THE INTERNAL ECONOMICS OF THE FIRM: EVIDENCE FROM PERSONNEL DATA*

GEORGE BAKER
MICHAEL GIBBS
BENGT HOLMSTROM

We analyze twenty years of personnel data from one firm. The hierarchical structure is quite simple and stable. Career movements suggest that the employee's rate of learning and the firm's learning about ability are important. There are promotion "fast tracks." Exit rates vary little with tenure or salary. The firm has personnel policies like those described in the internal labor markets literature, although several theoretical preconditions for ILMs, such as ports of entry and exit, are lacking. Job levels are important to compensation, but there is also substantial individual variation in pay within levels. Our companion paper (in this issue) explores the wage policy of this firm.

INTRODUCTION

There is a large and growing interest in the economic theory of the internal workings of firms. However, this literature is based on very little data and limited stylized facts. Personnel data can bridge this gap. Virtually all firms keep detailed records of employees' positions, performance, and compensation. Such data may also describe reporting relationships and organization structures. In this and a companion paper [Baker, Gibbs, and Holmstrom 1994] we analyze personnel data from one firm over twenty years. We use these data to peer inside the "black box" of the firm to explore the existence and nature of the internal labor market and the wage policy of the firm.

This paper is largely descriptive. Our objectives are to describe the workings of the firm in ways that are of interest to organization theorists, and to examine the internal labor market that might exist in the firm. Doing so may, in turn, stimulate new theories of

*We appreciate greatly the comments on various versions of this paper from John Abowd, Jeffrey Borland, Joetta Forsyth, Richard Freeman, Robert Gibbons, James Heckman, Edward Lazear, Joshua Lerner, Kristin McCue, Thomas Mroz, Ariel Pakes, Canice Prendergast, Sherwin Rosen, Erik Sirri, and Michael Waldman, and seminar participants at the University of Chicago, Harvard, Princeton, and Yale Universities, CPER's summer symposium in Economic Theory (Gerzensee, Switzerland), the conference on Incentives and Contracts at the University of Montreal, and the annual meetings of the European Economic Association and the American Economic Association. Excellent assistance was provided by David Nislick, Carol Smith, and William Simpson. Funding was provided by the Division of Research at the Harvard Business School, the University of Chicago, Yale School of Organization and Management, and the Academy of Finland.

The Quarterly Journal of Economics, November 1994

organizations. Our starting point in this descriptive task is Doeringer and Piore's 1971 book which described the characteristics of an internal labor market, and laid out some of the theoretical conditions under which one could arise and survive. We look for evidence of an internal labor market like that described by Doeringer and Piore, and for evidence of their underlying theory of internal labor markets.

Doeringer and Piore provide a succinct description of internal labor markets in their 1985 introduction to the second edition of their book:

> There is an institutional structure to labor markets reflected in a sharp distinction between internal and external market arrangements. The internal labor market is defined by an enterprise, or a part of an enterprise. . . . Entry into such markets is limited to particular jobs or ports of entry. The pricing of labor, and its allocation from the point of entry to other work positions, is governed by administrative rules and customs. These rules and customs differentiate members of the internal labor market from outsiders and accord them rights and privileges which would not otherwise be available. Typically, these "internal" rights include certain guarantees of job security, opportunities for career mobility, and equity and due process in treatment at the workplace [p. x].

Thus, internal labor market (ILM) theory is quite different from the traditional economic theory of the firm based on individuals contracting in spot markets. However, Doeringer and Piore's descriptions of firm policies have been subjected to little careful quantitative study. With this in mind, we set two tasks for ourselves in this paper. The first is to seek evidence for an internal labor market by looking for characteristics in our firm that match those described by Doeringer and Piore. Perhaps the most important element of the ILM description is that employees do not move from job to job in a firm by competing in a series of spot markets. Rather, employees have *careers* in firms that follow more-or-less defined paths in the organization. These career paths are stable through time and result in long-term worker-firm attachments. A second important claim is that the pricing of labor does not resemble that which would arise in a series of spot markets. Wages are tied to the characteristics of jobs, rather than individuals. Employees move from job to job during their careers, and their wages are determined in large part by the job they hold. Thus, wages in an internal labor market are strongly influenced by the rules and administrative procedures that tie wages to jobs. Changes in the external labor market influence these rules only weakly and with lags.

Our second task is to seek evidence that either supports or weakens the theory that underlies internal labor markets. According to Doeringer and Piore, an ILM must be "shielded from the direct influences of competitive forces in the external market" [p. 2]. Without such shielding, the ILM would quickly break down into a series of spot markets. There are several possible ways that such shielding can occur. One, suggested by Doeringer and Piore, is for firms to restrict movement between the internal and external markets to certain jobs, which they label "ports of entry and exit." In nonport jobs the internal labor market is insulated from market forces. Such ports might arise from the use of administrative rules and procedures, or if workers possess significant firm-specific human capital [Becker 1975]. In this case, there may be no good substitutes in the external labor market for the services of existing employees, leading to long-term worker-firm attachments. A related way that long term worker-firm attachments could arise is if the firm has significant amounts of private information about workers' skills or productivity. Greenwald [1979] suggests that such asymmetric information will lead to adverse selection in the labor market, producing fewer outside offers, lower turnover rates, and longer within-firm careers than would otherwise occur. Waldman [1984] shows that under such asymmetry, the firm will use its information advantage in its promotion decisions, and will misallocate employees to jobs to avoid signaling workers' true productivity to the market. Another consequence of Waldman's model is that workers will stay with firms longer than they would if the firm did not possess private information.

Our findings confirm the existence of an internal labor market in this firm, but we find mixed evidence on the underlying conditions that the theory suggests are necessary to support an ILM. Using only data on the patterns of job movements, we are able to infer the hierarchial structure of the firm. This structure is clear and simple, and remarkably stable over time. There are large numbers of lengthy careers characterized by movement through numerous jobs. We find only modest evidence for the importance of firm-specific human capital in this firm: external hires do not differ much (along the dimensions that we observe) from those promoted internally into the same jobs, and their subsequent career performance is almost as good. In addition, the existence of promotion "fast tracks" reveals that tenure with the firm does not result in better career attainment. However, we find support for the notion that firms learn about employees' abilities during their careers: the

cross-sectional variation in a cohort's abilities appears to decline as the firm gets more chances to observe and sort the cohort.

We find no evidence of ports of entry and exit. Significant entry occurs in all jobs and all levels in the firm. Exit is even more uniformly distributed. Surprisingly, there is almost no effect of position or wages on the likelihood of exit.

There is strong evidence for the importance of job levels as determinants of wages. Five job level dummies explain 70 percent of the cross-sectional variation in wages in this firm. However, wages are not "attached" to jobs in the sense described by Doeringer and Piore. Wage jumps at promotions are much smaller than differences in mean pay across levels, and there is substantial variation in pay within levels. The importance of levels to pay is largely driven by selection of individuals through promotion.

Finally, we find provocative evidence for the importance of administrative rules in wage determination. Raises are significantly affected by an employee's current wage relative to others in the same job: those with high within-job pay receive smaller wage increases than those with lower wages, holding evaluated performance constant. This administrative effect leads to some within-job-level pay compression and suggests that the firm does indeed have some sort of administered wage policy. Our companion paper explores this wage policy in greater detail.

I. The Dataset

Empirical work that looks inside the firm is not common. This mainly reflects the confidentiality of firm-level data. Most data in labor economics come from labor market surveys with little firm-specific information, from which inferences about promotions, hierarchies, or related phenomena are difficult to make. A few researchers have used firm-level data. One of the first was Osterman [1979], who studied the internal labor market of a large publishing firm using data (for a single year) acquired as a result of a discrimination suit. Medoff and Abraham [1980, 1981] examined confidential internal data from several firms and studied the relationships between experience, performance ratings, and earnings. Kahn and Sherer [1990] studied the link of merit pay and bonuses to performance in a sample of managers from one firm. Leonard [1990], Blackwell, Brickley, and Weisbach [1991], and Lambert, Larcker, and Weigelt [1993] analyzed promotions using career and compensation data across firms. Lazear [1992] studied

the personnel records of a large firm over thirteen years; our paper is closest in spirit to his. There is more work in sociology, although it generally does not reflect economic theories of the firm. The most well-known is Rosenbaum [1984]; his work inspired the tournament literature in economics.

Although we have a large dataset, we are in effect doing a case study, which has costs and benefits. Our dataset is more comprehensive and detailed than those used previously. This allows us to look at finely tuned questions, controlling for many factors, and have sufficient sample size to draw meaningful conclusions. Also, all employees we study worked under the same set of personnel policies. Other studies are limited in that it is difficult to compare some variables (such as hierarchical level) across firms. On the other hand, we should be careful in generalizing from one firm; these results could be idiosyncratic. Where possible, we compare our findings with those of related studies. For example, our analysis is broadly consistent with Lazear's and Rosenbaum's, and with texts on personnel administration.

The dataset contains confidential[1] personnel records for all management employees of a medium-sized U. S. firm in a service industry over the years 1969–1988. We obtained the firm's year-end backup personnel tapes, which included current information on every managerial employee in the firm as of December 31 of each year. Each observation contains an employee ID number, age, sex, race, education, job title, cost center description, cost center code, salary, bonus, salary grade, and performance rating. Not all variables are available for all years or records, although on the whole the dataset is complete. There are two major exceptions. Bonus data cover 1981–1988.[2] Also, titles were not coded for some new hires in the last years, though other variables were. Thus, assignment of these employees to levels (see below) was impossible in those years. This is an insignificant problem except in 1987–1988, in which roughly 10 percent of employees and half of new hires did not have title data. These missing data mean that we must handle inferences from title and level data in the last few

1. We are unable to disclose certain information such as industry; job titles are disguised.

2. Because we do not have bonus information prior to 1981, we have not used these data in any of our analyses. They are paid to 25 percent of employees in these later years (mainly those at the highest levels), and do not significantly change total compensation for most of these people. The median bonus for those who receive bonuses in Levels 1–3 is less than 10 percent of salary, and less than 15 percent for those in Level 4. Gibbs [1995] looks at these data explicitly.

years with some care. Where we report pooled results, we have always calculated the statistics over 1969–1985 to test for robustness of inferences. Many of our analyses use earlier cohorts; for these there are no missing title data. There are 68,437 employee-years of data, of which 5480 are foreign employees. Because salary data are in local currencies, analyses of pay variables use only U. S. employees. Appendix A describes the variables, and Appendix B provides summary statistics.

The timing of the variables is worth noting. Salary, title, performance rating, and other variables are year-end values. We do not know when during the year pay or title changes occurred or ratings were given, so these variables may not be exactly concurrent. In the statistical work we assume that title changes, pay changes, and ratings occur simultaneously. Where appropriate, we have measured effects using adjacent periods or two year windows; we found no differences in conclusions.

Finally, when we refer to entry or entrants, we mean entry or entrants into our dataset. This presents two problems. First, we do not know in what year those in the dataset in 1969 actually entered the firm. Therefore, whenever we do analyses that require tenure data, we exclude the 1969 "cohort." In addition, we cannot tell whether new entrants in any year are new hires at the firm; they could have been promoted from clerical to management positions. However, we expect that new promotees into management ranks would be treated similarly to outside hires, since the promotion entails a major shift in job tasks and a shift from hourly to salaried employment.

A. Overview of the Firm

Growth. Figure I illustrates how the firm grew and changed over 1969–1988. Panel a shows normalized assets, net income, and the number of management employees. Management constituted about 20 percent of total employment each year. The firm experienced steady growth in assets and employment over the entire period: the compound annual growth rate of management employees was about 8 percent. The size of the entry cohort in 1970 was about 220; by 1988 it was over 1000. Profitability also grew, with the exception of 1987.[3] The period covers a business cycle, from the oil shocks of the 1970s to the

3. There is a brief mention of restructuring in the 1987 annual report, but little evidence of it in the data. There was some early retirement in later years. After 1984 new titles proliferated, but only two were significant. Foreign employment almost tripled in 1985. Many of our analyses use pay data (U. S. employees) or early cohorts, so these changes make little difference.

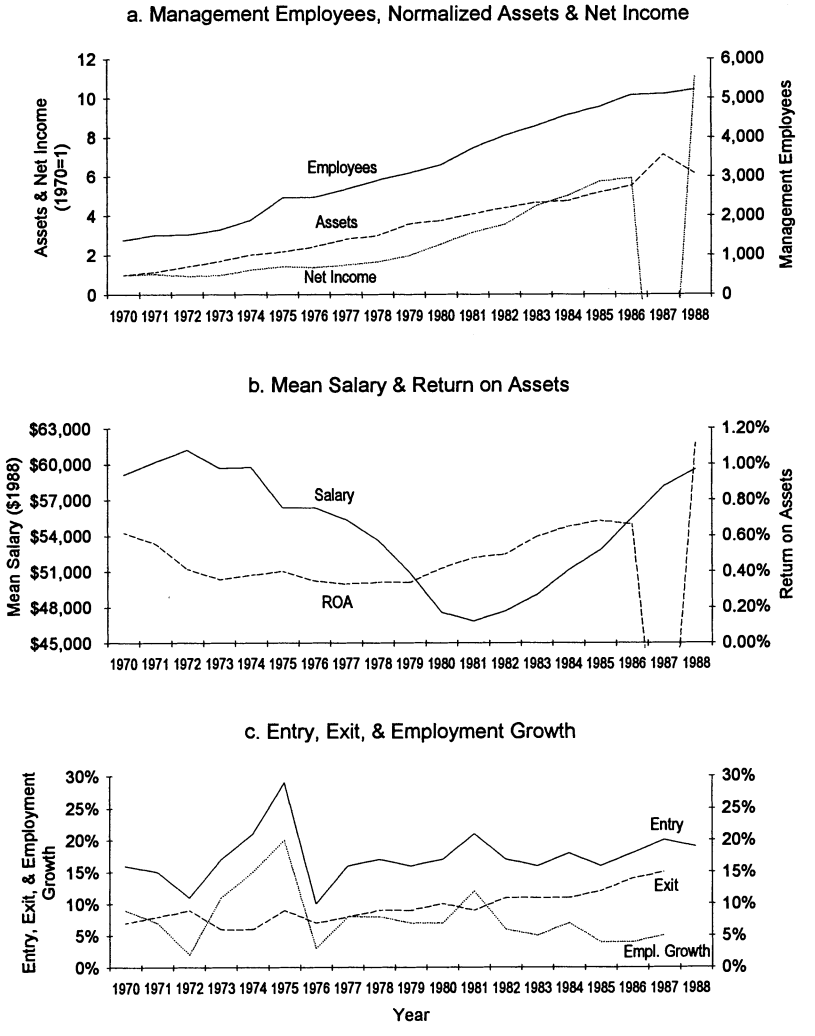

FIGURE I

Managerial Employment, Financial Performance, Wages, and Turnover, 1970–1988

All financial variables are calculated in 1988 constant dollars. In 1987, normalized net income = −13, and ROA = −1.1%.

expansion of the 1980s. Therefore, we observe the firm over a period of growth and varying economic conditions.

Wages, Turnover, and Implicit Contracting. Panel b of Figure I shows the return on assets and mean real salary. ROA shows

that, although profits were growing steadily, they did not match growth in firm assets. From 1969 until about 1977, financial returns declined. They rose until 1988, excluding 1987. Did wages follow the firm's performance, or were these changing results borne primarily by shareholders? Although wages did decline and rise again during the period, they did so over a different period than ROA. The fall in real salary is large: the mean declined 22 percent from the high in 1972 to the low in 1981 before recovering most of the loss by 1988.[4]

Panel c of Figure I shows entry and exit rates. In 1974–1975 there was a marked rise in entry, with a fall in 1976. Entry rates have a slight upward trend over time. Exit rates have a larger trend, doubling by the end of the period. Thus, the firm growth rate (the difference between entry and exit) has a slight downward trend. This employment growth rate has no obvious link with either the firm's financial returns or the wage cycle. Put together, the findings on wages, entry, and exit give some indication of how the firm structured its implicit contract with employees. There is little evidence that the firm adjusted total employment for either firm or economywide economic conditions. Apparently, this firm insured both pay and employment from firm-specific performance to some degree, but it did not provide much insurance against economywide shocks.

II. The Hierarchy

A. Identification of Levels

Jobs have many dimensions, such as function (e.g., accounting, marketing), work group, business unit, and reporting relationships. The dataset included over 4000 cost center codes and descriptions,[5] but we were unable to use these to describe the hierarchy because data on reporting relationships was unavailable. Hierarchies are usually said to consist of job titles aggregated into "levels" related to the job's authority and place in the path of decision making (hence the term level). Careers are often described as a series of promotions to higher-level jobs with higher rewards

4. The wage cycle is not due to observable differences in the composition of the workforce; see our companion paper [Baker, Gibbs, and Holmstrom 1994], where the wage cycle is analyzed extensively.

5. A cost center is an organizational unit defined for measuring costs, revenues, or profits. As the firm finds such a unit useful for measuring costs, it is likely that those in the same cost center have interdependent work.

and responsibilities. The level structure of firms, and its relationship to careers and compensation, have been poorly documented to date. Our first task was to identify job levels.

Because we are interested in the effects of levels on pay, we were careful to avoid using pay variables to identify levels. *To define levels, we relied exclusively on information about moves between job titles.* There are 276 different titles in the dataset, but a small number dominate employment. We focused initially on the fourteen titles that each represented at least 0.5 percent of employee-years; these comprised about 90 percent of observations and 93 percent of those with titles coded. To this list we added the top title, Chairman-CEO, and the only two titles observed in moves from the fourteen major titles to Chairman-CEO in order to fill in the job ladder to the top of the organization. We then created transition matrices showing moves between these major seventeen titles, both for individual years and over the whole sample. Table I presents the latter.

Table I shows how simple it was to assign levels to major titles. We first established entry (Level 1) jobs by looking at hiring patterns: titles Assistant J, Assistant K, and Assistant H were filled virtually 100 percent by new hires, while all other jobs were filled more by internal moves. For example, the vast majority of those entering Assistant J were new hires (51 percent of 10,648 $\approx$ 5430), while few entered from elsewhere (e.g., 1 percent of 4075 $\approx$ 41 from Assistant K). Most moves other than stays or exits from these three titles were to six other titles, H through M. These six were fed only trivially by other titles, and for them entry was much less important. These were categorized at Level 2. Moves other than stays or exits from these jobs went almost exclusively to three jobs (G, F, and Senior H), which were categorized at Level 3. This process was continued until the seventeen titles were assigned, yielding the eight levels indicated in Table I. This was very straightforward; all titles were fed almost exclusively from the next lower level, and fed almost exclusively into the next higher level. Moreover, Chairman-CEO (Level 8) was at one end of this chain, and the three entry titles at the other end; it seems clear that these are the highest and lowest levels in the management hierarchy.

It is natural to think of moves to higher levels as promotions, moves within the same level as lateral transfers, and moves to lower levels as demotions. These are easily seen in Table I. Single-level promotions are shown in the shaded boxes. Moves above and to the right of these, except from Entry and to Other, are

TABLE I

TRANSITION MATRIX BETWEEN MAJOR JOB TITLES, 1969–1988

Level	Old title	New title (next year) Exit	Level 1 Asst. J	Asst. K	Asst. H	Level 2 M	L	K	J	I	H	Level 3 G	F	Sr. H	Level 4 E	Level 5 D	Level 6 C	Level 7 B	Level 8 A	Other	Total %	Sample size
N/A	Entry	.	51	10	2	6	3	1	1	2	0	8	2	0	6	0	0	.	.	7	100	10,648
1	Asst. J	12	54	0	0	17	10	0	2	1	0	1	1	.	0	.	.	.	.	2	100	10,366
	Asst. K	7	1	74	.	4	8	6	0	1	.	0	0	.	0	.	.	.	.	0	100	4,075
	Asst. H	10	2	.	65	4	2	.	.	0	17	0	.	.	.	.	.	.	.	1	100	518
2	M	14	0	0	.	56	0	0	0	1	0	25	1	0	0	.	.	.	.	2	100	5,898
	L	7	0	0	0	1	74	2	0	0	0	17	.	.	.	.	.	.	.	0	100	5,100
	K	7	0	0	.	2	3	76	1	0	0	11	.	.	.	.	.	.	.	.	100	1,788
	J	12	0	0	0	2	2	0	64	0	.	18	.	.	1	.	.	.	.	0	100	917
	I	26	.	.	.	1	0	0	1	48	.	23	0	.	0	.	.	.	.	1	100	412
	H	8	0	.	.	0	1	.	.	.	72	2	.	14	0	.	.	.	.	2	100	504
3	G	9	0	.	.	0	0	0	0	.	.	76	0	.	13	0	.	.	.	1	100	12,471
	F	29	.	.	.	1	.	.	.	1	.	1	51	.	8	.	.	.	.	10	100	641
	Sr. H	9	.	.	.	0	.	.	.	.	.	1	.	83	8	.	.	.	.	.	100	448
4	E	10	.	.	.	0	.	.	.	.	0	0	.	.	89	1	0	.	.	1	100	11,423
5	D	6	.	.	.	.	.	.	.	.	.	.	.	.	0	87	3	.	.	3	100	987
6	C	6	.	.	.	.	.	.	.	.	.	.	.	.	1	1	85	1	.	7	100	211
7	B	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	79	7	3	100	29
8	A	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	90	.	100	19
N/A	Other	15	2	0	.	2	1	0	0	0	0	2	1	0	4	1	.	0	.	72	100	3,385
	Total	9	16	6	1	9	8	3	1	1	1	19	1	1	18	2	0	0	0	6	100	69,840

Shows all transitions between job titles, including entry, exit, and stays, from 1969 to 1988, as percentage of movements from a title (or entry) to a new title (or exit) in the next year. Jobs other than major titles from Figure II are combined as "Other." Titles F and I were added in later years, so that their percentages are higher in those years than over the entire sample. Shaded cells show promotions of one level. Moves above and to the right of the shaded cells, except from Entry and to Other, are promotions of more than one level. Numbers in boxed cells show stays (the diagonals of the boxes) and lateral transfers (the off-diagonals). Moves below and to the left of the boxes, except from Other and to Exit, are demotions. Zeros denote nonempty cells that round to zero, while '.'s denote empty cells.

multilevel promotions. Stays or lateral transfers are shown in the nonshaded boxes (stays are the diagonals). Moves below and to the left of these, except from Other and to Exit, are demotions.

Finally, thirteen of the major titles were related to some of the other seventeen in a clear hierarchical way, such as Assistant H to H to Senior H. This information was *not* used to assign levels, but in all cases the levels implied by title names matched our assignments and confirmed that upward moves are promotions. After major titles were assigned, we assigned less common titles based on moves between them and titles already assigned. For example, if a title was fed primarily from Level n, and fed primarily into Level $n + 2$, it was put at Level $n + 1$. We recursively applied such rules until over 99 percent of person-years with titles were assigned with confidence.

The results of the level assignment process are presented graphically in Figure II, which shows the structure of the hierarchy. The seventeen major titles are represented by circles whose areas are proportional to total employee-years; Title G (the most common title) comprised 18 percent of employment. Arrows show the direction of moves that consisted of 4 percent or more of moves (including exits) out of a given title. Beside each arrow is the percentage of moves from the base title. For example, of all observed moves out of Assistant J, 22 percent went to Title L, 4 percent to Title J, and 38 percent to Title M.

B. Simplicity and Stability of the Hierarchy

Simplicity. The hierarchy in Figure II is remarkably simple. Seventeen titles and eight levels (six with meaningful size) account for almost all employment; six titles cover 80 percent. All jobs feed primarily into one or two other jobs. There are seven major career paths, such as Assistant K to Title K, L, or M; to Title G. The sequence Assistant H to Title H to Senior H looks like the job ladders of the internal labor market literature. However, there are no other clearly demarcated job ladders. For example, most employees promoted out of Assistant J and Assistant K do not go to Titles J and K, respectively. Interestingly, all titles converge on Titles G and E. Rosenbaum [1984] had similar data and came closest to producing an analogous "organization" chart. He reported eight levels from plant floor to president, with similar relative sizes of levels. He did not describe the relationship of titles to levels. Leonard's [1990] data reveal that in very large corporations there

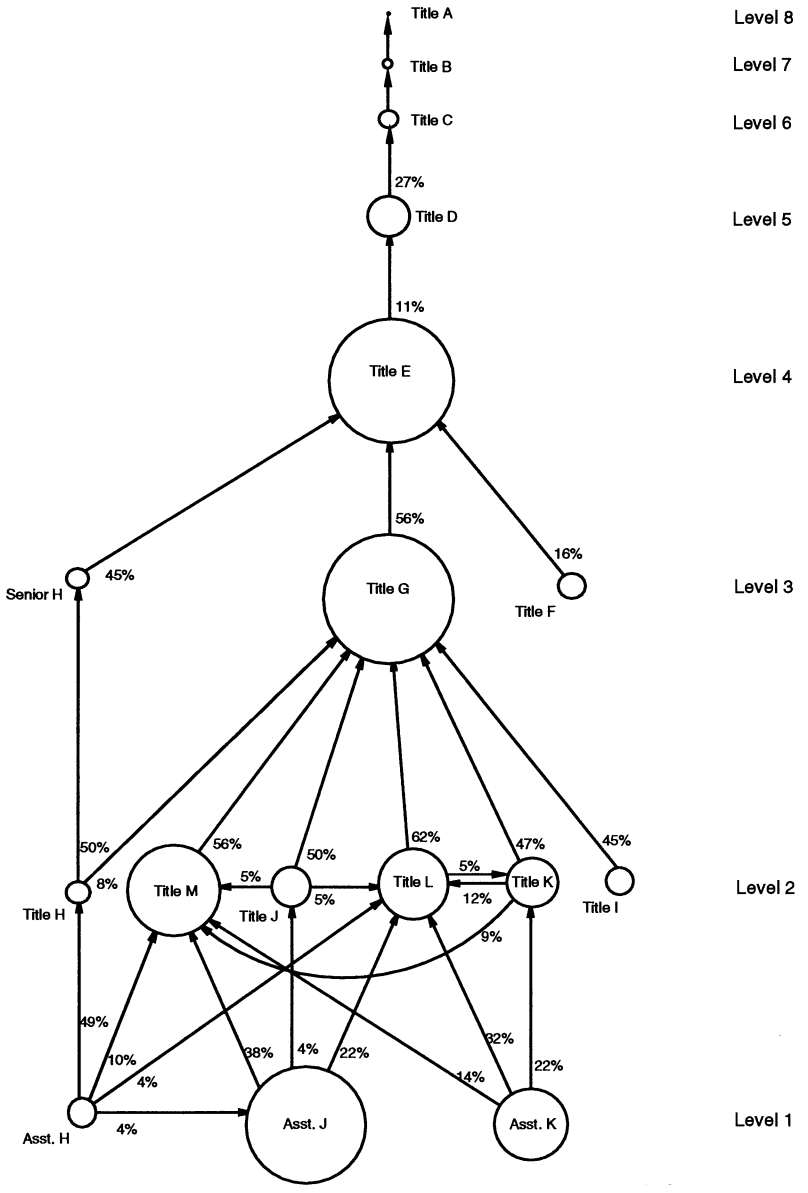

FIGURE II

Titles and Hierarchical Levels: 1970–1987

Circles represent all titles comprising at least one-half percent of person-years in the sample, except for Titles A (CEO), B, and C. The area of each circle represents the relative number of person-years for that title. For reference, Title G comprises 18 percent of person-years. Arrows show movements out of a title; numbers next to each arrow are the fraction of all movements out of the title (including exits) on that path. Because movements here exclude stays, these numbers represent *ultimate* (rather than annual) promotion rates. Only movements of 4 percent or greater out of a position, and no exits, are shown. Numbers for movements among the top three titles are omitted because of sparseness of data.

are up to sixteen management levels, but again there is no information on titles within levels.

An additional characteristic of the hierarchy merits mention: it really consists of two parts, Levels 1–4 and Levels 5–8. The lower half contains 97.5 percent of employees; in this sense the firm has four significant levels. There seems to be some difference in the nature of careers between the two parts. Level 4 is a crucial choke point, beyond which few advance. In upper levels, job tenure is longer, and outside hiring lower, although exit rates are only slightly smaller, as will be shown below. It is usually said that upper level jobs correspond more to general management: managing large groups, coordinating across business units, and strategic planning, while lower level jobs depend more on specialized functional knowledge and performing less complex tasks [Mintzberg 1973]. This is borne out by cost center descriptions, which give crude evidence on the nature of jobs. In Levels 1–4, about 60 percent correspond to specific "line" (revenue-generating) business units. These are positions with direct contact with customers or creating and selling products. In Levels 5–6, line jobs drop to about 45 percent. For Levels 1–4, roughly 35 percent of jobs are "staff" or "overhead" positions in areas such as Accounting, Finance, or Human Resources. At Levels 5–6 staff assignments drop to about 25 percent, and general management descriptions such as "General Administration" or "Planning" increase markedly to about 30 percent. At Levels 7–8 all jobs are of this form. Lower level jobs seem to rely more on general (functional) rather than firm-specific (coordination and strategy) skills. Thus, the firm can rely more on outside hires at lower levels. Longer tenure, lower promotion rates, and slightly lower exit rates in Levels 5–8 are consistent with this.

Structural Stability. The hierarchy was surprisingly stable over time. With few exceptions, titles important in 1969 were similarly important in 1988. The largest new titles (I and F in Figure II) were still of relatively small size. More surprisingly, the firm did not change the number of levels, even though employment tripled. Moreover, the relative size of levels remained virtually unchanged over all years. Figure III charts the relative size of levels in 1970, 1977, and 1984. As the firm expanded, it did so proportionally across levels. This begs the question of the determinants of a hierarchy. Why is it possible to describe so much about personnel policies (as we do below) with only eight levels and

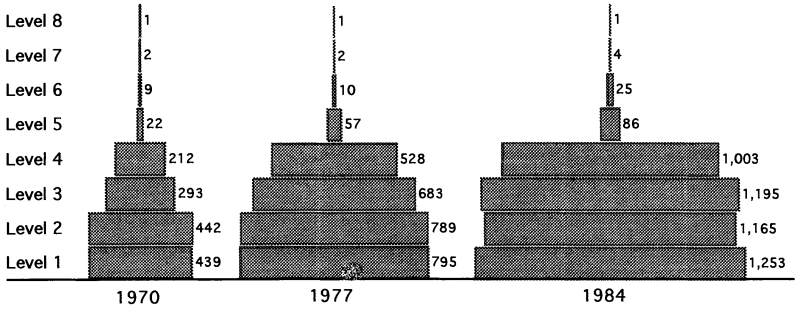

FIGURE III
Size of Levels in Selected Years

Each bar shows the relative size of Levels 1–8 that year. Numbers next to bars are the number of employees at that level that year.

seventeen titles? Equally interesting, why did the firm's structure not change over time and firm size? Theories of hierarchical structures and monitoring in hierarchies [Beckmann 1977; Calvo and Wellisz 1979] predict that levels expand proportionately with firm size, as we find. They also predict that the number of levels will grow with firm size, but that is not what we observe.

Steady State Job Transitions. The firm was stable in the composition of titles and levels. Are the patterns of career moves shown in Figure II similar over time? One approach is to test for differences in job transition matrices using a Chi-square test. However, our sample size is so large that we have power to detect statistical significance even if differences are small.[6] An alternative is to consider the economic significance of differences in job transition patterns over time. Figure IV plots the numbers of moves between major titles for 1969–1970, 1976–1977, and 1983–1984. The difference between these plots is small. The same title pairs tend to be important in all years, with similar relative magnitudes. The promotion system appears to be in a rough steady state. The vertical axes in these plots are the total number of moves of each kind; we see that the total number of moves quadrupled

6. On the other hand, a good percentage of the statistics did not reject stability in transition patterns despite our sample size. If we interpret the statistics as an index of organizational change, they uncover some patterns. Further separated years exhibit more divergent patterns of moves. 1975 was unusual—it was more different from adjacent years than are other years. 1975 was a very high entry year, which must have altered promotion patterns that year. Finally, transition patterns are more different in 1986–1988 than in other years, consistent with evidence of some restructuring then.

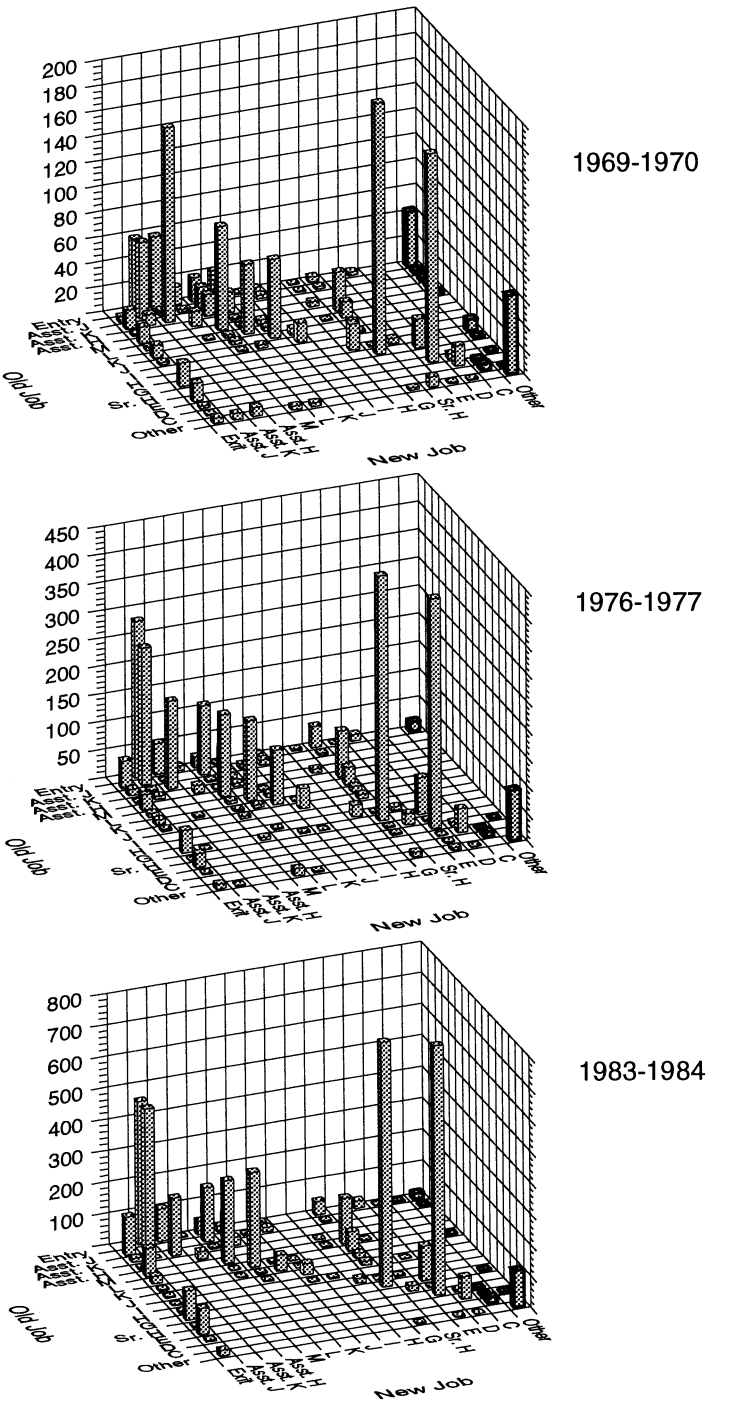

FIGURE IV

Job Transition Patterns for Major Titles in Selected Years

Each bar represents the number of transitions from a title in the previous year (Old Job) to a title in that year (New Job), including entry, stays, and exits. Jobs other than major titles from Figure II are combined as "Other."

between 1970 and 1984. This makes the conclusion that these movement patterns are in a steady state stronger; we see stability of move patterns along the dimensions of time and firm size. The structural stability and steady state growth of the hierarchy is striking considering that the data cover twenty years and the firm tripled in size, went through a business cycle in the middle of the sample periods, and did some restructuring at the end.

III. Careers, Entry, and Exit

The most basic element of an internal labor market is the concept of a career. According to Doeringer and Piore, when a job opens up in an ILM, those already inside the organization are given preference over potential outside hires, which results in longer worker-firm attachments than would arise if jobs were allocated by a series of spot markets. In this section we look for evidence on how the firm manages careers, entry, and exit.

Table II presents statistics on the distribution of career lengths, job mobility, and the age and education levels of entrants to this firm, as well as some characteristics of the different job levels. Careers are often long and generally involve movement among numerous job titles. This table shows the percentage of those entering the firm between 1970 and 1979 with one-year, two-year, five-to-ten year, and ten-or-more year careers, stratified by the level at which they entered the firm.[7] For the longer tenure employees it also shows how many different job titles they held. As can be seen, almost 40 percent of those entering Level 1 during this period stay ten years or more; 78 percent of these employees hold three or more titles over the course of their careers in the firm. Among those with careers of five to ten years, 51.5 percent hold three or more titles. Careers for those who enter at higher levels tend to be somewhat shorter, in part because they are older when they enter. We conclude from these data that careers are indeed important in this firm. The high frequency of long and varied careers seems consistent with Doeringer and Piore's description of careers in an internal labor market.

7. Entry years 1970–1979 were chosen to avoid censoring the sample when looking at longer careers. Patterns are similar for later entrants, although average career lengths do shorten somewhat over time in this firm. For a sample of entrants between 1970 and 1985, 13 percent leave after one year, and 12 percent after two.

TABLE II
CAREER AND LEVEL CHARACTERISTICS

	Level				
	1	2	3	4	5–8
Number of outside entrants at level	2,714	579	365	189	14
Percent with 1-year careers	10.7	15.2	10.7	15.3	7.1
Percent with 2-year careers	10.4	10.2	10.1	7.9	14.3
Percent with 5–10-year careers	25.5	19.7	25.5	24.9	42.9
Of which:					
Percent holding 1 title	16.0	25.4	38.7	66.0	66.7
Percent holding 2 titles	32.5	36.8	59.1	27.7	33.3
Percent holding 3 titles	34.3	35.1	2.2	4.3	0.0
Percent holding 4 titles	16.4	2.6	0.0	2.1	0.0
Percent holding 5+ titles	0.8	0.0	0.0	0.0	0.0
Percent with 10+ year careers	39.8	38.5	35.6	30.7	28.6
Of which:					
Percent holding 1 title	5.9	11.7	27.7	55.2	50.0
Percent holding 2 titles	16.0	18.8	59.2	34.5	0.0
Percent holding 3 titles	32.5	48.0	9.2	8.6	50.0
Percent holding 4 titles	37.0	17.5	3.1	1.7	0.0
Percent holding 5+ titles	8.5	4.0	0.8	0.0	0.0
Average age of new hires	32.5	35.3	38.3	43.5	43.4
Average years of schooling of new hires	15.6	16.4	16.5	17.0	18.0
Average work experience of new hires	10.9	12.9	15.8	20.5	19.4
Number promoted into level	0	1,617	1,098	589	87
Average age of those promoted into level	N/A	34.0	36.1	38.7	45.6
Average years of schooling of those promoted into level	N/A	15.7	16.1	16.5	17.1
Average work experience of those promoted into level	N/A	12.3	14.0	16.2	22.5
Number of person-years in level	16,981	17,725	17,253	13,892	1,643
Percent of all entrants into level who were outside hires	98.6	26.1	29.7	24.9	10.0
Promotion rate (percent) per year	26.3	18.0	10.9	1.4	4.5
Exit rate (percent) per year	11.4	11.5	11.0	9.6	8.2

The top panel of the table uses only those who entered the level from outside the firm between 1970 and 1979. The middle panel uses all those who entered the firm (at any level) between 1970 and 1979 and were subsequently promoted to the level at some time up to 1988. The bottom panel uses all employees at the firm in all years. Work experience is age − schooling − 6.

Ports of Entry and Exit. Table II provides direct evidence on a key assumption underlying ILM theory, that internal jobs are shielded from external labor market pressures except at ports of entry and exit. We look for the existence of ports of entry and exit

by examining what fraction of those who move into a level are promoted from inside rather than hired from outside the firm and by looking at exit rates across levels. Table II shows that Level 1 looks like a port of entry: 99 percent of those who entered the level were hired from outside. However, with virtually no demotions (see Table I) it must be that jobs in the lowest level hire almost exclusively from the outside. What is revealing, and contradicts the supposition that entry occurs only at designated ports, is the fact that there is substantial entry at all levels.[8] Over 25 percent of all those entering Levels 2–4 are hired from outside the firm. There is even less evidence for ports of exit: exit rates are almost uniform across levels. Furthermore, there are few significant differences in entry or exit rates across titles within levels. With two exceptions, no major title has an entry rate below 15 percent, nor an exit rate below 8 percent.[9] Thus, the external market directly influences personnel policies throughout the firm by entry and exit.

New Hires versus Incumbents. The fact that employees have long careers within the firm while there is substantial entry at all levels suggests an obvious question: how do those promoted from within differ from those hired from outside? If firm-specific human capital is important, then outside hires must have more general human capital in order to compete with incumbents. If all human capital is general, then any differences in human capital for new hires should be reflected in subsequent career advancement. Table II shows observable differences in human capital between new entrants into a level and those promoted into a level. As can be seen, new hires have about half a year more schooling (one year at Level 5 and above), are somewhat older, and have more work experience (except at the higher levels). This suggests that there are differences, although small, in the amount of general human capital possessed by the two groups.

Table III compares the subsequent career performance of new hires and incumbents. To make the two samples as similar as possible, the table compares new hires at Level 2 with those pro-

8. Lazear [1992] comes to the same conclusion with similar data on a single firm; Osterman [1984] also finds this using survey and interview data on twelve white collar firms.

9. The exceptions are Titles H and Senior H (see Figure II). These titles appear to be a "track," with less entry and exit than in the rest of the firm. Entry rates are 16 percent and 12 percent, respectively, and exit rates are 7.5 percent and 4.7 percent.

TABLE III

CAREER ATTAINMENT, NEW HIRES VERSUS INCUMBENTS PROMOTED INTO LEVELS 2–3, 1970–1979

Current level	Statistic	New hire/ incumbent	Level 2 entrants: years since entering level 2									
			1	2	3	4	5	6	7	8	9	10
1	% of	New hire		1.4	1.6	1.8	2.1	2.0	1.8	1.1	0.8	1.0
	Remaining	Incumbent		.	.	.	0.1	.	.	.	.	.
2	% of	New hire	100.0	79.4	51.5	39.7	33.3	29.0	24.6	23.3	22.5	22.0
	Remaining	Incumbent	100.0	84.2	49.7	32.1	23.7	18.4	13.7	11.6	10.1	8.6
3	% of	New hire		19.0	45.2	47.5	39.0	34.9	31.8	29.4	25.4	24.4
	Remaining	Incumbent		15.7	49.3	59.2	53.7	48.5	46.3	42.2	37.8	36.4
4	% of	New hire		0.2	1.6	10.9	25.6	33.9	41.1	44.7	48.4	46.8
	Remaining	Incumbent		0.1	0.9	8.7	22.5	32.8	39.4	45.4	50.6	53.1
5–6	% of	New hire		.	.	.	.	0.3	0.7	1.5	2.9	5.9
	Remaining	Incumbent		.	.	.	.	0.2	0.7	0.9	1.5	1.9
1–6	Level	New hire	2.00	2.18	2.47	2.68	2.88	3.02	3.14	3.22	3.30	3.35
	(average)	Incumbent	2.00	2.16	2.51	2.77	2.99	3.15	3.27	3.36	3.44	3.49
	Level	New hire	0.00	0.18	0.31	0.48	0.66	0.72	0.74	0.74	0.77	0.85
	(variance)	Incumbent	0.00	0.14	0.27	0.35	0.47	0.50	0.49	0.48	0.50	0.48
	Exit rate	New hire	15.2	12.0	10.7	12.7	8.6	8.8	6.1	6.9	9.0	7.8
	(%)	Incumbent	11.3	11.1	9.1	7.2	8.7	8.5	7.2	11.3	10.0	7.5
	N	New hire	579	490	431	385	336	307	280	262	244	222
		Incumbent	1,346	1,194	1,062	964	894	816	747	692	613	550

Current level	Statistic	New hire/ incumbent	Level 3 entrants: years since entering Level 3									
			1	2	3	4	5	6	7	8	9	10
1–6	Level	New hire	3.00	3.15	3.36	3.43	3.50	3.59	3.63	3.69	3.72	3.72
	(average)	Inc. (hired at Level 2)	3.00	3.05	3.37	3.50	3.61	3.73	3.81	3.88	3.94	4.07
		Inc. (hired at Level 1)	3.00	3.03	3.30	3.50	3.61	3.72	3.77	3.84	3.87	3.93
	Level	New hire	0.00	0.14	0.28	0.31	0.34	0.33	0.33	0.35	0.34	0.38
	(variance)	Inc. (hired at Level 2)	0.00	0.06	0.25	0.29	0.32	0.27	0.31	0.35	0.35	0.35
		Inc. (hired at Level 1)	0.00	0.03	0.21	0.26	0.26	0.25	0.24	0.23	0.21	0.25
	Exit rate	New hire	10.7	11.3	12.2	11.9	14.3	11.5	8.9	6.5	9.7	8.1
	(%)	Inc. (hired at level 2)	8.4	11.2	8.7	6.6	10.3	7.1	7.0	8.3	10.0	13.0
		Inc. (hired at Level 1)	8.2	8.4	8.7	8.8	6.3	8.7	9.2	11.8	9.5	11.5
	N	New hire	365	326	288	253	223	191	169	154	144	130
		Inc. (hired at Level 2)	225	206	183	167	156	140	129	120	110	99
		Inc. (hired at Level 1)	547	502	459	419	382	358	327	297	262	236

The top panel shows progressions of all employees entering Level 2 in 1970–1979, either new hires or incumbents promoted from Level 1. % of Remaining is the percentage of new or incumbent employees remaining in the firm who are in the given level. The middle panel shows the exit rate, and average and variance of the level attained by remaining new hires or incumbents, by number of years in Level 2. The bottom panel shows the same statistics for new hires or incumbents (promoted from either Level 1 or 2) in Level 3. Exit rates may be slightly smaller than implied by sample sizes, as a few employees moved to jobs we were unable to assign to a level. No employees in these groups were promoted to Levels 7–8. Inferences do not change if we restrict the sample to U. S. employees.

moted into Level 2, where both groups are "quasi cohorts" that entered Level 2 during the period 1970–1979.[10]

There is an interesting pattern in Table III. New hires are initially promoted more quickly than incumbents. For example, in the second year 19 percent of surviving new hires have been promoted to Level 3, but only 16 percent of surviving incumbents have been promoted. At five years, a larger fraction of surviving incumbents are at Level 3, but more new hires have moved on to Level 4. This suggests that the new hires' greater general human capital gives at least an initial advantage in promotions.[11] If firm-specific human capital were the only determinant of productivity, then incumbents would be favored for promotions. However, new hires do not experience greater advancement over the course of their careers with the firm. While some move faster than incumbents, more also experience no movement. At five years, 35 percent of surviving new hires are still at Level 2 or have been demoted to Level 1, while only 24 percent of surviving incumbents are at Level 2, and only one person has been demoted. Moreover, exit rates are higher for new hires in early years, but lower in later years. Ten years after entering Level 2, incumbents have moved ahead of new hires in proportional movement to Level 4, and have a substantially greater proportion at Level 3. New hires, however, have relatively more survivors at Levels 1, 2, and 5.

These patterns indicate that career outcomes are more variable for new hires than for incumbents. This can be seen directly by looking at the summary statistics (the middle panel) which show that while average level attainment is slightly higher for incumbents than for new hires, the variance of cohort level attainment is substantially greater for new hires. This suggests that while firm-specific human capital may partially explain career outcomes (incumbents do slightly better, in spite of their lower levels of general human capital), the more dramatic distinction between incumbents and new hires is that innate abilities of new hires at Level 2 vary more than abilities of those promoted from Level 1.

10. By a "quasi cohort" we mean a set of employees who entered some specific group (e.g., Level 2) over some period, whereas a cohort is a set of employees who entered in a single year. The time-windows of quasi cohorts reduce the effect of cyclical variation in variables. They also increase the sample size for some analyses. When we refer to tenure for a quasi cohort, we mean years of tenure for individuals, without reference to calendar years.

11. This is supported by the fact that it is the better educated who get promoted: the average years of education for those promoted to Level 3 in the first year is more than a year greater than the average education of those who remain in Level 2.

This difference could arise if the firm uses the incumbent employees' tenure in Level 1 to learn about their abilities, and to screen out the least able and the ablest individuals. In contrast, the firm has less information about those hired from outside, and so screens them in their subsequent career moves. The presence of this sequential screening process is further documented in the bottom panel of Table III. It shows mean and variance of cohort level attainment for a quasi cohort of those entering Level 3 between 1970 and 1979, stratified by the number of past promotions. While the average level attainment of those entering the firm at Level 1 or 2 is slightly higher than that of new entrants, the variance of outcomes is consistently and significantly lower for those with more history in the firm. This is strong evidence supporting the hypothesis that the firm uses the career system to learn about employees and to screen them on the basis of individual ability.

Timing of Adjacent Promotions. The above evidence on individual differences and their effects on career outcomes suggests several questions about how careers progress in the firm. Are there "fast tracks" in which those promoted quickly at one level are promoted more quickly at the next level? Does the firm screen out less productive employees? Do slow movers tend to leave? If individuals differ in terms of innate ability, and the firm uses promotions to sort individuals on the basis of this ability, then those promoted quickly once should be promoted quickly again. On the other hand, if all that matters is firm-specific human capital accumulation, and individuals do not differ much in the rate at which they learn, then those promoted quickly once will have less firm-specific human capital and will have to wait longer for their next promotion. Variations in exit rates by past career progress also shed light on these questions. Jovanovic [1979] suggests that exit rates should decline with tenure, as the quality of the match between workers' human capital and firms' job requirements becomes known. These ideas are tested in Table IV, which shows promotion and exit rates by tenure in Level 2 versus time to promotion from Level 1 to Level 2.[12]

The most interesting findings in Table IV are comparisons down columns, which control for tenure in Level 2. Holding current tenure constant, promotion rates decrease with tenure in the previous level. This is especially pronounced at low levels of

12. Patterns are similar in higher levels, though differences in exit rates are less pronounced.

TABLE IV
TIME TO PROMOTION IN LEVEL 1 VERSUS TIME TO PROMOTION OR EXIT IN LEVEL 2

Years at Level 1	Statistic	Years at Level 2 before promotion or exit									
		1	2	3	4	5	6	7	8	9	10+
1	Promotion rate (%)	22	40	29	23	11	18	14	6	25	7
	Exit rate (%)	16	18	16	10	15	12	11	12	8	11
	N	1494	851	313	140	80	51	28	17	12	28
2	Promotion rate (%)	14	27	25	21	14	14	12	8	15	7
	Exit rate (%)	10	10	9	9	7	14	7	11	10	15
	N	1134	805	468	272	164	105	58	36	20	27
3	Promotion rate (%)	6	19	17	23	17	20	14	9	0	4
	Exit rate (%)	9	8	9	5	11	14	8	14	18	18
	N	485	393	248	168	115	64	37	22	11	28
4	Promotion rate (%)	5	17	18	14	16	20	4	13	13	17
	Exit rate (%)	7	10	5	4	7	15	8	13	25	8
	N	224	175	120	78	56	41	24	15	8	12
5	Promotion rate (%)	3	9	10	4	18	10	8	10	0	0
	Exit rate (%)	9	7	10	12	6	10	0	20	0	8
	N	114	97	70	51	34	20	13	10	6	13
6	Promotion rate (%)	8	11	24	22	10	25	20	0	0	0
	Exit rate (%)	8	11	3	17	0	0	0	0	0	0
	N	53	44	29	18	10	8	5	4	2	6
7+	Promotion rate (%)	1	6	19	6	7	0	7	0	0	0
	Exit rate (%)	8	11	3	17	0	0	0	0	0	0
	N	78	64	48	35	29	21	15	6	4	4
All	Promotion rate (%)	15	28	23	19	14	16	11	8	11	6
	Exit rate (%)	12	12	10	8	9	13	7	13	13	12
	N	3582	2429	1296	762	488	310	180	110	63	118

Shows promotion and exit rates by time in Level 2, for those promoted to Level 2 at given years of tenure in Level 1. Promotion and Exit rates are the percentage of employees with that combination of tenure in Levels 1 and 2 who were promoted or exited that year.

prior tenure. For example, at the second year in Level 2, those promoted after one year in Level 1 have a 40 percent promotion rate, versus a 27 percent rate for those who took an extra year in Level 1. Those who were promoted sooner in Level 1 are more likely to be promoted sooner again at Level 2. Thus, there is evidence of fast tracks.

Equally interesting is the behavior of exit rates within columns. Those who were promoted to Level 2 sooner generally have higher exit rates than those who were promoted later. This effect is

most pronounced at low levels of tenure in Level 1. Thus, the firm does not retain proportionate numbers of the very fastest promotees into Level 2; there is a fast track *exit* effect. Perhaps some very high ability employees are not optimally employed at the firm, or the firm is not paying wages equal to expected marginal products for these employees. The latter interpretation is consistent with administrative constraints on pay levels, which we will discuss shortly. Finally, the last rows of Table IV (which combine all Level 1 tenure groups) show that exit rates drop with tenure in Level 2 in the first five years, then rise again with longer tenures. This could be interpreted as consistent with human capital matching models: as the workers and the firm assess the quality of the match in the early years, workers with inappropriate skills leave. After five years, there is little left to learn. However, the relatively high exit rates for those with the longest tenures suggests that firm-specific human capital is not very valuable in this firm.

These findings suggest that careers, as described by Doeringer and Piore, are important in this firm and that career dynamics are driven by the firm's learning about and selecting on ability. Greater education for new hires, combined with slightly better career progress for incumbents, suggests that firm-specific human capital plays a role, as do the modest declines in exit rates with tenure. However, the presence of promotion fast tracks and the greater variance in outcomes for those with shorter career histories with the firm suggests that this firm uses the career system to sort employees on the basis of either their level of firm-specific human capital, or their innate ability. Indeed, the distinction between ability and human capital may be artificial. The data are consistent with a model in which ability is purely the varying rate at which individuals accumulate human capital. Thus, those who learn quickly are promoted quickly and are more likely to learn the next job and be promoted quickly again. Those who do not learn either stay at their old jobs or leave the firm.

IV. Wages and the Hierarchy

The second major component of Doeringer and Piore's description relates to wages and wage determination in an internal labor market. They argue that wages for individuals, rather than being set in a spot market, are set by an administrative procedure that evaluates jobs and assigns wages to jobs based on job content:

> The process of job evaluation consists in rating a job in each of the factor categories and adding the points across categories to determine point totals. This is typically

done once for all jobs . . . when a job evaluation plan is first introduced. Jobs are then reevaluated only when they are thought for one reason or another to have changed. New jobs are, of course, evaluated when they are introduced. The job-evaluation point totals serve as a device for arranging jobs in a pay hierarchy [p. 67].

In this section of the paper we look for evidence of such administration of wages and analyze the structure of pay in this hierarchy.

There are two links between pay and hierarchical level that are of interest. The first is the shape of compensation moving up the hierarchy. Several theories predict that pay will be convex with respect to job level. Those that emphasize the role of talent in monitoring and coordinating hierarchical production imply that pay should rise quickly with level [Calvo and Wellisz 1979; Rosen 1982]. This is because more talented employees will be sorted into higher levels, and because higher-level decisions affect the productivity of lower-level employees, raising the marginal productivity of those at higher levels. Sequential incentive theories [Rosen 1986] argue that if promotion ladders drive incentives, horizon and other timing effects mean that pay must rise at an increasing rate as one moves up the hierarchy, especially at the top level. The prediction has received some support in studies by Leonard [1990] and Lambert, Larcker, and Weigelt [1993]. The other question of interest is the relative importance of jobs versus individualistic factors in determining pay. If pay is largely attached to levels in job ladders, this has important implications for understanding the wage policy of the firm. For example, in general, wages would not equal marginal products, and promotions would be the major mechanism for providing incentives.

A. Levels and Pay Ranges

Figure V plots mean salaries by level over time. We see that the relative structure of pay did not change over the business cycle. Economic conditions do not affect employees differentially across levels; percentage differences in pay across levels vary only trivially over the twenty-year period. This highlights the importance of the hierarchy in wage determination and is additional evidence that the basic structure of the internal labor market changed little over time.

Figure VI shows the structure of salaries in a typical year, 1980.[13] Curves connect the mean salaries across levels, while other points represent percentiles of the pay distributions for each level.

13. As implied by Figure V, plots for other years are quite similar.

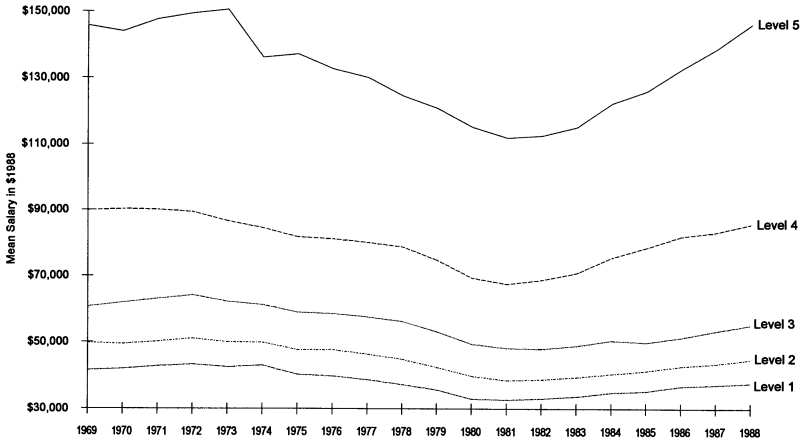

FIGURE V
Mean Salary by Level, 1969–1988
Calculated in 1988 constant dollars.

Panel a shows all levels, and Panel b shows greater detail for Levels 1–4. It is immediately clear that pay rises at an increasing rate with level; the relationship is quite convex. The jumps are especially dramatic at Levels 7–8, consistent with Rosen's model. The CEO's salary at Level 8 is more than fifteen times higher than the mean salary at Level 1. This wage growth up the hierarchy suggests that there are important incentives from the promotion ladder. Gibbs [1995], using the same data, shows that this appears to be the case. Promotees earn substantially more over the remainder of their careers than do those who are not promoted, and better performance ratings improve the likelihood of winning promotion. Moreover, in this firm the only way to earn rising real wages over the long run is through promotions: stayers earn on average zero or negative real wage growth over time.

B. Are Wages Attached to Jobs?

Panel b of Figure VI shows that there is substantial wage overlap across levels. The top half of employees in Levels 1–3 have pay overlapping the pay range of the next higher level, while the bottom half of employees in Levels 2–4 overlap the pay range of the next lower level. There is even a good deal of overlap between Levels 1 and 3. This is not due to differences in returns to tenure, nor to within-level title differences. There are similar overlaps

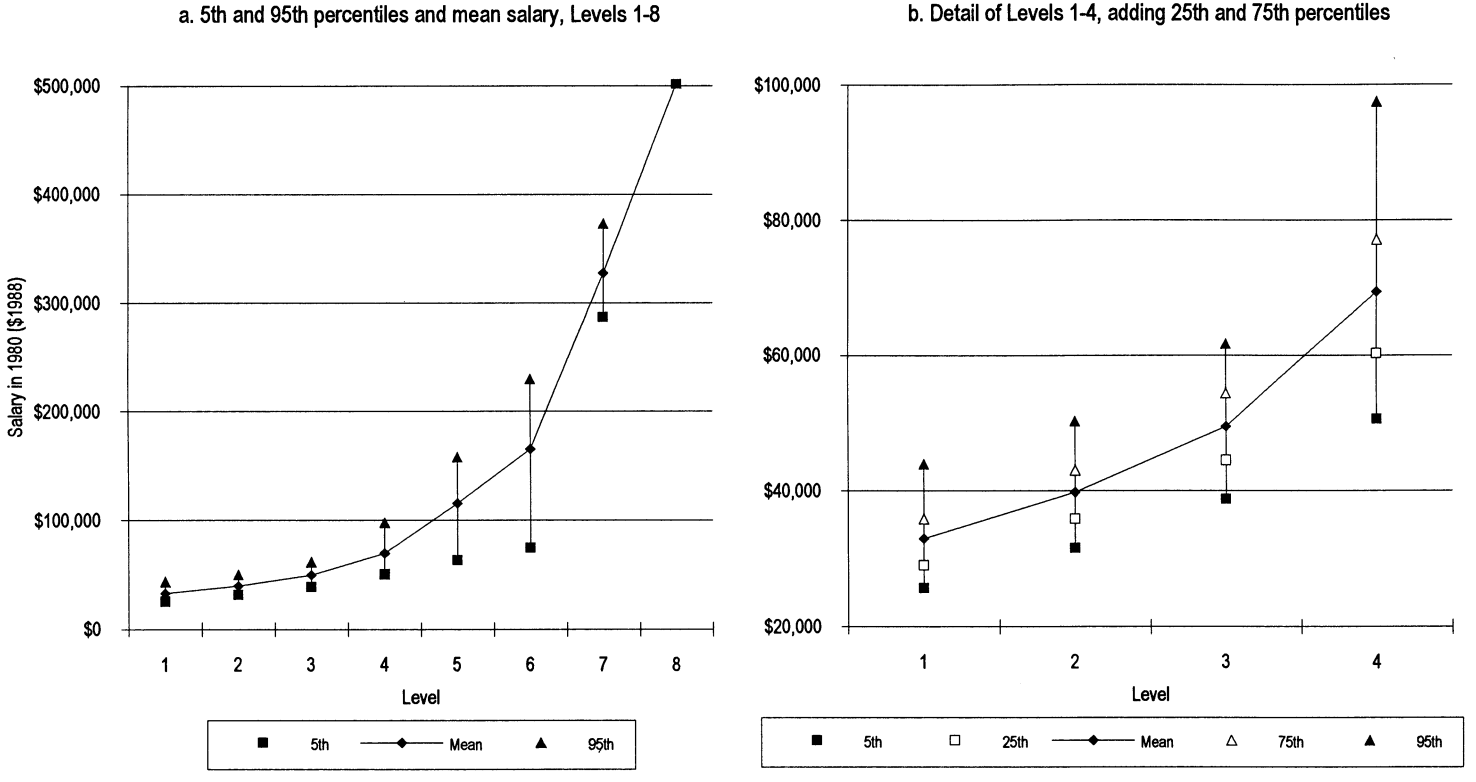

FIGURE VI
Salary Ranges by Level, 1980
Calculated in 1988 constant dollars. Level 8 has only one employee.

TABLE V
EFFECTS OF HUMAN CAPITAL AND HIERARCHICAL LEVEL ON CURRENT SALARY

Independent variables	1970–1988 Pooled regressions			1985 cross section
	i. Human capital	ii. Levels	iii. Combined	
Year dummies	yes	yes	yes	no
Sex dummy	yes	no	yes	yes
Race dummy	yes	no	yes	yes
Intercept	10.53	10.58	10.59	10.53
	(.02)	(.01)	(.01)	(.01)
13–16 years education	.04	.	−.01	−.01*
	(.004)		(.002)	(.008)
17–18 years education	.24	.	.08	.09
	(.004)		(.008)	(.01)
19+ years education	.34	.	.11	.10
	(.008)		(.006)	(.02)
Tenure	.05	.	−.003	−.01
	(.001)		(.0009)	(.003)
Tenure^2	−.001	.	.0004	.0008
	(.00008)		(.00006)	(.0002)
Level 2	.	.16	.14	.16
		(.002)	(.002)	(.01)
Level 3	.	.36	.33	.33
		(.003)	(.003)	(.01)
Level 4	.	.74	.68	.74
		(.003)	(.003)	(.01)
Level 5	.	1.16	1.08	1.13
		(.01)	(.01)	(.03)
Levels 6–8	.	1.43	1.35	1.49
		(.02)	(.02)	(.05)
R^2	.35	.68	.71	.70
R^2, regression w/out year dummies	.30	.64	.67	N/A
N	43,629	43,629	43,629	3955
Dependent mean	10.75	10.75	10.75	10.76

In all regressions the dependent variable is the log of real salary in 1988 constant dollars. Education variables are dummies for those levels of schooling; BA = 16, etc. Tenure is years with company since hire. Regressions similar to i–iii using fixed effects rather than sex, race, and education dummies do not change the results significantly. Standard errors are in parentheses. Due to large sample sizes, most coefficients are significant at the 1 percent level. The one that is not is indicated by an asterisk.

among members of the same entry cohorts, and across titles. Wages are not determined solely by job or level.

At the same time, levels are important for wage determination. This is quantified in Table V, which presents wage regressions

comparing the explanatory power of human capital variables (education and tenure, with demographic controls) and level dummy variables. The first three regressions are pooled cross sections over 1970–1988. These include one with just human capital variables, one with just level dummies, and one with both. The combined regression must be interpreted with care, of course, as tenure is correlated with level. It is included merely to show the marginal increase in explanatory power of adding human capital variables to the level regression.[14] The final column shows a single cross section for 1985, which is typical of other years. Regression i shows that human capital variables explain about 35 percent of the variance. Regression ii shows that levels are much more powerful in explaining the variance, as the R^2 doubles to 68 percent with only five level dummies (this is also true in the 1985 regression). Levels are indeed very important in explaining salary. This is a level, not a job title, effect. When we rerun regressions similar to those in Table V, replacing level dummies with title dummies (of which there are many more), R^2's increase by only 2 percent. This underscores the significance of the concept of levels for understanding firms. The firm sets the structure of levels and pay in such a way that pay is very similar across jobs at the same level. Finally, the table also shows R^2's for the same regressions without year dummies. Variations over the business cycle are much less important in explaining the log of pay than are level dummies, as suggested by Figure V.

Pay Premiums with Job Changes. If wages were determined by levels, then we would find important pay premiums earned on promotion. Table VI shows actual promotion premiums. The middle three columns show the difference in percentage real salary increase for those who stay at a level, or are demoted or promoted into the level, relative to the mean raise of all employees who were not promoted in the firm in that year (this controls for variation in raises and promotion rates over the business cycle). There are premiums for promotions and a small negative premium for demotions (this is reversed in upper levels). On average, promotions mean an immediate 6 percent increase relative to not being

14. This procedure for determining the relative importance of various determinants of wage variation is similar to that used by Groshen [1991]. She examines a sample of blue-collar workers that span firms and industries, and finds that what she calls human capital variables (which include certain job characteristics) explain less than half of the variation in intra-industry wage differentials.

promoted, and promotion premiums generally rise with level. Do promotion premiums match the average difference in pay across levels? The final column in Table VI shows the average (across years) percentage difference in mean salary between levels. For example, salary is 18 percent higher at Level 2 than at Level 1. The differences in average salary between levels are much greater than the premiums earned on changing levels, often by a factor of five times or more. Thus, promotion premiums explain only part of the difference in pay between levels.

Selection Effects on Pay Distributions in Levels. The main cause of the strong relationship between levels and pay, despite the large individual variation in pay within levels, lies in the selection of individuals to be promoted. The wage distribution in a level depends on wages of those entering the level (usually by promotion from below), wage growth within the level, and wages of those leaving the level by promotion or exit. All affect both the variances and means of wage distributions in levels. Tables VII and VIII examine these selection effects.

Table VII shows where promotees came from in the pay distribution in their prior job and where they went to in the pay distribution in their new job. The table presents the distribution of promotees across salary deciles in prior jobs, as well as the

TABLE VI
SALARY PREMIUMS BY TYPE OF JOB TRANSITION, AND ACROSS LEVELS

Level	% salary premiums on:			% difference, mean pay vs. level below
	Stay	Demotion	Promotion	
1	−0.5%	−0.7%	.	.
2	−0.4	−0.2	5.1	18
3	0.1	−3.2	5.6	23
4	0.8	0.4	7.4	47
5	−0.1	0.5	8.7	64
6	0.1	.	4.5	40
7	−0.9	.	22.3	107
8	0.0	.	14.8	48
1–8	0.0%	−0.9%	5.8%	

Salary premiums are mean percentage raises (across years) for those with that type of job move, relative to the mean raise (that year) of all employees in the firm who did not change level. Statistics are shown by current level, not level prior to promotion or demotion. % difference, mean pay vs. level below is the mean (across years) percentage difference between salary at that level and the next lower level.

TABLE VII

DISTRIBUTION OF PAY FOR PROMOTEES IN SALARY DECILES BEFORE AND AFTER PROMOTION

Promotion	Statistic	N	Percentage in each salary decile										
			Bottom	2nd	3rd	4th	5th	6th	7th	8th	9th	Top	All
Level 1	Decile before promotion	3947	4.4%	7.7%	9.1%	9.6%	9.3%	10.6%	12.6%	11.2%	13.1%	12.5%	100%
to Level 2	Decile after promotion	3947	17.1	15.4	13.1	10.6	8.3	8.8	7.1	7.3	7.1	5.2	100
Level 2	Decile before promotion	2910	2.7	5.1	7.2	8.3	9.7	11.7	12.1	13.9	14.3	15.1	100
to Level 3	Decile after promotion	2910	18.4	19.1	15.1	11.9	8.6	7.0	5.6	5.5	5.7	3.0	100
Level 3	Decile before promotion	1666	2.0	3.4	5.3	7.7	6.8	12.9	12.7	13.5	15.4	20.2	100
to Level 4	Decile after promotion	1666	32.7	23.9	15.7	10.6	5.9	5.9	1.7	1.6	1.2	0.7	100
Level 4	Decile before promotion	165	3.6	1.8	0.6	1.2	0.6	12.1	2.4	8.5	18.8	50.3	100
to Level 5	Decile after promotion	165	7.9	25.5	23.0	15.8	9.1	10.9	3.6	1.8	1.8	0.6	100

Shows distribution of salary deciles out of which employees were promoted, and into which they were promoted, for those promoted one level at a time out of Levels 1 to 4. Salary deciles are calculated over all employees in the same title in the relevant year.

distribution across salary deciles in new jobs.[15] If promotees come equally from all pay levels, and move equally into all pay levels, then these percentages should equal roughly 10 percent for each decile. There is wide variation in which deciles employees come from and go to. Only 12.5 percent of promotees to Level 2 come from the top of their previous salary range, and 4.4 percent come from the lowest decile. Nevertheless, there is a small tendency for promotees to come from the higher end of the salary range. There is a stronger tendency for promotees to enter the new job at the lower end of the salary range. For example, 17.1 percent enter in the lowest decile at Level 2, while almost half enter in the lower three deciles. These effects are more pronounced for promotions out of Levels 2–3. Level 4 is quite different. Fully half of promotees out of Level 4 are at the top end of the salary range. This is consistent with longer times to promotion, and lower promotion rates, at this level.

The evidence in Table VII rejects one possible interpretation of the importance of levels to pay: that they are merely verifications of the size of employees' compensation. Under this scenario, the firm would promote individuals as soon as pay reached a certain upper bound, so that *level* would be determined by *pay*. If this were true, then promotees would always come from the top decile in prior level: as is evident from Table VII, they do not.

Table VIII considers selection out of levels by exit rather than promotion. This is done by comparing the exit rates of employees in each salary decile. The table shows that there is little consistency in the pattern of exits across pay decile. For Levels 2, 3, 5, and 6–8, there are no statistical differences in exit rates between deciles. In Levels 1 and 4 there are a statistical differences, but little in the way of an economically significant pattern. At Level 1 the lowest paid are slightly more likely to exit, and the Level 4 pattern is slightly bimodal. However, the range of exit rates is small. Since exit rates do not vary much with pay, they cannot be a primary means by which selection effects determine the distribution of pay in levels; promotions play a much more important role.[16]

The small variation in exit rates across salary deciles is quite a surprising result. It contradicts the predictions of matching models which posit that when a bad match is discovered, the worker

15. Deciles are constructed by comparing salaries with those in the same job in the same year, then aggregated by level.

16. In our companion paper we examine more precisely the pay policy of this firm and look at the specific relationship between individuals' pay histories and their promotion prospects.

TABLE VIII
EXIT RATES BY LEVEL AND SALARY DECILE

Level	N	Percentage in each salary decile										χ^2 Stat
		Bottom	2nd	3rd	4th	5th	6th	7th	8th	9th	Top	
1	15,817	13.9%	13.4%	11.1%	11.3%	12.7%	10.6%	9.1%	11.7%	10.5%	10.7%	26.8*
2	16,129	12.8	12.2	11.4	9.9	11.7	12.4	11.3	12.0	11.8	11.4	7.7
3	15,140	11.7	11.1	10.8	11.8	10.0	10.4	8.8	11.0	12.0	11.2	11.7
4	11,932	12.1	10.7	8.0	7.4	11.1	9.2	9.0	11.7	10.2	10.1	25.1*
5	1,078	11.4	11.2	4.1	11.7	11.2	7.1	9.7	2.1	8.7	10.3	11.5
6–8	407	9.1	11.4	9.4	6.5	12.1	8.8	7.3	0.0	6.3	0.0	6.8
All	60,503	12.6	11.9	10.4	10.2	11.4	10.6	9.6	11.4	11.1	10.8	37.44*

Annual percentage exit rates are shown. Deciles are calculated within job title and year. The last column shows Chi-square statistics for the hypothesis that exit rates for all deciles in a level are the same. An asterisk indicates significant between-cell differences at the 1 percent level.

chooses a new firm, hoping for a better match. Table VIII shows that those who are well paid in their jobs, as well as those who are not, exit. This must mean that they believe that they are likely to do as well in the external labor market; i.e., that whatever talents made them well paid at this firm are not very firm-specific.

"Green Card" Effects. There is one other aspect of the relationship between pay and levels that bears directly on the question of the existence of an internal labor market in this firm. Many firms use centrally set guidelines or rules that put bounds on pay increases. These rules set the range within which an employee's raise must fall, based on her pay relative to some comparison group and her performance rating [Milkovich and Newman 1987]. The guidelines are frequently published by the Human Resource Department on pocket-sized cards (sometimes green) that are distributed throughout the organization. Green cards are usually structured in such a way that they generate larger wage increases for those with lower pay in their job, and smaller increases for those with higher pay; that is, they may reduce pay dispersion within a job. Such guidelines are examples of the kinds of administrative rules and procedures that the internal labor market literature stresses as important wedges driven between an employee's pay and what pay would be in a spot market.

We test for these effects in Table IX by reproducing the general structure of green cards as shown in Milkovich and Newman [1987, p. 354]. We place each employee into a salary quartile in her title in the year prior to each raise. Aggregating across titles within Levels 1–4 and combining Levels 1–7, Table IX presents the mean percentage real raise stratified by the quartile of pay versus the employee's performance rating.

There is strong evidence for green card effects in Table IX. In virtually all cases, those in higher salary quartiles earn lower percentage raises. This is true in every level. The effect is generally robust. It is evident in single years and controlling for tenure in a level. Nor is it driven by selection. The effect is present in similar magnitude if we look only at employees who are not promoted or at those who are. We also ran regressions of salary increases (for those not promoted) on current salary relative to others in the same job for each of Levels 1–5. The regressions show that an employee's raise is significantly negatively related to her current relative salary. In Level 1, a move from the tenth to the fiftieth percentile leads to about a 1.5 percent smaller raise, consistent with the numbers in Table IX. Considering that the real increase

TABLE IX
"GREEN CARD" EFFECTS OF RELATIVE SALARY IN TITLE ON RAISES, BY PERFORMANCE RATING

Level	Salary quartile in title	Performance rating 1	2	3	4–5	1–5
1	Top	3.2%	2.5%	1.8%	−1.6%	2.3%
	3rd	4.3	3.1	1.3	−2.7	2.5
	2nd	4.7	3.8	1.4	−2.5	3.0
	Bottom	7.2	5.5	2.8	−1.1	4.8
	N	1067	3001	2232	101	6401
2	Top	6.4	3.7	1.8	0.4	3.9
	3rd	7.2	4.5	1.5	−2.8	4.3
	2nd	8.7	5.2	2.0	−1.6	5.1
	Bottom	10.4	6.6	1.9	−2.5	6.0
	N	2021	5371	2202	83	9677
3	Top	6.6	3.9	1.6	−1.9	4.5
	3rd	7.5	4.7	1.5	−2.7	5.0
	2nd	8.3	5.7	1.7	−1.4	5.7
	Bottom	10.1	6.3	2.1	−1.5	6.4
	N	2729	5073	1421	67	9290
4	Top	7.3	4.2	0.9	−3.8	5.6
	3rd	8.0	4.9	1.5	−1.9	6.0
	2nd	8.7	5.0	1.8	−2.0	6.4
	Bottom	9.4	6.4	1.8	−3.2	7.1
	N	3398	3362	607	33	7400
1–7	Top	6.6	3.7	1.7	−1.3	4.3
	3rd	7.3	4.3	1.4	−2.5	4.5
	2nd	8.1	5.0	1.7	−2.0	5.1
	Bottom	9.4	6.2	2.2	−1.8	6.1
	All	7.7%	4.8%	1.8%	−1.9%	5.0%
	N	9679	17,320	6708	308	34,015

Shows the mean percentage raise, in 1988 constant dollars, by performance rating given in the same period. Statistics are broken out by current level and by the previous year's salary quartile among those in the same title. Levels 5–7 are not shown individually because of small sample sizes. Level 8 employees never received performance ratings. Sample sizes for each level/rating combination are also shown. Sample sizes for specific quartiles are approximately one fourth of these numbers.

for those not promoted is about 3.5 percent per year, this is not a trivial effect. Similar magnitudes are found in other levels.

Effects in percentage raises do not necessarily translate into effects in dollar raises because higher quartiles have larger salaries on which to base percentage changes. In fact, those in the top and third quartiles of pay have very similar real dollar raises in Levels 1–4. However, real dollar raises do increase from the third to the

bottom quartile, implying green card effects in the lower quartiles. In Level 1 those in the bottom quartile earn about $450 larger real raises per year than those in the third quartile, holding performance fixed. The difference between the second and third quartiles is $100–$150 per year. This pattern also holds in Levels 2–4. Green card effects in dollar raises reverse in Levels 5–6, although sample sizes are too small to draw firm conclusions. It may be that administrative pressures to reduce pay dispersion are smaller in higher levels.

V. Conclusions

We have offered an analysis of the internal economics of a firm using personnel data. Our emphasis has been on the structure of the hierarchy and the internal labor market, and their relevance for careers and compensation. Some findings confirm what would previously have been called anecdotal evidence or stylized facts: to the extent that we have converted stylized facts into hard facts, we feel that the effort is justified. Further, we have uncovered some interesting and new results, which suggest several general points of inquiry for the theory of the firm. Our major findings are as follows.

Structure and Stability of the Hierarchy. There is a clear hierarchy of levels in this firm. Levels are easily discernible from patterns of career moves. The hierarchy is remarkably simple in structure. There are only eight levels and fourteen major job titles. At each level there are usually only one or two major titles. The hierarchy is quite stable. The firm added no new levels over time as employment tripled. Major titles in 1969 were major titles in 1988, with little change in the distribution of employment across titles. Patterns of job moves are similar from the beginning to the end of the sample as well. Theories of the hierarchical structure of the firm are unable to address these findings. Why was the system of job titles so simple? Why did the firm not alter its hierarchy over changing economic conditions and firm size? Why were no new levels added?

We have also confirmed the importance of discrete job levels in this firm: titles are grouped into levels in ways that are important to careers. Almost everyone who enters the firm at the lower levels goes through the same number of promotions before reaching higher levels. In theory this need not be true: a firm with a less rigid hierarchy might have several different career tracks with different numbers of job levels and promotion patterns. In addition, the nature of jobs appears to be different at higher levels of the

hierarchy. Promotion rates fall dramatically, tenure increases, and exit rates fall slightly. The cost center descriptions suggest less functional orientation of tasks in positions in the upper ranks. This is consistent with the descriptive literature on careers, but such differences in tasks have not been analyzed by economists. It would be of interest to consider the causes of these differences across a hierarchy and the implications for career development, performance measurement, and incentive contracting.

Career Dynamics. We find clear evidence that an internal labor market is at work allocating people to jobs in this firm. Careers within the firm are often long and involve a number of job changes. Career moves are almost exclusively single-step promotions: demotions and lateral transfers are rare. We find no evidence to support the idea of ports of entry and exit: entry and exit are common at all levels of this firm.

We find evidence that general and firm-specific human capital matter to career outcomes, but that firm learning about employee ability is also an important determinant of career dynamics. When we compare the subsequent career performance of new hires into a level versus those promoted into the level, we find that while the average level of attainment of the groups is fairly similar, the variance of outcomes for new hires is greater. This strongly suggests that the firm uses lower-level job performance to learn about the innate abilities of employees and uses this information in its subsequent promotion decisions. This inference is supported by the existence of fast-track promotion effects in which those promoted quickly at one level are promoted more often and more quickly at the next level. Indeed, it appears that ability interacts with human capital in that workers accumulate human capital at varying rates. Our data on career dynamics suggest that the most useful way to think about workers' abilities is as the rate at which they accumulate human capital. Fast learners seem to have the most career success in this firm.

Surprisingly, the fastest promotees also exit more often. This would seem to be the opposite of what the firm would want and suggests that constraints imposed by the pay administration system may lead these people to quit. Such an outcome could be a result of the green card effect: administrative constraints may keep the firm from giving the best performers raises large enough to retain them.

Pay and Levels. Salary is strongly related to level. In pooled and cross-section regressions two-thirds of the variance of log salary is explained by five level dummies. Promotions bring

discrete salary premiums. The relationship between salary and level is strongly convex, consistent with tournament and hierarchical compensation theories. In addition, we find interesting evidence of a green card effect that contributes to within-job-level salary compression. However, there remain large overlaps in pay across levels. There is clearly a strong individual component to pay determination in this firm.

Reconciling the high explanatory power for levels in pay regressions with the overlaps in pay between levels requires an understanding of both the selection process that leads to promotion and particularly to the policies that determine wages in this firm. The firm appears to have centralized policies that affect compensation. Furthermore, compensation and career mobility are intimately related. Because we have some well-developed theories of compensation and career mobility, it is worth considering more carefully how these theories play out and how they are affected by administrative considerations. In our companion paper we pursue these questions by explicitly looking for evidence on several relevant theories of compensation. The primary goal of that paper is to develop a descriptive model of the wage policy of this firm.

We have used an unusual data source. Personnel data allow us to pick apart the phenomena of careers and compensation in detail. In doing so, we learn how well our theoretical mechanisms fit the data, which in turn should lead to better theories. It is clear that we have a long way to go. We have only scratched the surface in studying how firms are organized, and new theories and data will be required to deepen our understanding. Nevertheless, we hope to have shown the empirical promise of opening up the black box of the internal economics of the firm.

APPENDIX A:
DESCRIPTIONS OF VARIABLES

Variable	Description
Original variables	
Demographic:	
Age, sex, race	
Education	Level of schooling completed (degree).
Employee ID #	Constant for same employee over entire career.
Organizational:	
Title	e.g., "Department Manager."
Cost center	Twenty-digit name of organizational unit, e.g., "Accounts Receivable."
Cost center code #	Six-digit code.

APPENDIX A:
(CONTINUED)

Variable	Description
Compensation:	
Salary	Converted to 1988 constant dollars using CPI, all items (1991 Statistical Abstract of U. S.; Table 770, Column 1).
Bonus	Available 1981–1988. All bonuses were paid on February 1 of the following year. Converted to 1988 constant dollars as for salary.
Salary grade	Available 1979–1988; earlier years used varying systems.
Performance rating	Available in varying degree over time for about two-thirds of the records. Coded as 0 (not rated), 1–5 (1 = highest rating). Timing of the rating is unknown, but it is probably year-end given that bonuses are awarded on February 1 of the next year.
Derived variables	
Country of employment	Derived from cost center descriptions and salary data.
Education	Number of years: BA = 16, MBA = 18, etc.
Years at company	First year = 1, etc.
Years at job (title)	First year = 1, etc.
Level	Hierarchical level, based on job transition patterns. See text for a full description.

APPENDIX B:
SUMMARY STATISTICS FOR SELECTED VARIABLES AND YEARS

Variable		Year					
		1969	1974	1979	1984	1988	1969–1988
Salary $1988	mean	$59,317	$59,773	$50,925	$51,162	$59,599	$54,066
	median	$51,452	$53,357	$45,277	$45,103	$52,400	$47,506
	std. dev.	$35,205	$27,273	$24,885	$25,453	$31,574	$27,681
Performance rating % of ratings	1	82	45	36	25	30	31
	2	18	44	52	50	51	50
	3	0	11	11	23	18	18
	4–5	0	1	0	2	1	1
Years at co.	excl. 1969		3	4	5	5	4
Years at title	excl. 1969		2	3	3	3	3
Age	mean	44	40	39	39	38	39
Education	mean years	15	16	16	16	15	16
Salaried employees	U. S.	1250	1889	3091	4575	5218	62,957
	foreign	53	124	182	196	804	5,480

Number of observations vary as not all records have all variables. Salaried employees is total sample size after removing data for employees on various forms of leave or early retirement. For pay analyses, sample is U. S. employees. Tenure statistics exclude censored spells (those beginning up to 1969); in the last column these are over 1974–1988 to reduce censoring bias.

HARVARD UNIVERSITY
UNIVERSITY OF CHICAGO
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

REFERENCES

Baker, George, Michael Gibbs, and Bengt Holmstrom, "The Wage Policy of a Firm," *Quarterly Journal of Economics,* CIX (1994), 921–55.
Becker, Gary S., *Human Capital: A Theoretical and Empirical Analysis, With Special Reference to Education* (Chicago: University of Chicago Press, 1975).
Beckmann, Martin J., "Management Production Functions and the Theory of the Firm," *Journal of Economic Theory,* XIV (1977), 1–18.
Blackwell, David W., James A. Brickley, and Michael A. Weisbach, "Incentives of Divisional Managers: Evidence from Texas Banks," manuscript, University of Rochester, 1991.
Calvo, Guillermo and Stanislaw Wellisz, "Hierarchy, Ability, and Income Distribution," *Journal of Political Economy,* LXXXVII (1979), 991–1010.
Doeringer, Peter, and Michael Piore, *Internal Labor Markets and Manpower Analysis* (Lexington, MA: D. C. Heath and Company, 1971. Armonk, NY: London: M. E. Sharpe, Inc., reprinted 1985).
Gibbs, Michael, "Incentive Compensation in a Corporate Hierarchy," *Journal of Accounting and Economics/Journal of Labor Economics,* XIX (1995), forthcoming.
Groshen, Erica, "Sources of Intra-Industry Wage Dispersion: How Much do Employers Matter?" *Quarterly Journal of Economics,* CVI (1991), 869–84.
Greenwald, Bruce, *Adverse Selection in the Labor Market* (New York: Garland, 1979).
Jovanovic, Boyan, "Job Matching and the Theory of Labor Turnover." *Journal of Political Economy,* LXXXVII (1979), 972–90.
Kahn, Lawrence, and Peter Sherer, "Contingent Pay and Managerial Performance," *Industrial and Labor Relations Review,* XLIII (1990), 107S–20S.
Lambert, Richard, David Larcker, and Keith Weigelt, "The Structure of Organizational Incentives," *Administrative Sciences Quarterly,* XXXVIII (1993), 438–61.
Lazear, Edward P., "The Job as a Concept," in *Performance Measurement, Evaluation, and Incentives,* William J. Bruns, ed. (Boston: Harvard Business School Press, 1992).
Leonard, Jonathan, "Executive Pay and Firm Performance." *Industrial and Labor Relations Review,* XLIII (supplement February 1990), 13–29.
Medoff, James, and Katharine Abraham, "Experience, Performance, and Earnings," *Quarterly Journal of Economics,* XCV (1980), 703–36.
Medoff, James, and Katharine Abraham, "Are Those Paid More Really More Productive? The Case of Experience," *Journal of Human Resources,* XVI (1981), 186–216.
Milkovich, George T., and Jerry M. Newman, *Compensation* (Plano, TX: Business Publications, 1987).
Mintzberg, Henry, *The Nature of Managerial Work* (New York: Harper and Row, 1973).
Osterman, Paul, "Sex Discrimination in Professional Employment: A Case Study," *Industrial and Labor Relations Review,* XXXII (July 1979), 451–64.
Rosen, Sherwin, "Authority, Control, and the Distribution of Earnings," *Bell Journal of Economics,* XIII (1982), 311–23.
——, "Prizes and Incentives in Elimination Tournaments," *American Economic Review,* LXXVI (September 1986), 701–15.
Rosenbaum, James E., *Career Mobility in a Corporate Hierarchy* (New York: Academic Press, 1984).
Waldman, Michael, "Job Assignments, Signaling, and Efficiency," *Rand Journal of Economics,* XV (1984), 255–67.