am able to devote more attention to developing a good measurement model of ability. In my initial work I found that the pattern of positive and negative effects of different types of ability found by Willis and Rosen in their paper was evident in models similar to theirs and also in simple regressions of overall educational attainment and income on abilities. Thus I felt that attention to the measurement side of things was an important step.

The model is illustrated in Figure 1. The model was developed from the results of exploratory factor analyses along the lines of those discussed in the previous section. The rotated oblique solution for the exploratory model implies a set of zero loadings and free (non-zero) loadings. This structure was applied to the confirmatory factor model, with adjustments made to improve fit. The four-factor model was once again found to provide the best fit. Adding a second order factor significantly worsened the fit of the models. For the base-line model, constraining the inter-factor covariances to fit a single second-order factor added 3 degrees of freedom, but the fit statistic (which should be approximately chi-squared in distribution under the null hypothesis) increased by 237, a strongly significant increase. Nonetheless, the models with the "g" factor were used in further analysis, due to my interest in how other factors predict attainment with the general intelligence factor controlled (i.e., in Figure 1, testing whether the dotted paths are zero).

Table 4 shows the correlations between the four factors in the preferred measurement model. The "verbal" and "mathematical" first-order factors load strongly on the "g" factor. The other two tests less so.

Table 5 presents metric regression coefficients from a structural model where log earnings were regressed on level of schooling and the factors representing ability, while schooling was at the same time allowed to depend on the ability factors. In model 1, the only ability factor affecting schooling and earnings is "g." Models 2 through 5 add in the verbal, mathematical, speeded and technical first-order factors respectively. In three out of four cases, adding a first-order factor significantly improved the fit of the model. For example, adding the "speeded" factor (model 4) used 2 degrees of freedom to improve the fit statistic by 30.0, a clearly significant contrast. The model which included the "math" factor as an additional regressor (model 3) did not fit appreciably better than the baseline (model 1). Although the contrast of 6.9 on 2 degrees of freedom is significant at the 5% level, the BIC statistic,[2] which takes into account sample size, showed no net improvement in fit.

Of the first five models, the best fit came in the last, where the "technical" factor was allowed to affect schooling and earnings along with "g." Note the negative effect of technical knowledge on schooling controlling "g." It is tempting to ascribe this to substitution of knowledge about automobiles and tools for school knowledge among students who plan not to continue school. However, similar interpretations are not available for the negative coefficients in models 2 and 3. Also, controlling for the effects of respondent's age and mother's education on schooling and earnings did not diminish the negative effects (regressions not reported). The high intercorrelation among factors (Table 4) gives a hint that multicollinearity might have been operating to create implausible coefficients.

Model 6 in Table 5 shows an attempt to build a parsimonious model including "g." In it, schooling is affected only by technical knowledge and "g," while earnings are affected by schooling and speeded test taking ability. The fit of this model is quite a bit better than that of model 1. Note however, the final model, using all four first-order factors, also provides a good fit to the data, although the models are not comparable (i.e., they are not nested).

It is interesting to note that the major improvements in fit come in models where the "technical" ability factor is allowed to affect schooling attainment. The effect is always negative. This raises the possibility that, as Willis and Rosen observed earlier, there are some types of ability that are rewarded more in careers requiring lower levels of schooling. However, this model is not conducive to seeing if the effect of technical ability on earnings is different in these types of careers. That will be explored below.

From these confirmatory factor models, we can conclude that the first-order dimensions of ability produced by the ASVAB battery have distinct effects on earnings and educational attainment, apart from their contribution to "g," the general factor of ability. These effects are robust to various changes in specification. However, given the multicollinearity among these factors, these effects are difficult to interpret.

UNMEASURED ABILITY AND OCCUPATIONAL CHOICE

In this section and the next, I get to the heart of the Willis-Rosen model. I measure how different dimensions of ability determine the direction of educational and occupational choice.

This part of the analysis uses an endogenous switching regression model. An accessible introduction to this type of model is provided by Mare and Winship (1988; see also Maddala 1983; Heckman 1980). In this model we estimate three equations. The first is a logit model predicting the probability of attending college conditional on high school completion. The two remaining equations predict the earnings a respondent would have if he were to proceed immediately to work from high school and the earnings he would have if he were to attend college. Earnings are observed only for the path actually taken. Therefore, these earnings equations need to be corrected for selectivity. The predicted earnings are then allowed to affect the probability of attending college through the inter-equation correlations.

As mentioned earlier, Willis and Rosen's comparative advantage hypothesis can be stated in terms of the correlations between the residuals of the earnings and college attendance equations in the model described above. The hypothesis is that a person who anticipates earning more with a high school education than he or she would with college attendance will be less likely to attend college. This implies a negative correlation between college attendance and anticipated earnings with high school only. The college attendance equation should be positively correlated with the equation for anticipated earnings with college attendance.

There are three major problems with this modelling approach to schooling continuation decisions. One problem is that, for the model to make sense, future earnings as observed by the researcher must be related in a defined way to earnings anticipated by the decision maker at the time he decides to go or not to go to college. Although many researchers would not accept this approach as unproblematic (see Manski 1991a), it is nonetheless one of the few that have been developed. Since the point of this paper is to examine the claims of Willis and Rosen, and since alternative ways of measuring anticipated earnings have not been established, this part of their approach will be followed.

Second, Manski (1991b) has described the failure of identification in models where the conditional expectation of an endogenous variable serves as an argument in a behavioral equation. Although the nonlinearity of the probit equation makes for formal identification, a stronger case for identification can be made if there exist variables in each of the two types of equations which are neither independent nor functionally dependent on the set of variables in the other equation. That is, in Manski's words, "identification is possible only if [the set of variables in the two equations] are "moderately" related random variables."

Finally, there is the problem that parameters corrected for selectivity based on normality assumption are not robust to departures from normality (Goldberger 1983). More work needs to be done to explore the consequences of various transformations of the dependent variable to improve this aspect of the model.

To test effects on inter-equation correlations, three models are examined. In Model 1, closest to Willis and Rosen's approach, ability affects earnings and family background factors affect college attendance. Model 2 allows ability to affect both earnings and college attendance. Family income will also affect both types of outcomes, with other family background factors affecting only college attendance. Finally, Model 3 allows ability and all family background factors, with the exception of parents' education, to affect both earnings and college attendance.

In all three models the current unemployment rate (at time of earnings) affects only the earnings equation.[3] Except in the first model, this unemployment variable is the only one identifying the earnings equation. At least on a theoretical basis, this variable should have no relation to the variables in the college attendance equation, and thus it does not satisfy the criterion stated by Manski. Thus models 2 and 3 are primarily identified by the nonlinearity of the college attendance probit equation.

Table 6 shows fit statistics and the inter-equation covariances for the three models just described. In all three cases, the inter-equation covariances are strongly positive. That implies that a higher probability of attending college is associated with factors that result in higher anticipated earnings for either educational level. This contrasts quite strongly with the Willis and Rosen's finding of a negative correlation between anticipated earnings conditional on stopping at high school and the probability of attending college.

In this paper, I have transformed the measure earnings in hopes that, when it serves as a dependent variable, it will more closely fulfill the conditional normality assumption. When I used log earnings, the correlations appeared very similar to those found by Willis and Rosen. Since the data they used were not available, I was not able to test whether the difference lay in the modelling or in the data.

At this point I would like to add a last couple of cautions for interpreting these results. The earnings measured here are earnings occurring very early in the careers of the subjects. Later career earnings would be a better indicator of career earnings levels. In addition, there are the problems of model identification, discussed above, that make any estimate of these effects subject to some degree of doubt. A final difference is in the use of maximum likelihood techniques in this model. The maximum likelihood procedure allows the imposition of cross-equation restrictions to specify models, and provides more efficient estimates of the parameters. However, it is doubtful that the difference in method is responsible for such a wide swing in outcomes.

MEASURED ABILITIES AND EDUCATIONAL CHOICE

In this section I want to address the remaining unexamined hypothesis. In particular, I want to detect if there are particular measurable abilities which contribute to the success of persons who enter occupations which don't require college, and a different set more important for occupations requiring college.

Table 7 shows the reduced form coefficients for Model 2, which will be used for comparisons (other models produce similar results). Examining the parameter estimates presented in Table 7, we see that they generally conform to prior expectations (that is to say, none of the estimated effects looks particularly strange or out of place).

The most straightforward way to test Willis and Rosen's hypothesis is to constrain the four ability factors to be equal across the two earnings equations. The difference in the likelihood statistic between the constrained and unconstrained models is distributed as chi-squared with 4 degrees of freedom. For the baseline model, the contrast statistic is 18, (31,606 vs 31,588) as compared to the 95% confidence level chi-squared statistic for 4 degrees of freedom of 9.49. This indicates that allowing ability to affect expected high school and college earnings differently significantly improves the fit of the model. However, the level of significance is not extremely high. The BIC statistic also points to the constrained model as the preferred model (the statistic is 20,941 for the constrained model, 20,952 for the unconstrained model). When the same likelihood ratio test is applied in a model with oblique, rather than orthogonal, factors of ability, the results turn out to be identical.

I would therefore argue that we should accept the hypothesis that the dimensions of ability have equal effects across the two levels of schooling.

Looking back again at Table 7, it is clear that the biggest change in parameter estimates from the high school to the college earnings regressions involve verbal and mathematical ability. The latter effect is especially significant, and might be explained by the fact that among persons who attended college, there were varying final levels of education obtained.

It is interesting to compare the difference in results between models with oblique and orthogonal rotations of extracted factors, because the observed parameters look so different. Table 8 shows the results. The parameters of ability show a pattern of varying effects, just as was found in Table 1 (Willis and Rosen) and Table 5 (traditional attainment model with confirmatory measurement model). Note the absence of negative coefficients when the orthogonal factors are used and the appearance of negative coefficients with oblique factors.

Next look at the parameters of the college attendance equation. When the factors representing ability are oblique, the effect of technical ability on college attendance is negative. This matches the finding in the confirmatory factor model presented in Table 5. When the extracted factors are based on an orthogonal rotation, the negative coefficient of technical ability on schooling disappears. It is hard to judge whether the negative effect of technical ability on educational attainment is purely spurious, due to multicollinearity, or whether there is some aspect of ability or personality that is tapped by the technical knowledge test and leads young men to not attend college. Whatever this aspect might be, it does not seem to be anticipated earnings. If the results above are to be believed, measured abilities have equal effects on earnings at either educational level.

CONCLUSION

The evidence I have presented here provides little support to the notion that different dimensions of ability play a significant role in the process of status attainment. I have tested the direct effect of abilities on schooling and earnings, and both of the major empirical findings of Willis and Rosen, with results that are mixed at best.

The first hypothesis I tested was that there exists more than one ability factor affecting achievement. I found that different dimensions of ability do contribute to levels of schooling and earnings. However, the effects seem to be strongest in predicting college attendance, not earnings, as supposed by Willis and Rosen. While there may indeed be a dimension of ability involved in this process, it seems just as likely that the students who score better on the technical tests than on other tests are simply reflecting a process of adapting themselves to their likely career outcome.

The second hypothesis I set out to test was that different dimensions of ability have different payoffs in college-based careers than in careers requiring only high school education. Here the results were fairly clear-cut. The effect of ability measures on anticipated earnings given college attendance is not different from the effect on anticipated earnings given no college.

When it comes to the effects of unmeasured ability, the evidence is weaker. My results fail to replicate those found by Willis and Rosen. However, this finding turns on the use of the square root of earnings rather than log earnings as the dependent variable. There are also questions about the use of early-career earnings and questions of model identification which may cloud my results. Nonetheless, it is interesting to note that, once one steps outside the strict assumptions of the Willis-Rosen model, one finds much less evidence of the "negative selectivity" of high school earnings and college attendance.

I have tended to emphasize the doubts that can be cast on my findings, but I do believe that they are for the most part sound. All in all, I think the analysis here provides enough evidence to begin to cast some doubt on the Willis-Rosen analysis, and favor the idea that there is a single dominant underlying dimension to status attainment. Further research needs to be undertaken to explore the match between dependent variable specification and conditional normality. Furthermore, the finding of a possible negative effect of technical knowledge on schooling net of overall ability may lead to interesting findings about the relations between ability, opportunity and socialization in young men's schooling decisions.

More broadly, there is a continuing need to understand the process by which young people take into account various types of information in forming their decisions about career attainment. I believe that there is much to be drawn from both sociological and economic conceptions of this process.

NOTES.

1. The proper specification of earnings as the dependent variable depends on its distribution conditional on the educational path actually taken. The observed earnings variables should not necessarily have a normal (gaussian) distribution. Rather, the earnings that people would earn if they went to college (which is unobserved for those who did not) should be normally distributed. The earnings that people would earn if they did not go to college (which is unobserved for those who did) should likewise be normal in shape.

I have chosen to use a form for the dependent variable that I observed to have desirable properties when I looked at the unconditional distribution. To my knowledge, there is no easy way to examine the shape of the unobserved conditional distribution. Amemiya (1985, pp. 381-382) mentions some work that has been done on this. The next step in my research will be to examine the applicability of this research to the present problem. In the meantime, I have at least some assurance that the desirable properties of the square root transformation carry over to the conditional distribution, in that in the model examined below, the inter-equation covariances are much larger in relation to their standard errors than is the case when log earnings is used. Nonetheless, I recognize that my results can be challenged on this point.

2. BIC stands for "Bayesian Information Criterion." The probability of a model being true divided by the probability of a baseline model being true is log-proportional to the negative of this statistic, according to Raftery (1986). Thus the lower the

statistic, the better the fit of the model.

3. The ideal measure of anticipated earnings in our model would be lifetime earnings. Instead, the available data dictate using earnings at one point in time early in the career. Removing the period-specific influences makes the measured earnings a better indicator.

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Figure 1.

CONFIRMATORY FACTOR MODEL.

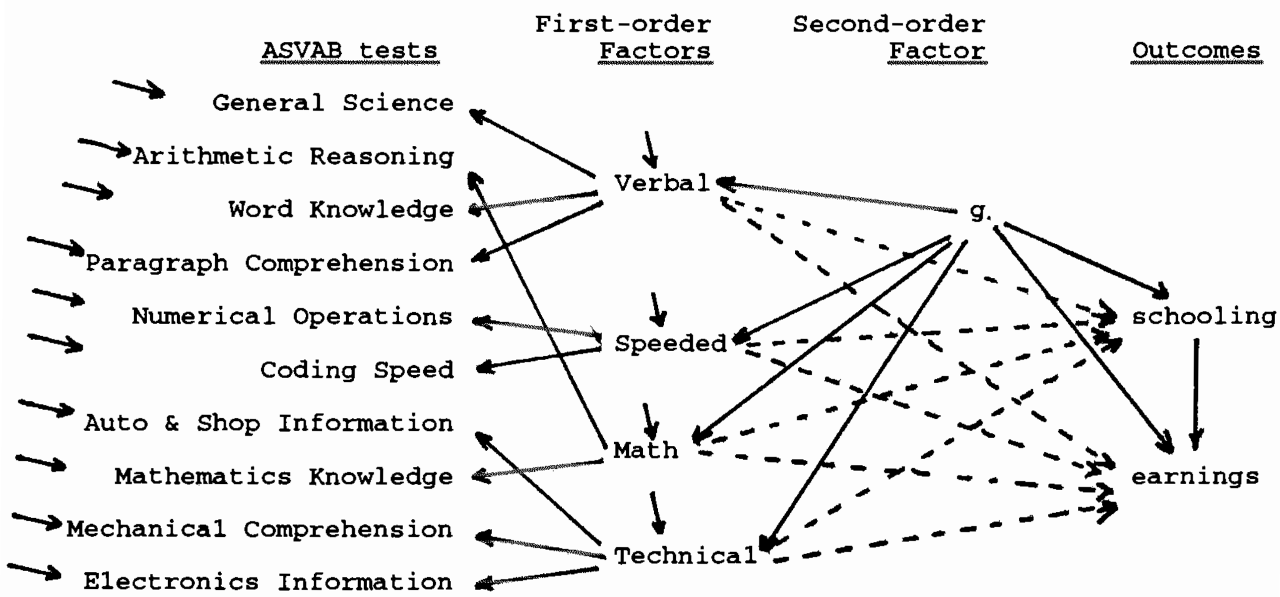

Table 1

DIFFERENTIAL EFFECTS OF TESTED ABILITIES
ON LOG EARNINGS AT MID-CAREER (Willis and Rosen)

	Education Level			
	high school only		attended college	
Test	Coeff	t-stat	Coeff	t-stat
Reading test score	.57	(3.28)	.27	(2.80)
Mechanical ability test	-.17	(-1.73)	-.21	(-3.59)
Mathematics test score	-.19	(-1.00)	.30	(3.31)
Manual dexterity test score	.36	(2.19)	.02	(0.16)

(Coefficients are multiplied by 100 for ease of presentation.
Source: Willis & Rosen, p. S-26)

Table 2

DESCRIPTIVE STATISTICS
NLSY (1979-1988), SELECTED MALES WHO HAVE COMPLETED GRADE 12

VARIABLE	NON-COLLEGE	COLLEGE ATTENDERS	FULL SAMPLE
College attendance	0.000	1.000	.429
	(.000)	(.000)	(.495)
Square root of income	88.188	112.580	98.653
	(38.343)	(38.354)	(40.193)
Verbal ability factor	-.064	.349	.113
	(1.268)	(1.209)	(1.259)
Technical knowledge	.640	.241	.469
	(1.084)	(1.058)	(1.090)
Speeded test scores	.168	.468	.297
	(1.147)	(1.053)	(1.117)
Math ability factor	-.249	.904	.246
	(1.114)	(1.290)	(1.322)
Verbal (oblique)	.246	.867	.512
	(.805)	(.684)	(.815)
Technical (oblique)	.571	.576	.573
	(.944)	(.847)	(.903)
Speeded (oblique)	.239	.827	.491
	(.918)	(.778)	(.908)
Math (oblique)	.029	1.096	.487
	(.878)	(.978)	(1.062)
Not 2-parent family	.185	.129	.161
	(.388)	(.335)	(.367)
Number of siblings	3.125	2.719	2.951
	(1.953)	(1.870)	(1.928)
Mother's education	11.323	12.673	11.914
	(2.288)	(2.506)	(2.478)
Father's SES	35.050	51.013	42.069
	(21.428)	(24.276)	(24.058)
Family income	8.105	7.978	8.050
	(4.167)	(4.457)	(4.293)
Year of H.S. diploma	79.191	78.346	78.829
	(2.254)	(2.095)	(2.226)
Area unemployment	9.076	7.761	8.512
	(3.166)	(2.954)	(3.144)
Sample size (N)	849	638	1487
Missing observations:			
Unemployment	64	44	108
Mother's education	41	8	49
Family income	175	150	325

Table 3

FACTOR ANALYSIS -- ORTHOGONAL AND OBLIQUE ROTATIONS

ORTHOGONAL ROTATION (VARIMAX) ROTATED FACTOR MATRIX:

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
General Science	.55400	.29612	.42318	.49619
Arithmetic Reasoning	.38883	.42354	.64119	.27801
Word Knowledge	.46602	.37277	.33587	.65873
Paragraph Comprehension	.40629	.39438	.38653	.49288
Numerical Operations	.23348	.76993	.30076	.20587
Coding Speed	.27024	.71139	.23023	.20518
Auto & Shop Information	.81014	.24388	.13599	.19841
Mathematics Knowledge	.28370	.41722	.71216	.29243
Mechanical Comprehension	.71456	.27033	.38250	.21072
Electronics Information	.68311	.26285	.32608	.38457

OBLIQUE ROTATION (OBLIMIN) PATTERN MATRIX:

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
General Science	.59154	-.22244	-.04831	-.20662
Arithmetic Reasoning	.07289	-.12747	.13612	-.65600
Word Knowledge	.95410	.01993	.05291	.03601
Paragraph Comprehension	.60954	-.02243	.13193	-.13970
Numerical Operations	-.00545	.02187	.84779	-.06946
Coding Speed	.02850	-.04613	.79321	.02723
Auto & Shop Information	.04673	-.84258	.09686	.09556
Mathematics Knowledge	.10571	.03061	.10132	-.77671
Mechanical Comprehension	-.00559	-.66768	.02348	-.29060
Electronics Information	.37831	-.49866	-.02317	-.10971

FACTOR LABELING

NAME	ORTHOGONAL ROTATION	OBLIQUE ROTATION
Verbal ability factor	Factor 4	Factor 1
Technical knowledge	Factor 1	Factor 2
Speeded test scores	Factor 2	Factor 3
Math ability factor	Factor 3	Factor 4

Table 4.

Confirmatory factor analysis: Correlations of four factors on the 10 ASVAB tests with "g" (second-order factor).

	F1 Verbal	F2 Math	F3 Speed	F4 Technical
Math	0.878			
Speed	0.752	0.702		
Technical	0.843	0.787	0.674	
"g"	0.970	0.905	0.775	0.869

Table 5

The Effect of Ability on Earnings and Level of Schooling Attained.

(No controls for family background. Experience implicitly controlled for by taking earnings 2 years after completion of school.)

Model summary statistics.					Parameter estimates (absolute value of t-statistics in parentheses).					
#	df	Chisq	BIC	Dep Var	School	Verb	Math	Speed	Tech	"g"
1	45	524.2	187.6	Earnings	.11 (6.9)					.34 (6.5)
				School						2.16 (26.2)
2	43	508.1	186.5	Earnings	.11 (9.1)	-.38 (3.3)				.75 (5.7)
				School		.33 (1.8)				1.81 (8.6)
3	43	517.3	195.7	Earnings	.11 (6.9)		-.42 (1.4)			.90 (2.2)
				School			1.01 (2.3)			.79 (1.3)
4	43	494.2	172.6	Earnings	.11 (7.1)			.33 (5.2)		-.02 (0.2)
				School				.18 (1.7)		1.96 (14.4)
5	43	368.0	46.4	Earnings	.14 (7.6)				.19 (3.9)	.12 (1.5)
				School					-.85 (11.1)	2.76 (24.8)
6	44	357.5	28.4	Earnings	.11 (7.9)			.32 (8.5)		
				School					-.87 (11.2)	2.78 (24.6)
7	39	313.3	21.6	Earnings	.15 (9.1)	-.34 (3.7)	.02 (0.2)	.34 (5.9)	.26 (5.8)	
				School		.95 (6.6)	1.17 (8.3)	.19 (2.1)	-.77 (10.9)	

Table 6

COMPARISON OF MODELS

	Goodness of fit		Inter-equation covariances	
MODEL	PARAMETERS	CHI-SQUARED	COV(1,2)	COV(1,3)
1.	30	32,082	17.5	19.7
2.	38	31,588	5.0	5.2
3.	44	31,558	4.5	6.0

Inter-equation covariances are all significantly different from zero at confidence level > 99%.

Table 7

REDUCED FORM REGRESSION RESULTS -- BASELINE MODEL*

	Coeff.	s.e.	t-stat
EQUATION 1 PROBIT DEPENDENT VARIABLE = COLLEGE ATTENDANCE			
Verbal ability factor	0.306	0.027	11.25
Technical knowledge	0.023	0.030	0.76
Speeded test score	0.348	0.030	11.72
Math ability factor	0.515	0.024	21.43
Not 2-parent family	-0.008	0.076	-0.11
Number of siblings	-0.031	0.015	-2.13
Mother's education	0.061	0.013	4.78
Father's SES	0.010	0.001	7.43
Family income	-0.036	0.055	-0.64
Year of H.S. diploma	-0.086	0.013	-6.59
EQUATION 2 NON-COLLEGE			
LINEAR REGRESSION - DEPENDENT VAR=SQ ROOT OF EARNINGS			
Verbal ability factor	1.67	0.588	2.84
Technical knowledge	4.10	0.644	6.36
Speeded test score	7.31	0.627	11.67
Math ability factor	2.71	0.596	4.54
Family income	13.02	1.212	10.74
Year of H.S. diploma	-3.75	0.316	-11.87
Area unemployment	-1.30	0.214	-6.07
EQUATION 3 ATTENDED COLLEGE			
LINEAR REGRESSION - DEPENDENT VAR=SQ ROOT OF EARNINGS			
Verbal ability factor	0.49	0.862	0.57
Technical knowledge	5.38	1.017	5.29
Speeded test score	6.76	0.955	7.08
Math ability factor	6.01	0.694	8.66
Family income	9.40	1.644	5.72
Year of H.S. diploma	-2.61	0.421	-6.20
Area unemployment	-2.25	0.284	-7.94
INTER-EQUATION COVARIANCES			
Cov (Equations 1-2)	4.959	0.308	16.10
Cov (Equations 1-3)	5.149	0.288	17.86

Total model -2*LOG LIKELIHOOD .. 31,588
Equation 1 -2*LOG LIKELIHOOD .. 1,436.4
Equation 2 R SQUARED 0.467
Equation 3 R SQUARED 0.233

* Additional controls are provided for missing data on mother's education, family income, and area unemployment.

Table 8

EFFECT OF ABILITY FACTORS IN BASELINE MODEL

	Orthogonal factors coefficient	Orthogonal factors std err	Oblique factors coefficient	Oblique factors std err
EQUATION 1 PROBIT DEPENDENT VARIABLE = COLLEGE ATTENDANCE				
Verbal ability factor	.3058	.0272	.3026	.0454
Technical knowledge	.0230	.0303	-.3416	.0335
Speeded test score	.3477	.0297	.1272	.0357
Math ability factor	.5150	.0240	.5194	.0351
EQUATION 2 - INCOME REGRESSION - (DID NOT ATTEND COLLEGE)				
Verbal ability factor	1.672	0.588	-1.088	1.037
Technical knowledge	4.095	0.644	2.494	0.794
Speeded test score	7.315	0.627	7.981	0.809
Math ability factor	2.706	0.596	0.299	0.887
EQUATION 3 - INCOME REGRESSION - (ATTENDED COLLEGE)				
Verbal ability factor	0.495	0.862	-4.925	1.469
Technical knowledge	5.378	1.017	4.692	1.057
Speeded test score	6.763	0.955	5.879	1.176
Math ability factor	6.007	0.694	6.170	1.101

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