NBER WORKING PAPER SERIES

VALIDATING HIRING CRITERIA

Andrew Weiss

Hanry Landau

Working Paper No. 2167

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
February 1987

The research reported here is part of the NBER's research program in Labor Studies. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #2167
February 1987

Validating Hiring Criteria

ABSTRACT

We construct a model in which firms use workers' productivities in determining their job assignments. A worker's productivity must exceed some lower bound to satisfy the minimum qualifications for a particular job. It the worker's productivity exceeds some upper bound he is promoted.

Under these conditions it is possible that the better educated and more experienced individuals would be the least productive workers on every job, even though, for each worker, education and experience increases his productivity. Whether this anomalous results occurs depends on the underlying distribution of ability in the population and the job assignment policy delineated above.

One implication of our analysis is that firms that use hiring criteria that accurately predict a worker's success on the job may not be able to validate those criteria through measurements of the performance of the workers that they had hired. EEOC rules that require hiring criteria to be validated in that fashion may penalize firms with the most efficient hiring and promotion standards.

Andrew Weiss
Bell Communications Research 2A-351
435 South Street
Morristown, NJ 07960-1961

Henry Landau
Bell Laboratories
600 Mountain Avenue
Murray Hill, NJ 07974

VALIDATING HIRING CRITERIA*

by

Andrew Weiss
Bell Communications Research and NBER

Henry J. Landau
AT&T Bell Laboratories

I. INTRODUCTION

It is a commonplace observation that while earnings generally increase with age, labor market experience, and education, performance within a job often decreases with age, experience and education. (See for example, Medoff and Abraham, Berg, Kutscher and Walker, or Clay.)

One reason for this apparent divergence between performance and earnings is that the distribution of workers on a job is generally truncated from above and below: there are usually hiring criteria that applicants must satisfy to be assigned to that job (or to keep it), and there are usually also promotion criteria. Since measures of productivity within a job are necessarily restricted to workers who were assigned to those jobs and have not yet been promoted (or demoted), there is a clear sample-selection bias operating. For example, Medoff and Abraham (1980a) find in an empirical study that better educated workers need to achieve a lower level of productivity before being promoted than do less well educated workers.[1] Hence, even if

---

* The opinions expressed are not necessarily those of AT&T Bell Laboratories, of Bell Communications Research, or of NBER.

1. This could be explained if some of the learning in school has a greater effect on productivity in higher level jobs than in lower level ones.

productivity were positively correlated with education we could find that the better educated within a job (those who haven't been promoted) are, on average, less productive than the less well educated workers.

In this paper we prove a stronger point. Suppose job assignments were determined ***solely*** by productivity (so that the same level of performance were required for each worker's promotion) and productivity were an increasing function of experience and education. The use of productivity as the sole criterion for promotions could still cause a negative relationship between productivity and experience (or education) within jobs. The reason is that although the productivity of each individual increases with experience, the distribution of people by innate ability changes across experience and education bands within a job. The lower innate ability of the more experienced and better educated workers on a job could outweigh the direct effect of experience and education on their performance, and cause a negative correlation between experience (or education) and performance on that job.

Our argument is based on a model in which productivity is linked to job assignment. Such a linkage is explicitly formulated in models by Calvo and Wellisz, Rosen, and Guasch and Weiss.

In the Calvo-Wellisz model, shirking by supervisors is more harmful to the firm than is shirking by production workers. Consequently the more able workers are assigned to supervisory positions and are paid more (to increase their effort).

In the Rosen model, the production technology of the firm amplifies the productivity of supervisors relative to that of production workers. The output of supervisors affects the output of their subordinates. In equilibrium, the most productive, and most highly paid, workers are assigned jobs higher up in the corporate hierarchy.

In the Guasch-Weiss model, promotions of the more able workers are used as sorting mechanisms to induce applications from workers of high ability.

II. THE MODEL

Assume a continuous distribution $F(i)$ of the underlying abilities of individuals in the population, $i \in R^+$, and we denote $F'(i)$ by $f(i)$. The productivity of an individual i is $ix + \alpha iy$ where x represents either experience, age or education (for concreteness we shall refer to x as experience); x affects productivity on all jobs equally; y is the worker's tenure on his current job, and does not affect the worker's productivity on other jobs; α is a non-negative constant.

Firms observe productivity. Only workers whose productivity is above r are hired for this job. Workers whose productivity on an alternative job exceeds s are promoted. If i and x were independent (or negatively correlated) an outside observer would note that workers with greater experience (or education) are both more likely to get these jobs and are more likely to be promoted.

Consequently the abilities and experience (or education) levels of workers on this job satisfy.

$$r \leq xi \leq s \ . \tag{1}$$

Since, according to (1), the job begins when $x = r/i$, and ends when $x = s/i$, we have

$$y = x - r/i \ , \tag{2}$$

$$0 \leq y \leq (s-r)/i \ . \tag{3}$$

To put this in terms of the variable x, we substitute for y from (2), obtaining

$$ix + \alpha iy = x(1+\alpha)i - \alpha r \ , \tag{4}$$

in which, by (1) i is restricted to the range

$$r/x \leq i \leq s/x \ . \tag{5}$$

From (5) it follows that on any job longer experience x is associated with groups of lower ability. We now show that this sorting effect can outweigh the direct effect of experience on the productivity of each worker.

By (4) and (5), the average productivity, $AP(x)$, of workers on a particular job who have total work experience, x, is

$$\begin{aligned} AP(x) &\equiv \frac{\int_{r/x}^{s/x} [x(1+\alpha)\, i \, - \alpha r] f(i)\, di}{\int_{r/x}^{s/x} f(i)\, di} \\ &= (1+\alpha)\, \frac{x \int_{r/x}^{s/x} i f(i)\, di}{\int_{r/x}^{s/x} f(i)\, di} - \alpha r \ . \end{aligned} \tag{6}$$

To show that this expression can decrease with increasing x we need only produce an example. Suppose

$$f(i) = \begin{cases} \frac{6}{5}[i^{-3} + i^{-4}] & , i \geq 1 \\ 0 & , i < 1, \end{cases} \tag{7}$$

and consider an experience cohort for which $r/x \geq 1$. Then we find

$$\frac{x \int_{r/x}^{s/x} i f(i)\, di}{\int_{r/x}^{s/x} f(i)\, di} = x \frac{(\frac{x}{r} - \frac{x}{s}) + \frac{1}{2}(\frac{x^2}{r^2} - \frac{x^2}{s^2})}{\frac{1}{2}(\frac{x^2}{r^2} - \frac{x^2}{s^2}) + \frac{1}{3}(\frac{x^3}{r^3} - \frac{x^3}{s^3})}$$

$$= \frac{1 + \frac{x}{2}(\frac{1}{r} + \frac{1}{s})}{\frac{1}{2}(\frac{1}{r} + \frac{1}{s}) + \frac{x}{3}(\frac{1}{r^2} + \frac{1}{rs} + \frac{1}{s^2})}$$

$$= \frac{3(\frac{1}{r} + \frac{1}{s})}{2(\frac{1}{r^2} + \frac{1}{rs} + \frac{1}{s^2})} + \frac{6 - \frac{9(\frac{1}{r} + \frac{1}{s})^2}{2(\frac{1}{r^2} + \frac{1}{rs} + \frac{1}{s^2})}}{3(\frac{1}{r} + \frac{1}{s}) + 2x(\frac{1}{r^2} + \frac{1}{rs} + \frac{1}{s^2})}$$

$$= \frac{3(\frac{1}{r} + \frac{1}{s})}{2(\frac{1}{r^2} + \frac{1}{rs} + \frac{1}{s^2})} + \frac{\frac{3(\frac{1}{r} - \frac{1}{s})^2}{2(\frac{1}{r^2} + \frac{1}{rs} + \frac{1}{s^2})}}{3(\frac{1}{r} + \frac{1}{s}) + 2x(\frac{1}{r^2} + \frac{1}{rs} + \frac{1}{s^2})},$$

the first reduction obtained by removing the common factor $x^2(1/r - 1/s)$ from numerator and denominator, and the second by writing the result, $(A + BX)/(C + Dx)$, in the form $B/D + (A - BC/D)/(C + Dx)$. As the final expression decreases when x increases, the average product of labor on the job is a decreasing function of total labor experience.

Thus for each individual, productivity increases with experience. However, in the job-experience cohort being selected, the more experienced workers are less productive.

Of course these results are sensitive to the distribution, $F(i)$, of ability in the population. For example, suppose that, within the relevant range of ability types,

$f(i) = Ki^{\beta}$, where K is a constant of normalization. Then given our learning function and job assignment criterion, expected productivity within the job would be independent of experience. (This result follows trivially from substituting into (6)). Note that this result holds regardless of the sign of B, so $f'(i)$ can be positive or negative. Examples of distributions for which expected productivity increases with experience are likewise easy to find.

As we already mentioned, this argument is directly applicable to the relationship between productivity and education: we need only change the definition of x and rewrite (6) as $AP(x) = \dfrac{x\int_{r/x}^{s/x} i\, f(i)\, di}{\int_{r/x}^{s/x} f(i)\, di}$.

III. DISCUSSION

We have shown that sample selection can cause the measured relationship between particular worker characteristics and productivity on a job to be the reverse of what it actually is in the entire worker population. The distributions we have chosen to illustrate this do not seem unreasonable. Moreover, there is evidence that promotional criteria are less stringent for better educated workers, which would tend to strengthen the bias further.

Consequently it may be impossible to validate a firm's hiring criterion by comparing the performance of different workers that were hired under that criterion. Indeed, validation of that sort may be measuring the distribution of unobserved ability differences rather than the effect of observed attributes on performance.

A similar critique can be made of studies that seek to judge the effectiveness of SAT scores or high school grades as predictors of academic success at a particular

University by comparing *ex post* academic success with SAT scores or high school grades of students that satisfied the admissions standards of the university. In that case, promotion in the work setting would have its analog in choosing an academically more demanding University.

REFERENCES

[1] Becker, G., *Human Capital*, Chicago: University of Chicago Press, 2nd edition; 1975.

[2] Belbin, R. M., "Difficulties of Older People in Industry," *Occupational Psychology*, 1953, 27, 177-190.

[3] Berg, I., *The Great Train Robbery*: Columbia Univ. Press, 1973.

[4] Birren, J. E., *The Psychology of Aging*, Englewood Cliffs, N.J., Prentice Hall, 1964.

[5] Calvo, G. and S. Wellisz, "Hierarchy, Ability and Income Distribution," *Journal of Political Economy*, **87**, (October 1979), 991-1010.

[6] Clay, H. M., "A Study of Performance in Relation to Age at Two Printing Works," *Journal of Gerontology*, 1956, 11, 417-424.

[7] Freeman, S., "Wage Trends as Performance Displays Productive Potential: A Model and Application to Academic Early Retirement," *The Bell Journal of Economics*, Vol. 8, (Autumn 1977), 419-443.

[8] Guasch, J. L. and A. Weiss, "An Equilibrium Analysis of Wage-Productivity Gaps," *Review of Economic Studies*, Vol. 49, (1982), 485-497.

[9] Kutscher, R. E. and Walter, J. F., "Comparative Job Performances of Office Workers by Age," *Monthly Labor Res.*, 1960, 83, 39-44.

[10] Lazear, E., "Why is There Mandatory Retirement?" *Journal of Political Economy*, Vol. 87, (December 1979), 1261-1284.

[11] Lazear, E., "Agency, Earnings Profiles, Productivity and Hours Restrictions," *American Economic Review*, Vol. 71, (September 1981), 606-620.

[12] Medoff, J., and K. Abraham, "Experience, Performance and Earnings," *Quarterly Journal of Economics*, Vol. 95, (December 1980), 703-736.

[13] Medoff, J., and K. Abraham, "Are Those Paid More Really More Productive?" *Journal of Human Resources*, Vol. 41, No. 2, (Spring 1981), 186-216.

[14] Mincer, J., *Schooling Experience and Earnings*, New York, NBER; 1974.

[15] Muriel, K. F. N. and Griew, S., "Age Experience and Speed of Response," In A. T. Welford and J. E. Birren, *Behavior Aging and the Nervous System*, Springfield, Illinois, Charles C. Thomas, 1965.

[16] Rosen, S., "Authority, Control and the Distribution of Earnings," *Bell Journal of Economics*, Vol. 13, (Autumn 1982), 311-323.