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Predicting Potential For Promotion: How The Data In Human Resource Information Systems Can Be Used To Help Organizations Gain Competitive Advantage

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Abstract

This paper utilizes the data contained in the Human Resources Information System (HRIS) of a company, called here "Engineering Solutions," and analyzes the drivers of potential for promotion among a sample of engineers. The methods used consist of basic statistical procedures, multiple regressions, ordered logits, and decompositions. The results show which variables are the main drivers of potential for promotion in this organization, which are minor drivers, and which do not matter at all.

Predicting Potential For Promotion: How The Data In Human Resource Information Systems Can Be Used To Help Organizations Gain Competitive Advantage

This paper starts with a simple value proposition: that companies can gain competitive advantage by more fully utilizing the data in their internal human resource information systems (HRIS). By analyzing what has worked to produce top people within their own individual organizations, managers can seek out and develop those competencies in current employees and new hires. Equally importantly, by knowing what makes little or no difference in their particular context, managers can avoid wasting their time on the factors that are unimportant for them.

The data found in human resource information systems complement the data that can be obtained from benchmarking and learning from the best practices of successful organizations (Rynes and Milkovich, 1986; Glanz and Dailey, 1992; Hammer and Champy, 1993; Pfeffer, 1998). When organizations benchmark, they study what has produced the best outcomes elsewhere and seek to act similarly. Certainly, there are many contexts in which learning from one's competitors and peers and imitating their successes (and failures) makes a great deal of sense. However, in other situations, a more valuable source of information is the company's own experience.

This paper presents a detailed study of the potential for promotion for engineers in one particular company, here called "Engineering Solutions." Numerous prior studies have been conducted of human resource variables in individual organizations (e.g., Medoff and Abraham, 1980, 1981; Caldwell and Spivey, 1983; Kirman, et al., 1989; Lazear, 1992; Baker, Gibbs, and Holmstrom, 1994a, 1994b; Batt, 1999, 2001). What these and other studies have in common is that they report which explanatory variables are statistically significant determinants of the dependent variable and, in the regression studies, the amount by which a one-unit increase in each explanatory variable affects the dependent variable. What they do not deliver, however, and what the present study provides in addition to regression and logit coefficients, are estimates of how important some variables are vis-à-vis others. As we will see, the answers here are of the type, “This variable is three times as important as that one, which in turn is ten times as important as the other one.” To the best of my knowledge, this paper and a companion study (Fields, 2002) are the first applications of this kind of decomposition analysis in the human resource management literature.

The database for this study was generously supplied by Deloitte and Touche. We started with a sample of 100 engineers hired by Engineering Solutions in 1996. Of these, 65 were still with the company at the start of 2002. I should note that I know nothing more about the organization or the workers in it other than what I present in the “Data and Measures” section below – nothing about the industry in which it operates, how it generates its earnings, what the engineers do, or how they are organized and managed - and therefore I can only speculate on what the company might be doing to bring about the outcomes we observe.

The contribution of the present study beyond my own earlier work on Engineering Solutions is the following. In a companion paper (Fields, 2002), I analyzed retention and performance of engineers at Engineering Solutions and showed that the company has succeeded in retaining certain types of engineers disproportionately: the better-performing ones, those with the psychological attributes that make for greater success, those who worked harder, and those with fewer dependent-related job issues. Going beyond the psychological variables, I found that some other characteristics made a small and often statistically insignificant difference to performance and that still other variables made no difference at all. This paper goes beyond that earlier work to link performance to the potential for further professional growth. I begin with the issue of whether promotion potential is essentially the same thing as job performance and show that it is not. I then examine the drivers of promotion potential using a variety of bivariate and multivariate techniques. The results are uniform: of the candidate variables that might explain potential for promotion, two exhibit major explanatory power, three have modest explanatory power, and seven explain nothing.

Theoretical Framework And Hypotheses

Theoretical Foundations

The importance of good people as a means of achieving organizational success is often stressed, both in the academic literature (Wright and McMahan, 1992; Pfeffer, 1998; Baron and Kreps, 1999, chap. 1; Noe et al., 2000; Bamberger and Meshoulam, 2001, chap. 7; Cappelli and Neumark, 2001) and in management books and articles (Gubman, 1998; Welch, 2001; Collins, 2001; Bossidy and Charan, 2002). There can be little doubt that the particular people hired into an organization and the way they are organized and managed can make a critical difference to organizational success or failure.

The organization under study in this paper is one with both external and internal job markets. Experienced engineers are hired for professional positions. In addition to the external market, the company has an internal labor market whereby engineers already in the organization are promoted to higher positions. Job ladders may be designed in a variety of ways including tournaments, up-or-out systems, promotion pyramids, or promotion purely for the sake of promotion (Lazear, 1998, chap. 9; Baron and Kreps, 1999, chap. 16; Gibbons, 1999). However it is that promotion possibilities are structured in a particular firm or for a particular group of employees within a firm, it is clear that job performance is an important factor in signaling the employee's potential worth in a higher-level position. Performance on the current job plays a special role in our analysis of potential for promotion among engineers at Engineering Solutions.

In theory, many other factors beyond performance on the current job could also influence an employee's potential for promotion. One is his or her human capital. Human capital consists of the productive skills and abilities embodied in people (Schultz, 1962; Becker, 1964; Mincer, 1974). Human capital can, of course, be augmented through education and training. Accordingly, those employees with more of the correlates of human capital – in particular, graduate degrees and more job experience – would be the ones who would be expected to exhibit the greatest potential for promotion.

Another set of factors determining the potential for promotion is the employee's personal characteristics (which, by one reckoning, might be thought of as part of human capital). Psychological attributes may be powerful determinants of an employee's value if s/he is promoted to a more senior position. It would be surprising indeed if psychological variables did not play a role in promotability rankings in our study.

Additionally, ratings of promotion potential may reflect discrimination by senior officials in the organization. Discrimination in the labor market can take many forms: discrimination in hiring, in pay, in job assignments, in training opportunities, and/or in promotions (Blau, Ferber, and Winkler, 2002; Ehrenberg and Smith, 2002). Often, such discrimination is covert in nature. It is possible, therefore, that employees with certain characteristics may be found to do less well in a particular labor market dimension in ways that had not been codified in the organization's personnel manual or even known before. For this reason, a number of such demographic characteristics are included in our analysis.

In summary, theory and prior empirical work offer a great deal of guidance on possible influences on potential for promotion in general. However, neither theory nor past studies in other organizations can tell us which variables matter how much in explaining the potential for promotion for this particular occupational group (engineers) in this particular organization (Engineering Solutions). What the determinants are in this case is an empirical question, to which we now turn.

Hypotheses

Correlation between performance and potential for promotion: The simplest and most naïve hypothesis is that potential for promotion is essentially the same thing as current job performance. If this view is correct, managers would be found to be rating the employees who are currently performing the best as those with the highest potential for promotion. This may perhaps be because a manager who tends to rate an employee higher in one dimension might have a tendency to rate the employee higher in other dimensions in order to appear to be consistent and justify the rating on any given item; in the psychological literature, this is termed the "halo effect." According to this hypothesis, there would then be a very high correlation between the performance and potential variables. Thus:

> *Hypothesis 1: Engineers who have performed better to date exhibit higher potential for promotion.*

The drivers of potential for promotion compared with the drivers of job performance. If the naïve hypothesis is correct and potential for promotion and current job performance are essentially the same thing, then the variables that determine one would be the same as those that determine the other. Hence:

> *Hypothesis 2a: The characteristics that make for higher job performance are the same as those that make for higher promotion potential in bivariate analysis.*
> *Hypothesis 2b: The characteristics that make for higher job performance are the same as those that make for higher promotion potential in multivariate analysis.*

Further analysis of the drivers of potential for promotion. Suppose that the naïve hypothesis is correct and that current job performance and potential for promotion are essentially the same thing. Then when performance is included in a multivariate model, performance would explain virtually all the variation in potential for promotion and all other variables would pale into insignificance. On the other hand, if the naïve hypothesis is incorrect, performance may play a role in the presence of other factors that also affect the potential for promotion. Alternatively, once these other factors are included in the analysis, the employee's current job performance may be found to add little or no explanatory power to understanding his or her promotability rating. In this latter case, potential for promotion is determined by other characteristics found more frequently among high performers. According to this latter view:

> *Hypothesis 3a: Characteristics besides job performance contribute to the potential for promotion in bivariate analysis.*
> *Hypothesis 3b: Characteristics besides job performance contribute to the potential for promotion in multivariate analysis.*
> *Hypothesis 4: Holding constant other characteristics that raise the potential for promotion, higher job performance makes little extra difference.*

The relative weights of various explanatory variables. As described in detail below, decomposition analysis indicates how important each explanatory variable is in accounting for the dependent variable. In other words, the power of the decomposition model is that it tells us which explanatory variables provide how much information about the dependent variable. It is possible, of course, that everything that matters in determining the dependent variable matters the same amount – that is, one statistically significant explanatory variable may carry the same weight as every other. This is not likely to be the case. Rather, it would be expected that some variables are considerably more important than others in explaining potential for promotion at Engineering Solutions. Hence:

Hypothesis 5: The variables that make statistically significant contributions to explaining potential for promotion have different explanatory power.

Because no previous work has been done on this issue in this company, we have no basis for judging a priori which variables will turn out to be the most important.

Another hypothesis about the decomposition arises from the naïve hypothesis that performance and promotion potential are essentially the same thing. If the naïve view is correct, then the same variables that exhibit the greatest weight in explaining performance would also be the most important in explaining potential. On the other hand, if potential and performance really are different entities, then different variables would be found to explain the two of them. Formulated in terms of the naïve view, we have the following hypothesis:

Hypothesis 6: The characteristics that account the most for higher job performance are the same as those that account the most for higher job potential.

Robustness test: allowing for unobserved individual effects. The final hypothesis concerns the role of unobserved factors that affect our dependent variable, promotion potential. In this study, as in every other, the variables we have available to work with include some but not all of the influences on the dependent variable. However, methods are available for approximating the influences that these unobserved factors have on the dependent variable. The null hypothesis is that unobserved factors matter but that they do not bias the effect of observed factors on the dependent variable. The alternative hypothesis is that the estimated effects of the included variables change when the effects of unobserved factors are allowed for. Framed in terms of the null hypothesis, we have:

Hypothesis 7: The estimated effects of measured explanatory variables are not appreciably altered when unobserved individual effects are allowed for.

Data, Measures, And Methods

Data

As already described, the data set for this study was supplied by Deloitte and Touche for a client known here as "Engineering Solutions." The sample for analysis in this study consists of 65 engineers out of an original 100 who had been hired in 1996 and were still with the firm at the start of 2002.

Measures

Potential for promotion (POTRANKNUM). The dependent variable in this study is the employer's ranking of the employee's current potential for promotion. Each employee is classified into one of four categories: "can move up at least two levels," "can move up one level," "at level," "should be moved down one level." In this study, these four categories are scaled +2, +1, 0, and –1 respectively.

Performance (PERF). At Engineering Solutions, each employee receives an annual performance evaluation. The overall evaluation in the year 2001 is summarized on a five-point scale: "substantially exceeds expectations," "exceeds expectations," "meets expectations," "meets some expectations," "not meeting expectations." For purposes of this analysis, these five categories are scaled from +2 to –2.

Education (PHD, MS). The company's human resource information system contained data on the highest degree attained by the engineer when he or she started working for the company in 1996 and also as of the end of 2001. The three categories are Bachelor's, Master's, and Ph.D.

Type of degree (CHEM). The engineers in our sample were either chemical engineers or mechanical engineers. Type of degree is a binary variable taking on the value 1 for chemical engineers and 0 for mechanical engineers.

Age (AGE). The age variable is the employee's age as of the end of 2001.

Gender (MALE). Gender is a binary variable taking on the value 1 for males and 0 for females.

Ethnicity (ASIAN, BLACK, WHITE). In the company's HRIS, individuals are coded as being white, black, Asian/Pacific, or other. In the statistical work, binary variables are created for black and Asian/Pacific engineers. They are compared with a group consisting mostly of whites and a small number of others.

Salary (STARTSAL, CURRSAL). The data set contains information on starting salary in 1996 and current salary as of the end of 2001.

Number of jobs held (JOBSHELD). Many engineers switch from one job to another within the company. The number of jobs held is the number of jobs, including the present one, in which the employee has worked since joining the firm.

Number of separation days (SEPDAYS). Engineering Solutions offers its employees vacation days, paid holidays, and sick days. In addition, some employees are classified as having taken separations. A "separation" consists of a spell of four or more continuous days off other than vacation days, paid holidays, and sick days. In this study, the number of separation days is the total number of separation days taken since the time of hire.

Current number of dependents (NUMDEP). The number of dependents is recorded as of December, 2001.

Communicates effectively (EFFCOM), adapts to change (ADAPTCHN), thinks creatively (CRETHINK), and manages others effectively (MANOTHER). Each of these is the manager's current rating of the employee on a four-point scale. "Role model" is assigned a 4, "consistently displays" a 3, "sometimes displays" a 2, and "does not display" a 1.

Psychological variables. For some of the analysis, the ratings on "communicates effectively," "adapts to change," "thinks creatively," and "manages others effectively" are referred to collectively as "psychological variables."

Statistical and Econometric Methods

Elementary descriptive statistics, simple correlations, simple regressions and bivariate ordered logits (Hypotheses 1, 2, and 3). Some of the hypotheses concern simple associations without controlling for other variables. Ordinary Pearson correlation coefficients are used to determine if one variable is significantly related to another. To quantify the amount by which a change in one variable raises or lowers another, simple regressions are used. Because the potential variable is categorical, ordered logit models are also estimated. The percentage contributions of each explanatory variable in explaining a dependent variable are assessed using the pseudo-R^2's from ordered logit regressions.

Multiple regressions and ordered logits with multiple explanatory variables (Hypotheses 2, 3, and 4). To test for the effect of one explanatory variable holding other explanatory variables constant, most of the analysis is conducted using multiple regressions. The results are then checked using ordered logits. Multiple regressions have two advantages for our purposes here. First, the regression coefficients provide estimates of how many points or fractional points the dependent variable is changed by a one-unit change in a given explanatory variable. Second, the decomposition analysis described below was designed to work for multiple regressions, in which the dependent variable is an exact linear function of the explanatory variables, but not for ordered logits, in which the effects are non-linear. On the other hand, the ordered logit model has an advantage of its own: it takes account of the discrete nature of the dependent variable without imposing the assumption that regression does that the distance between pairs of categories is the same regardless of which two categories are being compared.

Decompositions (Hypotheses 5 and 6). To gauge the information content of these variables, I use a multivariate decomposition model (Fields and Yoo, 2000; Fields, 2001). The model was originally formulated to apportion income inequality to a number of explanatory factors such as education, job experience, and the like. The weights assigned to the several explanatory variables are constructed to sum to the total percentage of variance explained, R^2. These weights, derived axiomatically, are given by the following formula:

$$s_j = \frac{a_j * \sigma(X_j) * cor[X_j, Y]}{\sigma(Y)}, \qquad (1)$$

where s_j is the weight of the j'th explanatory variable, a_j is that variable's regression coefficient, $\sigma(X_j)$ is the standard deviation of the j'th explanatory variable, cor[X_j, Y] is the correlation between the j'th explanatory variable and the dependent variable Y, and $\sigma(Y)$ is the standard deviation of the dependent variable. The normalized weights p_j are obtained by dividing each s_j by R^2, so that each weight is expressed as a fraction of the total percentage of variance explained and the weights sum to 100%:

$$p_j \equiv \frac{s_j(\ln Y)}{R^2(\ln Y)}. \qquad (2)$$

Applied to the present context, these formulas can be used to provide the fraction of the variation in potential for promotion that is explained by the employee's education level, degree type, psychological characteristics, and so on.

Seemingly unrelated regressions (Hypothesis 7). Part of the analysis involves comparing the determinants of two dependent variables, promotion potential and current job performance. It is possible that unobserved individual effects affect both of these dependent variables. To test for this possibility, Zellner's seemingly unrelated regression model is used to estimate the promotion potential and performance equations (Zellner, 1962). The importance of unobserved person effects is tested using the Breusch-Pagan test (1980).

Statistical And Econometric Results

Descriptive Statistics

Table 1 presents descriptive statistics. For categorical variables, these are the fraction of engineers with that particular characteristic. For continuous variables, these are means.

Table 1
Engineering Solutions:
Summary Statistics For 65 Engineers Hired Into
The Company In 1996
And Still With The Company As Of January 2002

Variable	Distribution Among Active Engineers
Current Potential	
Can move up at least two levels	21
Can move up one level	20
At level	17
Should be moved down at least one level	7
Current Performance	
Substantially exceeds expectations	5
Exceeds expectations	28
Meets expectations	28
Meets only some expectations	2
Not meeting expectations	2
Degree as of 1996	
Ph.D.	16
Masters	20
Bachelors	29
Degree as of 2002	
Ph.D.	21
Masters	22
Bachelors	22
Type of Degree	
Chemical engineer	36
Mechanical engineer	29
Mean Age	35.8
Prior Experience	
Yes	38
No	27
Gender	
Male	42
Female	23
Ethnicity	
White	28
Black	10
Asian/Pacific	18
Other or unknown	9
Mean Starting Salary	$41,615
Mean Current Salary	$71,692
Communicates Effectively	
Role model	21
Consistently displays	31
Sometimes displays	12
Does not display	1
Adapts to Change	
Role model	22
Consistently displays	34
Sometimes displays	6
Does not display	3
Thinks Creatively	
Role model	11
Consistently displays	38
Sometimes displays	13
Does not display	3
Manages Others Effectively	
Role model	29
Consistently displays	27
Sometimes displays	6
Does not display	3
Mean Number of Jobs Held Since Joining the Firm	3.5
Mean Number of Separation Days Taken Since Joining the Firm	4.2
Mean Current Number of Dependents	1.1

Correlation Between Performance and Potential for Promotion

Table 2 displays the correlation matrix for all of our variables. Correlations significant at the 10% level are marked by *s. What is noteworthy, here and in the rest of the results below, is the large number of statistically significant relationships despite having a sample size of only 65 cases.

The coefficient of correlation between performance and potential for promotion is a statistically significant 0.42. This result confirms Hypothesis 1: engineers who have performed better to date exhibit higher potential for promotion. However, this coefficient is also statistically significantly different from 1.0; this is the first piece of evidence against the naïve hypothesis that performance and potential for promotion are essentially the same thing.

Drivers of Potential for Promotion Compared with Drivers of Job Performance.

Under the naïve hypothesis, the factors that significantly affect promotion potential would also be the ones that affect job performance at Engineering Solutions. As the correlation matrix in Table 2 shows, some of the variables are the same and some are not. The variables that are statistically significantly associated with potential (besides performance) are chemical/ mechanical engineer, gender, starting salary, current salary, number of jobs held, effective communication, adaptability to change, creative thinking, and managing others. On the other hand, the variables that are statistically significantly associated with performance (besides potential) are Ph.D., chemical/mechanical engineer, current salary, number of jobs held, effective communication, adaptability to change, creative thinking, and managing others. Moreover, even the explanatory variables that do exhibit statistically significant correlations with both potential and performance in most cases exhibit quite different correlations between the two dependent variables. This is further evidence that potential for promotion and job performance are not the same thing.

These correlation results therefore lead to a rejection of the bivariate form of Hypothesis 2 that the characteristics that make for higher job performance are the same as those that make for higher promotion potential. Rather, we find that while some of the explanatory variables are the same, others are different.

Table 2
Engineering Solutions:
Zero-Order Correlation Matrix
Note: Correlations statistically significant at the 10% level or better are marked by *s.

	potranknum	perf	phd	ms	chem	age	male	asian	black	white	startsal	cursal	jobsheld	sepdays	numdep	effcom	adaptchn	crethink	manother
potranknum	1.0000																		
perf	0.4201*	1.0000																	
phd	0.1245	0.2178*	1.0000																
ms	0.0126	0.1278	0.4942*	1.0000															
chem	0.4805*	0.2197*	0.0244	0.2083*	1.0000														
age	0.0007	0.0786	0.1327	0.0554	0.0227	1.0000													
male	0.3380*	0.0927	0.0392	0.0534	0.4053*	0.0035	1.0000												
asian	0.0080	0.1338	0.2341*	0.1520	0.1405	0.1135	0.2611*	1.000											
black	0.0659	0.0041	0.2525*	0.3050*	0.1320	0.1710	0.1372	-0.2639*	1.000										
white	0.0720	0.0688	0.2688*	0.1000	0.0317	0.0847	0.0590	-0.5384*	-0.3709*	1.000									
startsal	0.2430*	0.0825	0.0381	0.0023	0.0730	0.0107	0.1552	-0.0182	-0.0064	0.2008	1.000								
cursal	0.4762*	0.6140*	0.0247	0.0992	0.2339*	0.0094	0.1238	0.0725	0.0246	-0.0496	0.4095*	1.000							
jobsheld	0.4452*	0.2938*	0.4669*	0.5769*	0.5571*	0.0254	0.4384*	-0.3985*	-0.0510	0.3001*	0.1859	0.2111*	1.000						
sepdays	0.0844	0.2045	0.0389	0.0885	0.1712	0.0886	0.1050	0.0265	-0.0543	0.0954	-0.0118	0.1687	0.1994	1.000					
numdep	0.0283	0.1885	0.0891	0.0233	0.0394	0.2085*	0.1076	0.0575	0.1427	-0.1658	0.1695	0.2121*	-0.1516	-0.0227	1.0000				
effcom	0.5809*	0.5253*	0.1437	0.0710	0.3265*	0.0366	0.1929	-0.0892	0.0527	0.0410	0.0634	0.4898*	0.3254*	0.2786*	0.1592	1.000			
adaptchn	0.2920*	0.4981*	0.2237*	0.0585	0.0619	0.0166	0.0225	0.0550	-0.0298	-0.0124	0.0749	0.2898*	0.0912	-0.1106	0.1912	0.3461*	1.000		
crethink	0.2267*	0.6484*	0.2876*	0.1199	0.3192*	0.1412	0.1389	0.0101	0.0134	0.0612	0.0080	0.3119*	0.2903*	0.2033	0.1002	0.2768*	0.3333*	1.000	
manother	0.4318*	0.5337*	0.1013	0.0903	0.3601*	0.1215	0.2790*	-0.0301	0.1257	-0.0508	0.0927	0.2866*	0.2557*	0.1977	0.2105*	0.5899*	0.2567*	0.4169*	1.000

This conclusion is reinforced by the multiple regression results described in Table 5. But before we are in a position to compare the determinants of potential with those of performance in a multivariate setting, we must further analyze what determines potential.

Further Analysis of Drivers of Potential for Promotion

The correlation matrix in Table 2 is one way of determining how closely a particular explanatory variable is associated with the potential for promotion. Another way of gauging this relationship is a comparison of ordered logit regressions. Ordered logit regressions recognize that the dependent variable is a categorical one measured on a four-point scale ranging from "should be moved down one level" on up to "can move up at least two levels." In addition to the logistic coefficients themselves, ordered logits generate pseudo-R-squareds. These pseudo-R-squareds are the proportion of variance in the promotion variable explained by a given explanatory variable. By ranking the explanatory variables from highest pseudo-R-squared to lowest, we can measure which variables drive potential more than others.

These pseudo-R-squareds are shown in Column (1) of Table 3. We see that by this criterion, the variables significantly explaining potential for promotion are, in order of importance, communicates effectively, current salary, mechanical/chemical engineer, performance, manages others effectively, prior experience, gender, adapts to change, thinks creatively, and starting salary. The remaining variables (degree level, ethnicity, number of separation days taken, number of dependents, and age) do not contribute significantly to explaining potential.

Table 3
Engineering Solutions:
Bivariate Analysis of the Effects of Various Explanatory Variables
on the Potential for Promotion

Independent Variable	**Percentage Contribution of the Variable in an Ordered Logit Regression**	**Regression Coefficient**
	(1)	(2)
Communicates effectively	6% **	0.77**
Current salary	0.1%**	0.000034**
Mechanical/chemical engineer	.1%**	-0.96** for Chem
Number of jobs held in the company	8.5%**	0.26**
Performance	8.3%**	0.52**
Manages others effectively	7.5% **	0.53**
Prior experience	4.8%**	0.68**
Gender	4.4%**	0.70** for Male
Adapts to change	3.7% **	0.38**
Thinks creatively	2.5% **	0.31*
Starting salary	2.2%*	0.000031**
Degree level	0.7%	-0.33 for Ph.D., -0.14 for M.S.
Ethnicity	0.3%	0.02 for Asian, 0.19 for Black
Number of separation days taken	0.2%	0.006
Number of dependents	0.0%	0.03
Age	0.0%	-0.0001

Notes to Table 3: Variables marked by ** are statistically significant at the .05 level or better, variables marked by * are statistically significant at the .10 level. The percentage contributions in Column (1) are the pseudo-R^2's obtained from ordered logits of the four-point potential ranking on the independent variable in question.

The correlations in Table 2 and the Pseudo-R-squareds in Column (1) of Table 3 can tell us the degree of association between any given explanatory variable and potential for promotion, but they cannot tell us the amount by which the potential for promotion increases or decreases across engineers with different values of the explanatory variables. The first way of gauging these magnitudes is to run a multiple regression with the four-point promotion scale as the dependent variable and individual explanatory variables as independent variables. The results are presented in Column (2) of Table 3.

Certain variables exhibit quite large effects on the four-point "potential for promotion" scale. According to these regression coefficients, all of the psychological variables are important. An increase of one point on the four-point "communicates effectively" scale increases promotion potential 0.8 points, a one point increase in "manages others effectively" increases promotion potential by 0.5 points, a one point increase in "adapts to change" increases promotion potential by 0.4 points, and a one point increase in "thinks creatively" increases promotion potential by 0.3 points. Other variables that also show sizeable effects are type of engineer (mechanical engineers are 1 point higher on the promotion scale than chemical engineers), gender (men score 0.7 points on promotion potential), current salary (a $10,000 increase in starting salary or current salary is associated with a 0.3 point increase in promotion potential), and number of jobs held in the company (each job held raises promotion potential by 0.3 points).

Finally, it is worth noting that the regression coefficient on the performance variable is 0.5. If performance and promotion potential were the same variable, the coefficient would be 1.0. This coefficient is significantly different from 1.0.

In sum, this subsection has shown that in bivariate analysis certain characteristics contribute to the potential for promotion, consistent with Hypothesis 3.

We turn now to multiple regressions to test which of the variables available to us have important influences on promotion potential controlling for other possible influences. The first regression in Table 4 includes variables that were known at the time of hiring. In the presence of other variables in that category, the ones that appear as statistically significant determinants of potential are having a graduate degree (negative effect), being a chemical engineer (negative effect), and having prior experience (positive effect).

Regression (2) in Table 4 contains only those variables that were learned after hiring. This regression shows that statistically significant predictors of promotion potential, holding other post-hire variables constant, include number of jobs held in the company (positive effect) and being an effective communicator (positive effect). Current salary also exhibits a positive effect in this equation, but this should be interpreted as an indicator of the valuation the firm places on this particular engineer and not as a driver of higher potential.

In regression (3), the variables that were found to be statistically significant in regressions (1) and (2) or nearly so are included. This regression produces several variables that are highly significant or nearly so and several others that are clearly insignificant. After eliminating the latter variables, we end up with regression (4) as our “final” potential regression.

Regression (4) shows that a number of variables are statistically significant in the presence of other factors; these include having a graduate degree (negative), being of Asian/Pacific origin (positive), being an effective communicator (positive), having held more jobs in the company (positive), current salary (positive), and prior experience (positive). The remaining variables are statistically insignificant.

These, then, are the drivers of potential for promotion, holding other variables constant. These results provide a multivariate answer to Hypothesis 3: the characteristics enumerated in the preceding paragraph do indeed contribute to the potential for promotion in the presence of other variables.

Table 4
Engineering Solutions:
Multivariate Regressions of the Effects of Various Explanatory Variables

Independent Variable	*Variables Known at Time of Hiring*	*Variables Learned After Hiring*	*Variables Statistically Significant or Nearly So in (1) and (2)*	*Drop the Very Insignificant Variables Included in (3)*	*Variables in (4) with Performance Added*
	(1)	(2)	(3)	(4)	(5)
Ph.D. in 1996	-0.967***				
	(0.323)				
M.S. in 1996	-0.543*				
	(0.301)				
Ph.D. in 2001			-0.423	-0.425	-0.424
			(0.299)	(0.282)	(0.284)
M.S. in 2001			-0.814***	-0.810***	-0.811***
			(0.296)	(0.257)	(0.260)
Chemical Engineer	-0.727***		-0.302	-0.293	-0.279
	(0.250)		(0.256)	(0.246)	(0.255)
Age	0.001		0.002		
	(0.017)		(0.015)		
Asian	0.418		0.396	0.423*	0.437*
	(0.274)		(0.244)	(0.220)	(0.229)
Black	0.057		-0.086		
	(0.329)		(0.304)		
Male	0.160		0.010		
	(0.262)		(0.239)		
Prior Experience	0.573*		0.426	0.404	0.406
	(0.310)		(0.289)	(0.258)	(0.261)
Starting Salary	0.000		0.000		
	(0.000)		(0.000)		
Current Salary		0.0000184**	0.0000127	0.0000141*	0.0000151*
		(0.0000082)	(0.0000090)	(0.0000078)	(0.0000087)
Number of Dependents		-0.078			
		(0.106)			
Number of Separation Days		-0.007	-0.008	-0.008	-0.008
		(0.007)	(0.007)	(0.007)	(0.007)
Effective Communication		0.416**	0.371**	0.356**	0.360**
		(0.186)	(0.184)	(0.170)	(0.173)
Adapts to Change		0.094	0.079	0.077	0.087
		(0.144)	(0.144)	(0.138)	(0.146)
Creative Thinking		-0.108	-0.176	-0.185	-0.165
		(0.157)	(0.158)	(0.148)	(0.172)
Manages Others Effectively		0.191	0.151	0.156	0.166
		(0.157)	(0.157)	(0.143)	(0.150)
Number of Jobs Held		0.158**	0.210**	0.221**	0.225**
		(0.062)	(0.098)	(0.088)	(0.090)
Performance					-0.050
					(0.207)
Constant	0.177	-2.815***	-2.183**	-2.016***	-2.223*
	(0.878)	(0.618)	(0.972)	(0.753)	(1.149)
R-squared	0.40	0.49	0.61	0.61	0.61

* significant at 10%; ** significant at 5%; *** significant at 1%

With these results in hand, we are now in a position to test Hypothesis 4: that holding constant other characteristics that raise the potential for promotion, higher job performance makes little extra difference. The test consists of adding the performance variable to the variables included in regression (4) of Table 4. When this is done, performance appears with a negative coefficient that is statistically insignificant. Hypothesis 4 is thereby confirmed.

We are also in a position to return to Hypothesis 2, which stated that the characteristics that make for higher job performance are the same as those that make for higher promotion potential. Table 5 reproduces the preferred model for promotion potential, regression (4) of Table 4, and places it alongside the preferred equation for job performance from Fields (2002). What we find is:

- Some variables are statistically significant determinants of both potential and performance or nearly so: being an effective communicator, holding more jobs in the company, and being of Asian/Pacific origin
- Some variables are statistically significant determinants of potential only: education level, current salary
- Some variables are statistically significant determinants of performance only: chemical/mechanical engineer, adapting to change, creative thinker, manages others effectively, prior experience

These regression results give a multivariate answer to Hypothesis 2: the characteristics that, other things equal, make for higher job performance are quite different from the characteristics that, other things equal, make for higher potential for promotion. This rejection of the multivariate version of Hypothesis 2 accords with the confirmation of the rejection version presented above.

Table 5
Engineering Solutions:
Multivariate Regressions Of The Drivers Of Potential Compared With The Drivers Of Job Performance
(Standard Errors In Parentheses)

Independent Variable	*Dependent Variable*	
	Current Potential Ranking	Job Performance
	(1)	(2)
Ph.D.	-0.425	
	(0.282)	
M.S.	-0.810***	
	(0.257)	
Chemical Engineer	-0.293	0.326*
	(0.246)	(0.174)
Asian	0.423*	0.347**
	(0.220)	(0.156)
Prior Experience	0.404	0.200
	(0.258)	(0.157)
Current Salary	0.0000151*	
	(0.0000088)	
Separation Days	-0.008	
	(0.007)	
Effective Communication	0.356**	0.243**
	(0.170)	(0.111)
Adapts to Change	0.077	0.249**
	(0.138)	(0.094)
Creative Thinking	-0.185	0.488***
	(0.148)	(0.102)
Manages Others Effectively	0.156	0.176*
	(0.143)	(0.103)
Number of Jobs Held	0.221**	0.077
	(0.088)	(0.050)
Constant	-2.016***	-3.687***
	(0.753)	(0.480)
R-squared	0.61	0.66

* significant at 10%; ** significant at 5%; *** significant at 1%

Relative Weights of Various Explanatory Variables in Accounting for Promotion Potential and Job Performance

Lest the preceding results be misinterpreted as saying that all highly statistically significant variables are equally important, the decomposition model described above has been applied to the determinants of potential for promotion. Panel A of Table 6 presents the proportions of the explained variance that can be attributed to each of the statistically significant explanatory variables. The weights fall into three groupings:

- Two statistically significant variables from the regressions – the psychological variables and the number of jobs held in the company – have large weights in the potential for promotion equation, each explaining about 30% of what is explained by the model as a whole.

- Three statistically significant variables from the regressions – current salary, chemical/mechanical engineer, and prior experience – have intermediate weights, each explaining between 10% and 15% of what is explained by the model as a whole.
- The two remaining statistically significant variables from the regressions – ethnicity and number of separation days – explain nothing or almost nothing.

It should be recalled that other variables on which we have information showed no sign of being important in earlier steps and so are excluded from the decomposition. These variables – degree level, age, gender, starting salary, and number of dependents – also explain none of the variation in potential for promotion.

Hypothesis 5 stated that the variables that make statistically significant contributions to explaining potential for promotion have differential explanatory power. These decomposition results decisively support that hypothesis.

Given these results, we may ask how the pattern of explanatory weights for potential differs, if at all, from the pattern for performance. Hypothesis 6 states that the characteristics that account the most for higher job performance are the same as those that account the most for higher promotion potential. The performance results, taken from the earlier study, appear in Panel B of Table 6. The performance results are similar to the potential results in one very important respect: for both dependent variables, the single most important set of explanatory variables is the set of psychological factors. In all other respects, the results are quite different. Even for the psychological variables, they are much more important for performance than they are for potential. As for the other variables, those that have some role to play in accounting for differences in potential for promotion have no role to play in accounting for differences in job performance. This is yet another piece of evidence against the naïve hypothesis that managers' evaluations of the engineers' job performance and of their potential for promotion are picking up essentially the same overall assessment of individual engineers' quality.

Table 6
Engineering Solutions:
Multivariate Decomposition Of The Factors Contributing
To Explaining Promotion Potential And Job Performance

A. Results For Potential

Independent Variable	**Percentage Contribution of the Variable in a Multivariate Decomposition of Promotion Potential***
Psychological variables: communicates effectively, adapts to change, thinks creatively, manages others	32.4%
Number of jobs held in the company	27.8%
Current salary	15.5%
Chemical/mechanical engineer	11.6%
Prior experience	11.6%
Degree level	3.1%
Ethnicity	-0.7%
Number of separation days	-1.6%
Total	100%

B. Results for Performance

Independent Variable	**Percentage Contribution of the Variable in a Multivariate Decomposition of Job Performance***
Psychological variables: communicates effectively, adapts to change, thinks creatively, manages others	65.6%
Number of non-vacation days taken	14.1%
Number of dependents	7.6%
Ethnicity	4.3%
Prior experience	0.9%
Mechanical/chemical engineer	0.5%
Age	0.1%
Degree level	0.1%
Starting salary	-0.1%
Male/female	-0.4%
Number of jobs held in the company	-0.5%
Total	100%

* These are weights p_j given by equation (2) in the text.
Source of Panel B: Fields (2002).

Robustness Tests

Allowing for unobserved individual effects. The variables from the company's Human Resource Information System that were made available for this study include only some of the potentially relevant factors affecting engineers' potential for promotion. To test whether the unobserved individual effects influence the pattern of results, I estimated Zellner's Seemingly Unrelated Regression (SUR) model for promotion potential and job performance taken together. The results for these two panels appear respectively in Columns (1) and (2) of Table 7. Comparing these results using SUR with the Ordinary Least Squares results in the corresponding columns of Table 5, we see that they are virtually the same. This gives us additional confidence in the OLS results reported above and confirms Hypothesis 7: that the estimated effects of measured explanatory variables are not appreciably altered when unobserved individual effects are allowed for.

Table 7
Engineering Solutions:
Multivariate Regressions Explaining Performance And Potential Using
Zellner's Seemingly Unrelated Regression Model
(Standard Errors In Parentheses)

Independent Variable	**Dependent Variable**	
	Current Potential Ranking	**Job Performance**
	(1)	(2)
Chemical Engineer	-0.295	0.326*
	(0.246)	(0.174)
Asian	0.420*	0.347**
	(0.220)	(0.156)
Effective Communication	0.350**	0.243**
	(0.170)	(0.111)
Adapts to Change	0.075	0.249***
	(0.138)	(0.094)
Creative Thinking	-0.188	0.488***
	(0.148)	(0.102)
Manages Others Effectively	0.157	0.176*
	(0.143)	(0.103)
Prior Experience	0.397	0.200
	(0.258)	(0.157)
Number of Jobs Held	0.221**	0.077
	(0.088)	(0.050)
Ph.D.	-0.424	
	(0.282)	
M.S.	-0.811***	
	(0.257)	
Current Salary	0.0000149*	
	(0.0000078)	
Number of Separation Days	-0.008	
	(0.007)	
Constant	-2.036***	-3.687***
	(0.752)	(0.480)
R-squared	0.61	0.66

* significant at 10%; ** significant at 5%; *** significant at 1%

Additionally, the Breusch-Pagan test of independence of residuals in the promotion and performance equations produced a correlation coefficient of –0.03 with a chi-square value of 0.058 and a p value of 0.81. These results indicate that the unobserved elements of promotion potential and the unobserved elements of job performance are not significantly correlated with one another.

It should be pointed out that the similarity between the SUR and the OLS results does not mean that all relevant determinants have been included. What it does mean is that the omission of unmeasured determinants does not bias the apparent effect of measured determinants.

Ordered logits. The final robustness check is a test of whether the ordered logit model produces a similar pattern of important and unimportant variables in the promotion potential equation. Table 8 displays the ordered logit estimates, using the same set of explanatory variables as are used in the preferred regression, model (4) of Table 4. Comparing the two sets of results, we see that the coefficients differ (as indeed they should, because ordered logit coefficients have no natural scale) but the patterns of statistical significance (the z statistics in Table 8 and the t statistics in Table 4) are virtually the same. This is yet one additional piece of evidence confirming that we have in fact correctly identified the important determinants of the potential for promotion.

Table 8
Engineering Solutions:
Ordered Logit Analysis Of The Effects Of Various Explanatory Variables
On The Potential For Promotion

Independent Variable	*Ordered Logit Coefficient*
Ph.D.	-1.371
	(0.871)
M.S.	-2.347***
	(0.835)
Chemical Engineer	-0.775
	(0.722)
Asian	1.416**
	(0.714)
Prior Experience	1.191
	(0.777)
Current Salary	0.000**
	(0.000)
Separation Days	-0.027
	(0.019)
Effective Communication	1.040**
	(0.488)
Adapts to Change	0.202
	(0.414)
Creative Thinking	-0.669
	(0.454)
Manages Others Effectively	0.590
	(0.413)
Number of Jobs Held	0.648**
	(0.285)

* significant at 10%; ** significant at 5%; *** significant at 1%

Discussion

Overview

In this paper, I have utilized the data contained in the Human Resources Information System (HRIS) of a company, called here "Engineering Solutions." The database covers 100 engineers who started with the company in 1996, of whom 65 were still employed there at the end of 2001. This paper analyzes the drivers of potential for promotion, evaluated on a four-point scale: "can move up at least two levels," "can move up one level," "at level," or "should be moved down one level." The analysis here of potential for promotion complements an earlier analysis of retention (whether the engineer was still with the company five years after being hired) and job performance (on a five-point scale ranging from "substantially exceeds expectations" on down to "not meeting expectations") presented in Fields (2002).

The methods used consisted of basic statistical procedures, multiple regressions, ordered logits, and decompositions. Each provides particular ways of gauging the statistical significance and quantitative importance of the various explanatory variables.

Perhaps most remarkable is the number of variables that have been found to be statistically significant and quantitatively important using a sample of just 65 individuals. These results highlight the value of using information from companies' Human Resource Information Systems for managerial decision-making.

Together, the results from applying these methods paint a consistent overall picture. They show that potential for promotion is a quite different factor from job performance at Engineering Solutions. They show us too which variables are the main drivers of potential for promotion at Engineering Solutions, which are the minor drivers, and which do not matter at all.

Let us now consider these findings and their implications in greater detail.

Potential for Promotion versus Job Performance

We have found that potential for promotion is by no means the same thing as job performance at this company. A naïve expectation might have been that when managers rate particular employees highly on one of these factors, they rate them highly on the other (the so-called "halo effect").

This naïve view is decisively refuted by several pieces of evidence. First, potential for promotion and job performance have indeed been found to be correlated, but with a correlation coefficient of only 0.4. Second, many variables found to be statistically significant in explaining one are found to be statistically insignificant in explaining the other. Third, of the statistically significant variables, although the psychological variables are the leading factor in explaining both potential and performance, these variables are twice as important in explaining job performance as they are in explaining potential for promotion. Fourth, the remaining explanatory variables are ordered entirely differently for the two dependent variables.

I infer that managers at Engineering Solutions are carefully considering the talents and preferences of each individual when evaluating his or her potential for promotion. Some engineers may be very skilled at direct engineering work, yet show little potential for being managers of engineers. Other engineers may have strong preferences for continuing the hands-on work of engineering rather than the more remote duties of managing others. From our finding that performance and potential have different drivers, it appears that the company has done an effective job of offering rewarding career opportunities both to engineers who continue as engineers and to those who manage others.

The Main Drivers of Potential for Promotion

Two variables have been found to be major drivers of potential for promotion at Engineering Solutions. The first is a group of psychological attributes of the engineer. Those engineers that rate highly on effective communication, adaptability to change, creative thinking, and managing others are the ones judged as having the highest promotion potential. Given the importance of these psychological attributes both to potential for promotion (the subject of this study) and to job performance (the subject of my earlier study), one action implication is that the company should direct its campus recruiters and hiring managers to look carefully at these psychological traits if they are not already doing so. In view of the findings here, formal psychological assessments of potential employees would apparently produce large benefits. Given the low cost of such screening mechanisms, the company would probably do well with such testing.

The other variable that plays a major role in predicting potential for promotion is number of jobs held at the company. Here, there are at least three reasons why this variable may have been found to be so important.

One is that having held more jobs may signal potential for future promotions. This is because the very skills, talents, and attributes that have produced past promotions may be expected to continue to produce promotions in the future. If this is the case at Engineering Solutions, those employees who have held more jobs in the company to date because they have already been promoted would be precisely the ones whom we would expect would continue to be promoted in the future.

Another possible explanation has to do with internal bidding for talent. In some organizations, project leaders form ad hoc teams and alliances of employees for particular projects. When one project is completed, employees enter the internal labor market for other projects. Employees who are known to have performed well on previous assignments are eagerly sought after for future assignments. If Engineering Solutions has such an internal market for the services of its engineers, this could also help explain why engineers who have held more jobs in the company are the ones rated as having the greatest potential.

A third potential reason for finding that number of jobs held in the company is a major predictor of potential for promotion has to do with the engineer's knowledge of different parts of the company. Many organizations have formal, periodic job rotation schemes, in some cases just for young professionals and in other cases for everyone. Those engineers who have worked in more parts of the company may have a better understanding of how the various divisions and units contribute to the ultimate bottom line, and so may be more valuable for that reason.

Minor Drivers of Potential for Promotion

Turning now from the major variables to the less important ones, three other statistically significant variables from the regressions were found to have intermediate weights. Each explains between 10% and 15% of what is explained by the model as a whole.

The first minor driver of potential for promotion is current salary. The most likely explanation for current salary being observed to play a positive role is that the company is likely paying higher salaries to those engineers whom it judges to be performing the best and to have the greatest potential for making even greater contributions to the organization in the future. By the same token, the company may also be penalizing the engineers who are not performing well and who exhibit little growth potential, in effect managing them out of the company. It appears that Engineering Solutions is successfully using its compensation policy to help identify, retain, and promote its best.

Another variable found to be statistically significant but of modest quantitative importance is whether the person is a chemical or a mechanical engineer. Chemical engineers are found here to have lower potential. However, they also exhibit higher performance. No information is available to me about what types of professional duties these two groups of engineers perform. Without this, it is impossible to draw any inferences about what the company is now doing or should be doing about these two types of engineers.

The third variable that was found to be statistically significant but with relatively modest explanatory power is whether the employee had prior experience when joining the company in 1996. The most probable reason that this variable makes a difference is that Engineering Solutions is successful at finding talent not only among new college graduates but also among engineers who are already employed elsewhere. Without further information, we cannot tell whether experienced hires are successful primarily because the company actively seeks out good people in other organizations, primarily because experienced engineers seek out Engineering Solutions as a desirable place to work, or because of both of these.

Insignificant Drivers of Potential for Promotion

The last finding is about variables that show no sign of being important. Several variables have been found in this study either to be statistically insignificant or to play a minor role in explaining potential for performance. This insignificant category includes ethnicity, number of separation days, degree level, age, gender, starting salary, and number of dependents. Armed with this information, the company can manage what matters and ignore what doesn't. For managers, knowing what can safely be ignored may be as important as knowing what must be attended to.

Limitations and Directions for Future Research

This research is not without its limitations. First, the information analyzed here comes from a single company and from one occupational group within that company. We have no idea how generally applicable these particular conclusions are. More case studies are needed.

Second, we know nothing about this company, either its internal workings or the external context within which it operates. In this and other studies like it, it will be useful to link such organizational and contextual information to the statistical analysis.

Third, the information here is from a single cross section. Many other interesting things could be learned if we had repeated observations on the same individuals. This too awaits further case studies in other organizations.

Despite these limitations, it has been heartening to discover how much can be learned by statistical and econometric analysis of data of this kind.

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