Abstract—Recent confirmation of sheepskin effects in the returns to education for prime age white males has been taken as evidence of screening or signaling in the labor market. We report evidence of sheepskin effects among women and minority males and demonstrate that they are somewhat smaller for lower diploma years but larger for higher diploma years than those of white males. These are among the first broad based results confirming the frequent contention derived from signaling models that minorities have smaller returns to low productivity signals but larger returns to high productivity signals.

I. Introduction

Recently in this Review, Hungerford and Solon (1987) confirmed the existence of sheepskin effects in the returns to education. Using both spline and step functions they identified significantly larger returns to diploma years than to other years of education. The finding that a diploma had value independent from the accumulated years of education indicated that in addition to any role it plays actually making workers more productive, education also credentials workers as more productive. This was a natural conclusion given that earlier work took the absence of sheepskin effects as sufficient to dismiss the screening hypothesis altogether (see Layard and Psacharopoulos, 1974). The possibility that diploma years serve as a signal of productivity immediately suggests the literature on statistical discrimination. This literature argues that employers base earnings and hiring on a conditional expectation of productivity given the individual worker's signal of productivity. Recent work by Golbe (1985) demonstrates that in an imperfect signaling model, like those associated with statistical discrimination, one should expect minorities to receive greater returns to signals of high productivity than do white males. In Golbe's model this follows because minorities face a higher cost of achieving an inaccurately high signal than do white males. The logic for this latter assumption is not spelled out but some oblique appeals are made to the differential resources available to different demographic groups which can be devoted to the market for signals. For instance, connections with colleges which provide differential access may be less frequent and more tenuous for minorities.

The claim of Golbe has received some sporadic and idiosyncratic support. For example, medical board certification increases the earnings of female doctors more than those of male doctors (Culler, Ohfeldt, and Becker, 1987). Similarly, a study of academics indicates that black males with publications earn more than their white counterparts (Freeman, 1977). Interestingly, blacks with no publications were shown to earn less than their white counterparts. Also, it has been shown that blacks receive greater increases in occupational status from college graduation, but smaller increases from high school graduation when compared with whites.

By returning to the data source of Hungerford and Solon, we seek to determine whether the claim that minorities receive larger returns to signals of high quality is substantiated by the pattern of sheepskin effects. We emphasize that this is different than simply examining the pattern of educational returns for different demographic groups. We control for such divergent returns in an effort to identify the value of the signal or credential per se. If the general flavor of the signaling models is correct we expect that the return to minorities for signals of high productivity will be larger. We emphasize that such a finding does not diminish the likelihood of discrimination. Indeed, discrimination can exist side by side with the finding that the return to productivity signals differs by race or gender.

The next section briefly outlines a signaling model predicting that minorities receive greater returns to signals of high productivity. Following that, we estimate the size of sheepskin effects for four demographic groups based on race and gender. Our evidence strongly supports the pattern suggested by the model although some room for questions remains. The final section discusses these questions, presents alternative explanations for the pattern of the sheepskin effects and draws conclusions.

II. A Signaling Model

We suppose that workers have signals of productivity which are imperfectly correlated with their actual productivity. Of special concern is the likelihood that
diplomas are just such signals. In particular, we anticipate that productivity is measured with error:

\[ h = a + \epsilon, \]

where \( h \) is the signal of productivity which is equal to the actual productivity, \( a \), plus \( \epsilon \), a measurement error. Knowing this structure the firm estimates productivity as a conditional expectation given the value of \( h \) which they observe:

\[ \hat{a} = E(a|h). \]

Assuming that both \( a \) and \( \epsilon \) are normally distributed with means \( k \) and zero, respectively, one can evaluate the expectation as follows:

\[ \hat{a} = \gamma h + (1 - \gamma) k. \]

In this expression \( \gamma \) is directly related to the accuracy of the signal and is equal to the squared correlation coefficient between \( a \) and \( h \),

\[ \gamma = \text{Cov}(a,h)/\text{Var}(h) = \text{Var}(a)/[\text{Var}(a) + \text{Var}(\epsilon)]. \]

Thus, if the indicator were perfectly correlated with productivity, \( \gamma = 1 \), the employer would lose no information by observing the signal rather than the actual productivity. Obviously, this is an extreme case. The other extreme occurs where there is no correlation, \( \gamma = 0 \). In this circumstance the employer gets no information by observing the signal and, in the absence of other information, must assume each worker has the mean productivity, \( k \). In terms of figure 1, the first extreme would be represented by a 45 degree line and the second by a horizontal line at the productivity value \( k \). It is worth noting that this structure mimics the frequently used approach of the rational expectations model to extract information from noisy signals.

Following Golbe, and earlier work by Borjas and Goldberg (1978), it might be reasonable to consider a circumstance where \( \gamma \) differs between majority and minority groups.\(^5\) In particular, if the cost of obtaining an inaccurate signal is higher for minorities, or if minorities have less resources with which to purchase inaccurately large signals, it may be reasonable to assume that

\[ \gamma_b > \gamma_w. \]

This suggests that the signal is more closely correlated with productivity for minorities (represented by \( b \)) than for majorities (represented by \( w \)). This circumstance is presented in figure 1 which shows the closer relationship between the expected productivity and the signal for the minority with the steeper line. The looser relationship for the majority is presented with the less steep line. Both groups share the same mean value of productivity, \( k \), and both conditional expectations go through the point of means.

Now consider two signals; one of low productivity, \( h_1 \), and one of high productivity, \( h_2 \), where \( h_1 < k < h_2 \). The minority worker has lower expected productivity, and receives a lower wage, than his majority counterpart with the low productivity signal:

\[ \hat{a}_b = \gamma_b h_1 + (1 - \gamma_b) k < \gamma_w h_1 + (1 - \gamma_w) k = \hat{a}_w; \]

but a higher expected productivity and wage than his majority counterpart with the high productivity signal:

\[ \hat{a}_b = \gamma_b h_2 + (1 - \gamma_b) k > \gamma_w h_2 + (1 - \gamma_w) k = \hat{a}_w. \]

This is also shown on figure 1. This result predicts precisely Freeman's finding for black academics. At issue is whether this finding carries over to a more general signal of productivity, a diploma.

III. Measuring Sheepskin Effects for Women and Minorities

In an effort to compare sheepskin effects for women and minorities we first reestimate baseline effects for nonagricultural white males age 24 to 65. Our sample is drawn from the May 1978 Current Population Survey as was that of Hungerford and Solon. Also, following their work, we estimate a discontinuous spline function with education divided into three regions. The discontinuities are at years of education equal to 8 and 12. The dependent variable is the natural log of the ratio of usual earnings to usual hours. The other independent variables include a constant, years of experience, experience squared, and dummy variables equal to

\[ 6. \]

\[ y = \gamma h + (1 - \gamma) k \]

\[ yw = \gamma w h + (1 - \gamma) k \]

\[ yb > yw. \]

Both of these previous papers merely consider a dichotomous signal of quality such as passing a skills test. This is clearly inappropriate for an examination of education in which there are a variety of levels of education and appropriate diplomas.
whether the worker has years of education greater than 8, greater than 12, greater than 16, equal to 17 and equal to 18. This specification is an exact replication of that of Hungerford and Solon. We were not, however, able to do their variation which included years of education raised to higher powers. While such variables are acceptable in the white male equation, they violate tolerance requirements in the equations of the smaller demographic groups. The restricted specification is required for a valid comparison across groups and barely changes the sheepskin estimates for the white males.

The first column of table 1 presents our replication of Hungerford and Solon and highlights each of the five dummy variables. These variables were designed to capture the sheepskin effects to graduation from grade school, high school, undergraduate school, and graduate school. The only significant effect for the white males in their sample was for graduation from college. Our estimation produces nearly identical results with the point estimates and significance virtually the same. We do, however, find the possibility of a weak effect for high school graduation. We suspect slightly different exclusions or sample filters might explain the modest differences in the two statements.

We now estimate the same spline function over three different subsamples, minority men, white women and minority women. If the particular theory of signaling outlined earlier is appropriate we should find larger returns associated with those dummy variables which signal higher productivity. Specifically, we expect that the returns to the various college degrees should appear larger while those for grade and high school may appear smaller. In this way we associate the dummies for college and graduate school with signals greater than the mean, $k$ in our model, and those for grade and high school with signals less than the mean.

The complete specification and the results are shown in the three remaining columns of table 1. The second column represents the results for black males and makes obvious several differences. First, the black male return to the completion of college (as opposed to attending four years of college) is significant and more than twice the size of that for white males. Second, black males receive an earnings premium for graduate school while white males do not. The sheepskin effect associated with this final dummy is substantial and significant. This is not the case for whites. Again, we emphasize that the usual returns to education (including graduate school) are captured by the spline function. The dummy variables measure the additional premium associated with the signals of the various education credentials. Third, while there seems to be a weak but positive premium associated with high school graduation for white males, there is no such premium for black males.

<table>
<thead>
<tr>
<th>Term</th>
<th>Men: White</th>
<th>Men: Minority</th>
<th>Women: White</th>
<th>Women: Minority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.7814</td>
<td>0.8517</td>
<td>0.5825</td>
<td>1.0800</td>
</tr>
<tr>
<td></td>
<td>(0.0243)</td>
<td>(0.0636)</td>
<td>(0.0180)</td>
<td>(0.3212)</td>
</tr>
<tr>
<td>Experience</td>
<td>0.0344</td>
<td>0.0240</td>
<td>0.0082</td>
<td>0.0180</td>
</tr>
<tr>
<td></td>
<td>(0.0013)</td>
<td>(0.0037)</td>
<td>(0.0016)</td>
<td>(0.0035)</td>
</tr>
<tr>
<td>Experience Squared</td>
<td>-0.0006</td>
<td>-0.0004</td>
<td>-0.0001</td>
<td>-0.0004</td>
</tr>
<tr>
<td></td>
<td>(0.00004)</td>
<td>(0.00008)</td>
<td>(0.00003)</td>
<td>(0.00007)</td>
</tr>
<tr>
<td>Years of Education</td>
<td>0.0606</td>
<td>0.0240</td>
<td>0.0784</td>
<td>-0.0282</td>
</tr>
<tr>
<td></td>
<td>(0.0100)</td>
<td>(0.0165)</td>
<td>(0.0143)</td>
<td>(0.0198)</td>
</tr>
<tr>
<td>Spline for Ed &gt; 8</td>
<td>-0.0250</td>
<td>0.0103</td>
<td>-0.0326</td>
<td>0.0342</td>
</tr>
<tr>
<td></td>
<td>(0.0131)</td>
<td>(0.0250)</td>
<td>(0.0176)</td>
<td>(0.0266)</td>
</tr>
<tr>
<td>Spline for Ed &gt; 12</td>
<td>0.0102</td>
<td>-0.0419</td>
<td>0.0352</td>
<td>0.0671</td>
</tr>
<tr>
<td></td>
<td>(0.0101)</td>
<td>(0.0253)</td>
<td>(0.0124)</td>
<td>(0.0242)</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses.
This pattern of results fits with the signaling model summarized in figure 1. For signals of lower productivity (high school graduation in this case) whites seem to receive a larger premium than blacks. For signals of higher productivity (college and graduate school graduation) the opposite is true, blacks receive larger premiums than whites.

The third and fourth columns present the results for white women and black women, respectively. They can also be contrasted with those for white men. They again present a reasonably good fit with the predictions of the signaling model. Both groups of women receive large sheepskin returns to graduate school which the white men do not. This is evidenced by the substantial positive and significant coefficients for the dummies associated with education of 17 and 18 years for both groups of women. Black women also receive a much larger sheepskin effect for completion of undergraduate school than do the white men. The black women receive no sheepskin effects associated with years 8 and 12. The white women present a slightly less clear picture on this score. White women actually seem to receive a negative sheepskin effect for grade 8 which, while fitting with our qualitative prediction, is difficult to explain. It should be noted that only 5% of white women have 8 years of education or less. Also, the white women receive a positive sheepskin effect associated with grade 12 as did the white men.

In terms of the model, the somewhat confusing pattern of the grade and high school dummies for white women may suggest that their signals are correlated with productivity in a different manner than either racial minorities or white males. Specifically, they may hold an intermediate ground between white males and racial minorities. Despite this, the general pattern of results seems to be consistent. All three of the new demographic groups receive sheepskin effects for graduate school that the white males do not. Whenever the new groups receive a sheepskin effect for college graduation, it is larger than that received for white males. Both groups of racial minorities do not receive the sheepskin effect for high school graduation which is weakly indicated for white males.

We recognize that no statistical significance has been attributed to the sheepskin effect differences we have discovered. We note that relevant F-tests indicate that each of the three new groups has an earnings equation structure which differs significantly from that of white males. To directly examine sheepskin differences would require a single estimating equation which would appropriately constrain the coefficients on education and experience to be identical across all four demographic groups, or would require a full set of structural dummies for each group. Our current approach does allow us to test the significance of the differences if we assume the absence of covariance in the coefficient estimates across the equations. Many, but not all, emerge significant. We caution that such tests can only be suggestive.

The rather low \( R^2 \) in the four equations are of the same general magnitude as those reported by Hungerford and Solon. However, we emphasize that the explained variance is much higher for the three minority groups. This presents additional confirmation that the signal quality is better for those groups than for white males.

IV. Conclusion

To the extent that the results present a consistent picture, they suggest that screening or signaling may exist for each demographic group. This in and of itself is an important finding which expands and generalizes the results for white males presented by Hungerford and Solon. In addition, the results suggest a pattern of the differences between the three new demographic groups and the white males. Most clearly, the new groups appear to enjoy larger sheepskin effects for signals of high productivity, college and graduate school. Less clearly, they may also enjoy smaller sheepskin effects for signals of lower productivity, grade and high school. Such results are consistent with signals of productivity which are more closely correlated with actual productivity for the new groups than for white males. This contention has frequently been suggested but has, so far, received only limited support.

It is crucial to note that there exist alternative explanations for the pattern of results we report. For instance, minorities might be in a different labor market than white males and the different pattern of results may simply reflect different patterns of labor demand and supply. Minorities with high degrees of education are limited in supply and greatly in demand relative to white males. Similarly, minorities with low degrees of education are plentiful and not greatly in demand relative to white males. While a plausible explanation, one would expect this influence to be shown not only in sheepskin effects but in returns to years of education per se. This does not seem to be the case. The return to additional years of education is higher for whites than for blacks in any region of the spline.

Similarly, it might be that the pattern of sheepskin effects results from a general "obstacles" model in which minorities achieve high levels of education only when they are unusually productive. Such an explanation implies minority earnings gaps should diminish with education levels and, correspondingly, that the

\[ \text{NOTES} \]

\[ \text{723} \]

\[ ^6 \text{The } R^2 \text{ they reported was 0.1404. We agree with their assessment that the low value probably results because of the compounding of measurement error from both the numerator and the denominator of the dependent variable.} \]
minority return to additional years of education should be higher than that of white males which it isn't. The empirical results indicate minorities receive greater value from diplomas not from years of education. It obviously remains possible that the obstacles exist uniquely for diplomas.

Alternatively, there remains Chiswick's (1973) suggestion that graduates are, on average, the more efficient learners and that as a result they enjoy proportionately larger increases in productivity than their years of education alone would indicate. Thus, the sheepskin effect arises from education increasing productivity and a self-selection process rather than from signaling. While entirely plausible, such a theory could be reconciled with the race and gender patterns only if the variance in learning efficiency is greater for the minority groups. The larger variance would lead to greater productivity and earnings gaps between those with and without diplomas.

Finally, one might imagine that affirmative action gives rise to a fear of law suits from minority employees and that this in turn alters the willingness to pay for various signals. Thus, in hiring a minority employees seek productivity signals higher than the true productivity required as a hedge against being wrong and facing a law suit. Sowell (1981) has suggested that affirmative action hurts minorities in just this way by increasing the risk associated with being hired and bidding up the needed credentials. While this may be true, it is not at all inconsistent with differential signal accuracy and it is interesting that the argument is easily phrased in terms of a signaling model.

Despite these comments, we do not suggest that the signaling model presents the only possible explanation. Rather, we are content to confirm the presence of sheepskin effects among minorities and to observe that the pattern of differences is consistent with the signaling model. We also reiterate our observation that the statistical significance of these differences must remain in some doubt given our current testing framework.

REFERENCES
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