THE ANATOMY OF JUMPS AND FALLS IN WAGES

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I. INTRODUCTION

The determinants of workers' wages are a principal focus of labor economics. Annual growth in wages is of particular concern, since past pay raises are an important determinant of the current wage. Economists routinely estimate rates of increase in wages in response to experience, among other variables.[1] They usually calculate smooth rates—a natural consequence of undertaking aggregate calculations—but wage growth in fact is seldom smooth.[2] More typically, earnings change discontinuously, responding to such factors as annual performance reviews, union-negotiated wage increases, promotions, quits, and firings.

This paper investigates the anatomy of jumps and falls in wages, assessing their sources and consequences. Jumps and falls are related to discrete job events: promotions, terminations, and quits. These phenomena are broken down by industry, race, gender, and other characteristics. The role of discontinuities has long been of interest to labor economists due to their linkage to the formal job structure of

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firms, which is the domain of internal labor markets (Doeringer & Piore, 1972). The role of these discontinuities is particularly important in labor market models of contests and tournaments, and in the literature on the superstar phenomenon.[3]

A number of processes could explain large changes in payoffs; these include learning, resolution of information lotteries, internal labor markets, and transactions costs. Determining the relative importance of these influences is clearly important for policy purposes; this is the goal of this paper. Our approach is largely descriptive. At present little is known at the firm level about the relative importance of large payoffs in explaining wage variability, nor about the determinants of these large payoffs. To distinguish among the various influences, we compare the results of standard wage equations and results obtained with "prize" equations, where the dependent variable indicates the occurrence of a discrete labor market event, such as a large wage increase. All of our analyses are conducted in real dollars. In many instances, the theoretical models predict the same direction of influence in the prize equation as in the wage equation, whereas in others the predictions of the competing models differ.

For example, in the pure capital and learning theories, job tenure should have a positive and nondecreasing effect on increases in the worker's wage level. Attention to wage jumps shifts the focus of the analysis, giving more emphasis to sorting and matching models. Such models predict that after the firm and worker have had sufficient time to observe each other in a particular context, there should be fewer adjustments that would lead to discontinuous wage changes.

We find that high tenure workers have higher wages and lower probabilities of receiving good and bad prizes. Moreover, past prizes, both good and bad, have permanent effects. We also find that big wage jumps are more prevalent than big wage falls. Perhaps workers can mute the effect of penalties by quitting. Institutional and legal wage restrictions also may be influential.

Recent theoretical work in labor markets shows that rank-order tournaments—the best metaphor may be a golf tournament—can serve a fundamental role within the context of employment relationships.[4] Such tournaments are particularly useful when the employer may not know what level of output to expect from employees but is able to distinguish among levels of performance, or when there is only a single position to be filled, as happens when managers compete for a vacant vice presidency.[5] Recent work by Frank and Cook (1995) shows that in some fields—e.g., law and entertainment—these tournaments are extreme, with huge salaries received by those who come out on top.[6] They raise significant questions about the equity and efficiency implications of such wage-reward structures. The jumps and salaries that workers in our sample receive—though often appropriately thought of as rewards in contests—are much less extreme than the ones Frank and Cook study.

Contests serve multiple purposes. First, they motivate employees to work harder to increase their probability of securing a higher reward. Second, they lead workers to sort themselves; only talented individuals will choose to work in a situation where the payoff depends (probabilistically) upon performance. This is an especially

important function when workers have information about their own abilities that their employers cannot observe. Third, contests enable employers to assign duties efficiently based on information not available before the contest was run. For example, if work skill predicts managerial skill, at the end of the period the best worker might be promoted to supervisor.

In sum, theory suggests that discontinuous wage changes have distinct labor market roles to play. Rather than, for example, providing smooth rates of increases associated with increases in workers' experience, we often observe bumps up such as those associated with promotions. Focusing on the entire continuum of wage changes, as in standard empirical analyses, in effect assigns the average effect of such discontinuities to continuous variables such as tenure, whereas the actual processes at work may be quite different. Analyzing mean wage levels for particular labor market events such as promotions reported by the respondent may also be informative, but major wage jumps and falls are not always linked to such events. Rather, the wage jump or fall may itself be the critical event of interest; it is such events that we explore in this paper.

Section II lays out the data, and describes the gross anatomy of wage jumps and falls. Section III looks at who receives jumps and falls. Section IV conducts a parallel analysis of job events. Section V examines the role of wage jumps and job events on wage variation. Section VI concludes. The determinants of wages, and the particular role of jumps and falls, is the subject of the Appendix.

II. THE SAMPLE, THE VARIABLES, AND THE GROSS ANATOMY OF JUMPS AND FALLS IN WAGES

The data for the empirical analysis (see Table 1) are drawn from the University of Michigan Panel Study of Income Dynamics (PSID) for the years 1978–1987 (waves 11–20 of the PSID). The sample is restricted to individuals who were continuously employed and headed households in every year.[7] Workers paid on a basis other than salary or hourly wage (for instance, piece rates) were excluded, as were those who reported their race as other than black or white, and those who did not report their gender. Our full sample contains data for 780 workers over a 10-year period.[8] Since a lagged wage variable is used to compute wage changes, we use nine years of observations, yielding a total sample size of 7,020 salaries and wages. Given our qualification criteria, only 16% of our workers are women, implying that the sample for men is both larger and more representative, and the results for men are more conclusive.

The basic measure of compensation for hourly wages is the reported hourly wage; for salaried workers it is an hourly wage computed from reported annual hours and earnings. Wages are expressed in real terms (1982 dollars) using the GDP deflator.[9] (During the sample period, inflation ranged from a high of 13.3 percent in 1979, to a low of 1.1 percent in 1986.)

Table 1. Description of Variables and Their Mean Values

Variable	*Definition*	*Full Sample*	*JUMP = 0*	*JUMP = 1*	*FALL = 0*	*FALL = 1*
Real Wage	Wage rate in dollars per hour (1982 dollars)	9.40	9.81	10.41	8.93	7.91
		(3.50)	(3.41)	(4.06)	(3.22)	(3.16)
% Δ in Real Wage	% real wage change this year t+1. Matched to year t+1 data	0.03	0.05	0.27	–0.04	–0.20
		(0.15)	(0.03)	(0.16)	(0.03)	(0.10)
Promoted	Promotion d.v.: 1 if promoted this year, 0 otherwise	0.04	0.04	0.09	0.02	0.03
		(0.19)	(0.20)	(0.29)	(0.13)	(0.17)
Terminated	Fired d.v.: 1 if worker was fired this year, 0 otherwise	0.01	0.8E-2	0.9E-2	0.6E-2	0.04
		(0.10)	(0.09)	(0.09)	(0.08)	(0.19)
Quit "Wages Up"	Quit d.v.: 1 if worker quit this year for a higher wage, 0 otherwise	0.03	0.03	0.10	—	—
		(0.16)	(0.16)	(0.30)		
Quit "Wages Down"	Quit d.v.: 1 if worker quit this year for a lower wage, 0 otherwise	0.02	—	—	0.03	0.09
		(0.14)			(0.16)	(0.29)
Job Characteristics						
Union Status	Collective bargaining status d.v.: 1 if worker is covered by a collective bargaining agreement, 0 otherwise	0.39	0.41	0.31	0.41	0.33
		(0.49)	(0.49)	(0.46)	(0.49)	(0.47)
Long Job Tenure	Tenure d.v.: 1 if worker's tenure at the Job is greater than 2 years, 0 otherwise	0.79	0.81	0.64	0.85	0.71
		(0.41)	(0.39)	(0.48)	(0.36)	(0.45)
Salaried	Pay status d.v.: 1 if worker is paid a salary, 0 if paid hourly	0.42	0.39	0.55	0.36	0.55
		(0.49)	(0.49)	(0.50)	(0.48)	(0.50)
Worker Characteristics						
Black	Race d.v.: 1 if black 0 otherwise	0.32	0.29	0.34	0.33	0.36
		(0.47)	(0.45)	(0.47)	(0.47)	(0.48)
Female	Sex d.v.: 1 if female, 0 otherwise	0.16	0.15	0.15	0.17	0.15
		(0.36)	(0.36)	(0.36)	(0.38)	(0.36)
Married	Marital status d.v.: 1 if married, 0 otherwise	0.78	0.78	0.78	0.76	0.81
		(0.42)	(0.42)	(0.41)	(0.42)	(0.40)
Blue Collar	Collar color d.v.: 1 if blue collar occupation, 0 otherwise	0.63	0.64	0.55	0.65	0.61
		(0.48)	(0.48)	(0.50)	(0.48)	(0.49)

Less than High School	Education d.v.: 1 if worker has not finished high school, 0 otherwise	0.25 (0.43)	0.24 (0.42)	0.22 (0.41)	0.27 (0.44)	0.26 (0.44)
High School	Education d.v.: 1 if highest degree is high school diploma, 0 otherwise	0.58 (0.49)	0.60 (0.49)	0.57 (0.50)	0.58 (0.49)	0.55 (0.50)
College Degree	Education d.v.: 1 if highest degree is bachelor's degree, 0 otherwise	0.12 (0.33)	0.12 (0.32)	0.16 (0.37)	0.11 (0.31)	0.12 (0.33)
More than College	Education d.v.: 1 if worker has college degree plus additional schooling, 0 otherwise	0.05 (0.21)	0.04 (0.20)	0.05 (0.22)	0.05 (0.21)	0.06 (0.24)
Industry						
Agriculture, Mining & Construction	Industry d.v.	0.04 (0.21)	0.04 (0.19)	0.05 (0.21)	0.05 (0.21)	0.06 (0.25)
Manufacturing, Transportation & Communication	Industry d.v.	0.43 (0.50)	0.46 (0.50)	0.39 (0.49)	0.42 (0.49)	0.40 (0.49)
Wholesale or Retail Trade	Industry d.v.	0.15 (0.36)	0.15 (0.35)	0.15 (0.36)	0.16 (0.36)	0.16 (0.36)
Services	Industry d.v.	0.22 (0.41)	0.21 (0.41)	0.23 (0.42)	0.22 (0.41)	0.21 (0.41)
Public Sector	Industry d.v.	0.12 (0.32)	0.12 (0.33)	0.14 (0.35)	0.10 (0.31)	0.12 (0.33)
Sample Size		7020	2980	996	2281	763

Note: Standard deviations in parentheses.

A. Wage Jumps

For each worker in each year, we computed the wage jump dummy variable. Workers who received the largest 25 percent of wage increases in each year received "wage jumps"; those who received the largest 10 percent of wage increases received "extreme jumps." These jumps are defined in percentage terms, not absolute amounts. Given natural variability in the economy over time, the size of a raise that qualifies as a wage jump varies from year to year. We focus on ordinary wage jumps; extreme jumps are too infrequent to analyze conclusively. "Wage falls" and "extreme falls" were defined analogously.

Table 1 describes the variables used in the analysis. The average real wage change for those with wage jumps is 27 percent, and their average real wage equals $10.41 per hour. This real wage implies average annual earnings of roughly $20,000, which accords with aggregate data for the period.

Table 1 indicates that many major wage increases are not explicitly tied to either promotions, or quitting to obtain a better job. Indeed 80 percent of the jumps resulted from wage increases and bonuses within the worker's particular job class. These results indicate that a focus on identifiable reported events such as promotions may miss major events affecting workers' wages.

B. Job Characteristics

Over one-third of the sample workers are covered by a collective bargaining contract, and almost half are paid a salary. A third variable indicates whether a worker has been at his or her current job for an extended period—that is, two years or longer. This choice of functional form for the tenure variable reflects empirical evidence, as in Viscusi (1980), that the wage-tenure profile and worker mobility patterns are initially very steep, and flatten out after a few years.

C. Worker Characteristics

These include the usual indicators of race and sex. We denote occupation by the blue-collar dummy variable, and educational attainment by dummy variables indicating the highest degree the worker has earned. Industry dummies for the one-digit SIC code, with public sector workers as the omitted industry, complete the list of explanatory variables.

The variation in the magnitude of the variables by jump and fall status, as presented in the four right-most columns, presents some interesting patterns. Job status, such as union membership and tenure, varies quite substantially across the different columns. In contrast, personal characteristics, such as marital status and gender, are relatively invariant. The role of these variables is explored further below.

D. Jumps and Falls

Table 2 shows the percentage of workers whose wages jumped or fell each year and the percentage of each year's aggregate wage increases that is due to jumps and falls. Our focus is on wage jumps, which are typically more common, as shown in the % of sample with Jump/Fall columns of data in Table 2. In each of the years 1978–1986, between 48 and 61 percent of the workers in our sample received real wage increases. (The low year, 1981, was characterized by 10.3 percent inflation and 7.6 percent unemployment.) The average size of a wage jump, an increase in the upper 25 percent of all real wage increases, ranges from $1.86 to $2.44 per hour. Wage falls are comparable in absolute value, averaging between $1.44 and $2.48 per hour. The empirical analysis treats jumps and falls consistently.[10]

The most notable statistics in Table 2 are the data in the final columns describing the portions of total wage increases and decreases earned by jumpers and fallers; the aggregate increases are measured in percentage terms.[11] In 1986, for example, 65 percent of the total increase in real wages accrued to workers in the upper 25th percentile of the distribution of real wage increases, while 66 percent of the total decrease in real wages came from workers in the lowest 25 percent of the wage decrease distribution. In no year did less than three-fifths of the increases and decreases go to the jumpers and fallers. Equally striking are the percentages of total increases and decreases earned by those in the upper and lower 10 percent tails of the wage change distributions. Workers in the upper 10 percent of increases earned 33 to 40 percent of total wage increases; those in the bottom 10 percent of the wage fall distribution account for 36 to 46 percent of the total decrease.[12]

One striking feature of Table 2 is that the "qualifying value" for a fall is always less than that for a jump. A second is the similarity in percentages of increases and decreases going to jumpers and fallers. This is surprising given that Card and Hyslop (1996) find that firms rarely impose negative nominal wage changes on workers. However, both real and nominal wage cuts have been found to occur with reasonable frequency in studies using other data sets, as in the studies by McLaughlin (1994) and Baker, Gibbs, and Holmstrom (1994).

Table 3 gives the actual numbers of jumps and falls that workers received in nine periods. Sixty-nine percent of the workers experienced at least one jump; 55 percent had at least one fall. In a year, a jump is 14.07% likely; a fall happens 10.33% of the time. The null hypothesis assumes that whether an individual receives a jump or a fall this year is independent of his past experience. The expected numbers of jumps and falls, shown in Table 3, assume independence. The independence hypothesis is strongly rejected. There are too many individuals receiving no jumps and falls over a nine-year period, and a number receiving too many.[13]

or the conclusion of multi-year evaluations such as those before the granting of partnership or academic tenure.

To get a better picture of long-run patterns of wage changes, we looked into the long-term effects of wage jumps and falls. If such events were primarily due to measurement error, we would expect their effects to wash out over time. Table 8 and the Appendix explore effects of wage events using a variety of lags. They indicate that wage jumps and falls have significant effects on wages well after the periods in which they are experienced, implying that wage jumps and falls are significant phenomena with permanent consequences.

III. WHOSE WAGES JUMP AND FALL?

In this section we investigate whose wages jump and fall, looking at workers' demographic characteristics, education, and industry. We pay particular attention to job history: length of tenure, past jumps and falls, and job events such as quits and promotions. Of particular interest are comparisons with the predictions of the standard models addressing human capital, monopoly unions, and discrimination. This analysis is complemented by Section IV, which examines the determinants of job events, and by the Appendix, which includes jump and fall variables in a standard wage equation.

The focus here continues to be ordinary (75th percentile) wage jumps and falls.[15] The estimating equations used to determine who will experience jumps and falls in wages are

$$Prob[JUMP_t = 1] = \Phi(x\beta),$$

and

$$Prob[FALL_t = 1] = \Phi(x\gamma),$$

where Φ denotes the logistic distribution.

Tables 4 and 5 report logit estimates for four versions of the wage jump and fall equation. The four equations in each table assess the effects of observable characteristics on the jump or fall variable. The first equation contains no information on past job events; the second equation incorporates job event history (past jumps and falls plus promotions, terminations, and quits); the third includes the lagged real wage rate but not job events; and the fourth includes past job events and the lagged wage. The wage is lagged twice to avoid endogeneity that would otherwise arise since the jump variable is defined using $w_t - w_{t-1}$. Inclusion of the wage level indicates whether jumps are simply a high-wage phenomenon or are linked to the sources of the wage level. The past wage rate variable also controls for the net wage effects of past jumps and falls that have generated the previous wage level. The job tenure variable is lagged one year since its value becomes zero after a jump or fall that leads to a job change.

Table 4. Logit Estimates of Wage Jump Equations

	Coefficients (Standard Error)			
	Baseline Equation	*Baseline Equation with Job Events*	*Baseline Equation with Lagged Wage*	*Baseline Equation with Lagged Wage and Job Events*
Constant	−1.450*	−2.200[a]	−0.830[a]	−1.493[a]
	(0.251)	(0.279)	(0.293)	(0.327)
Black	0.331[a]	0.308[a]	0.286[a]	0.241[b]
	(0.096)	(0.104)	(0.098)	(0.105)
Female	−0.150	−0.126	−0.295[b]	−0.331[b]
	(0.167)	(0.176)	(0.171)	(0.182)
Married	0.166	0.108	0.176	0.117
	(0.137)	(0.146)	(0.136)	(0.145)
High School	0.005	0.015	0.092	0.130
	(0.113)	(0.121)	(0.116)	(0.125)
College	0.221	0.366[a]	0.406[b]	0.593[a]
	(0.167)	(0.177)	(0.176)	(0.186)
More than College	0.031	0.003	0.261	0.273
	(0.227)	(0.243)	(0.237)	(0.259)
Long Job Tenure_{t-1}	−0.318[a]	−0.039	−0.316[a]	−0.043
	(0.101)	(0.113)	(0.101)	(0.114)
Union Status	−0.242[a]	−0.120	−0.190[b]	−0.049
	(0.085)	(0.101)	(0.097)	(0.103)
Blue Collar	−0.325[a]	−0.266[a]	−0.397[a]	−0.356[a]
	(0.104)	(0.109)	(0.106)	(0.112)
Agriculture, Mining, and Construction	−0.183	−0.372[b]	−0.207	−0.387[b]
	(0.203)	(0.218)	(0.204)	(0.218)
Manufacturing, Transportation, and Communication	−0.322[a]	−0.333[a]	−0.308[a]	−0.322[a]
	(0.129)	(0.136)	(0.129)	(0.136)
Wholesale, Retail Trade	−0.480[a]	−0.628[a]	−0.558[a]	0.741[a]
	(0.181)	(0.195)	(0.184)	(0.198)
Services	−0.168	−0.155	−0.239	−0.242
	(0.144)	(0.154)	(0.146)	(0.156)
Year 1981	−0.057	−0.404	−0.102	−0.454
	(0.156)	(0.302)	(0.157)	(0.302)
Year 1982	0.233[b]	0.173	0.200	0.126
	(0.140)	(0.158)	(0.149)	(0.159)
Year 1983	0.199	0.249	0.165	0.212
	(0.149)	(0.158)	(0.149)	(0.159)
Year 1984	0.165	0.173	0.146	0.148
	(0.150)	(0.158)	(0.150)	(0.160)
Year 1985	0.230	0.222	0.233	0.221[a]
	(0.148)	(0.158)	(0.149)	(0.158)

(continued)

Table 4. Continued

	Coefficients (Standard Error)			
	Baseline Equation	*Baseline Equation with Job Events*	*Baseline Equation with Lagged Wage*	*Baseline Equation with Lagged Wage and Job Events*
$Jump_{t-1}$	—	–0.307[a]	—	–0.367[a]
		(0.146)		(0.147)
$Jump_{t-2}$	—	–0.098	—	–0.025
		(0.133)		(0.134)
$Jump_{t-3}$	—	0.096	—	0.146
		(0.128)		(0.129)
$Jump_{t-4}$	—	–0.259[a]	—	–0.211[b]
		(0.096)		(0.097)
$Fall_{t-1}$	—	1.841[a]	—	1.882[a]
		(0.116)		(0.119)
$Fall_{t-2}$	—	0.649[a]	—	0.543[a]
		(0.139)		(0.142)
$Fall_{t-3}$	—	0.322[b]	—	0.241[b]
		(0.144)		(0.146)
$Fall_{t-4}$	—	0.259[a]	—	0.211[b]
		(0.086)		(0.097)
Promotion	—	1.425[a]	—	1.423[a]
		(0.179)		(0.179)
Quit	—	0.931[a]	—	0.894[a]
		(0.192)		(0.193)
Termination	—	–0.114	—	–0.149
		(0.430)		(0.434)
$Real\ Wage_{t-2}$	—	—	–0.055[a]	–0.074[a]
			(0.016)	(0.018)

Notes: [a]Denotes coefficients that are statistically significant at the 99 percent confidence level, one-tailed test.

[b]Denotes coefficients that are statistically significant at the 95 percent confidence level, one-tailed test.

The results in Tables 4 and 5 differ in many respects from the standard wage equation estimates presented in the Appendix. An important aspect of our results is that they complement the standard human capital and discrimination models. For example, although blacks on average are paid less than whites, they experience a disproportionate share of wage jumps and wage falls, a result that is strong in all four specifications.

Might the lower wages of black workers explain their greater propensity for jumps and falls, perhaps because percentage changes are likely to be greater for lower wages? Equations (3) and (4) address this possibility. Though low-wage

Table 5. Logit Estimates of Wage Fall Equations

	Coefficient (Standard Error)			
	Baseline Equation	*Baseline Equation with Job Events*	*Baseline Equation with Lagged Wage*	*Baseline Equation with Lagged Wage and Job Events*
Constant	−1.999[a]	−2.000[a]	−2.084[a]	−3.597[a]
	(0.284)	(0.309)	(0.328)	(0.362)
Black	0.248[b]	0.193[b]	0.258[a]	0.255b
	(0.107)	(0.133)	(0.109)	(0.115)
Female	−0.037	−0.094	−0.012	0.084
	(0.197)	(0.203)	(0.203)	(0.213)
Married	0.518[a]	0.515[a]	0.517[a]	0.507[a]
	(0.165)	(0.168)	(0.165)	(0.170)
High School	−0.018	−0.031	−0.033	−0.122
	(0.122)	(0.127)	(0.125)	(0.131)
College	−0.020	−0.104	−0.051	−0.297
	(0.192)	(0.199)	(0.201)	(0.208)
More than College	0.278	0.189	0.240	−0.047
	(0.245)	(0.255)	(0.256)	(0.264)
Long Job Tenure_{t-1}	−0.295[a]	0.097	−0.296[a]	0.094
	(0.112)	(0.124)	(0.112)	(0.124)
Union Status	−0.332[a]	−0.225[b]	−0.341[a]	−0.278[a]
	(0.107)	(0.112)	(0.108)	(0.114)
Blue Collar	−0.140	−0.141	−0.128	−0.064
	(0.115)	(0.120)	(0.118)	(0.123)
Agriculture, Mining, and Construction	0.311	0.290	0.313	0.282
	(0.211)	(0.224)	(0.211)	(0.224)
Manufacturing, Transportation, and Communication	−0.095	0.002	−0.098	−0.016
	(0.150)	(0.156)	(0.150)	(0.156)
Wholesale, Retail Trade	−0.029	0.091	−0.018	0.164
	(0.195)	(0.204)	(0.197)	(0.205)
Services	−0.080	−0.039	−0.075	−0.028
	(0.170)	(0.181)	(0.172)	(0.182)
Year 1981	0.108	0.159	0.115	0.195
	(0.153)	(0.287)	(0.160)	(0.268)
Year 1982	−0.260[a]	−0.197	−0.255	−0.158
	(0.104)	(0.171)	(0.164)	(0.171)
Year 1983	−0.191	−0.184	−0.185	−0.152
	(0.161)	(0.188)	(0.182)	(0.169)
Year 1984	−0.178	−0.224	−0.173	−0.202
	(0.161)	(0.168)	(0.161)	(0.168)
Year 1985	−0.244	−0.287[b]	−0.243	−0.281[b]
	(0.163)	(0.170)	(0.163)	(0.170)
Jump_{t-1}	—	1.325[a]	—	1.380[a]
		(0.118)		(0.120)
Jump_{t-2}	—	0.640[a]	—	0.586[a]
		(0.135)		(0.136)

(continued)

Table 5. Continued

	Coefficient (Standard Error)			
	Baseline Equation	*Baseline Equation with Job Events*	*Baseline Equation with Lagged Wage*	*Baseline Equation with Lagged Wage and Job Events*
$Jump_{t-3}$	—	0.314[b]	—	0.273[b]
		(0.137)		(0.137)
$Jump_{t-4}$	—	–0.100	—	–0.138
		(0.103)		(0.104)
$Fall_{t-1}$	—	–0.144	—	–0.175
		(0.171)		(0.172)
$Fall_{t-2}$	—	0.298[b]	—	0.327[b]
		(0.147)		(0.150)
$Fall_{t-3}$	—	0.517[a]	—	0.579[a]
		(0.145)		(0.146)
$Fall_{t-4}$	—	0.100	—	0.138
		(0.104)		(0.104)
Promotion	—	–0.279	—	–0.268
		(0.263)		(0.263)
Quit	—	1.055[a]	—	1.088[a]
		(0.198)		(0.198)
Termination	—	2.083[a]	—	2.108[a]
		(0.289)		(0.270)
Real $Wage_{t-2}$	—	—	0.009	0.061[a]
			(0.017)	(0.019)
Year 1980	–0.542b	–0.306	–0.343	–0.175
	(0.297)	(0.546)	(0.316)	(0.352)
Year 1981	0.384	0.624	–0.444	0.030
	(0.244)	(0.466)	(0.339)	(0.364)
Year 1982	–0.80	0.469	–1.020[a]	–0.360
	(0.263)	(0.472)	(0.389)	(0.396)
Year 1983	–0.307	0.315	–0.059[a]	–0.638
	(0.278)	(0.491)	(0.404)	(0.437)
Year 1984	–0.089	0.549	–0.244	–0.127
	(0.265)	(0.475)	(0.324)	(0.378)
Year 1985	–0.355	–0.028	0.138	0.195
	(0.290)	(0.535)	(0.302)	(0.350)
Year 1986	–0.195	–0.003	–0.636[b]	0.301
	(0.278)	(0.535)	(0.362)	(0.342)
$Jump_{t-1}$	0.234	–0.172	–0.079	0.432[b]
	(0.173)	(0.348)	(0.234)	(0.241)
$Fall_{t-1}$	–0.552[b]	0.078	0.445[b]	0.606[a]
	(0.270)	(0.358)	(0.246)	(0.256)
Real $Wage_{t-2}$	0.015	–0.030	–0.142	–0.017
	(0.026)	(0.048)	(0.035)	(0.036)

Notes: [a]Denotes coefficients that are statistically significant at the 99 percent confidence level, one-tailed test.

[b]Denotes coefficients that are statistically significant at the 95 percent confidence level, one-tailed test.

workers receive more jumps, blacks receive more jumps even after controlling for wage level. Quite possibly this is because employers judge blacks as more heterogeneous in ability.

The experience of female workers, who are paid significantly less than male workers, also suggests that low wages are not the key factor promoting jumps. Females do not disproportionately experience wage jumps and falls; indeed they receive them less often. Since our sample is restricted to female household heads, a considerable portion of the heterogeneity among female workers may have been eliminated.

Tables 4 and 5 show that those with college degrees garner significantly more jumps, but not more falls. We conjecture that this is due to greater heterogeneity of ability for college-educated workers relative to the jobs they hold, with the able reaping their rewards over time. A related possible explanation is that firms run more tournaments for college workers, as in Rosen's (1981) superstars model.

The worker job tenure variable reduces the likelihood of jumps and falls; this effect is statistically significant when the job event variables are not included. A possible explanation is that the longer a worker remains in a position, the more the employer resolves his uncertainty about the worker's productivity.[16] Including the extensive jump and fall history variables in equations (2) and (4) in Tables 4 and 5 eliminates the effect of the tenure variable. The higher pay of long-tenure workers reflects their greater productivity, but the effect of tenure on wage levels largely reflects the worker's history of discontinuous wage changes.

In the monopoly union model, workers covered by a collective bargaining agreement are paid more than those who are not; however, these higher wage levels do not imply that these workers experience more wage jumps.[17] The results in equation (1) in Table 4 indicate that workers covered by a collective bargaining agreement are less likely to experience a wage jump (two columns in Table 4) and significantly less likely to have a fall (all four columns of Table 5), controlling for demographic factors. (If we also control for jump and fall history, union status no longer reduces jumps significantly, but continues to reduce falls.)

There are at least four plausible explanations for the asymmetry in the discontinuous wage changes for unionized workers. First, there may be less unobserved heterogeneity among union members. Because union wages are high, more workers may apply, so that employers can select a more uniformly qualified crew. Second, unions negotiate contracts that constrain the use of sharp downward wage shifts. Third, firings for unionized workers are more difficult, particularly those due to isolated job incidents as opposed to persistent poor performance. Fourth, unionized workplaces may provide other mechanisms for motivating workers. The role of unions in encouraging worker "voice" and in enhancing workers' productivity may fulfill some roles normally served by contests.[18]

The equations in columns 2 and 4 of Tables 4 and 5 provide evidence on the relationship between jumps and falls and contemporaneous job events (promotions, quits, and terminations), as well as the worker's history of jumps and falls. Workers

agreement quit and get promoted less often; the effect on terminations, though negative, is not statistically significant. Taken in conjunction with the earlier results indicating that unions constrain wage jumps and wage falls, these findings suggest that unions also constrain promotions and quits. What appears to be most constrained is union workers' overall wage variability, as we shall see in Table 7.

The patterns displayed by better educated workers are broadly consistent with expectations. Workers with high school and college educations are more likely to receive promotions than their grade school-educated counterparts. The frequency of terminations does not vary significantly for any of the educational groups.

Table 7. Regression Results for Log of Coefficient of Variation of the Real Wage Rate

	Coefficient (Standard Error)		
	Baseline Equation	*Baseline Equation with Jump/Fall Variables*	*Baseline Equation with Jump/Fall Variables and Contest Tools*
Constant	–2.014[a]	–2.565[a]	–2.708[a]
	(0.112)	(0.085)	(0.087)
Blaack	0.176[a]	0.66[b]	0.092[a]
	(0.046)	(0.034)	(0.034)
Female	–0.079	–0.070	–0.090
	(0.079)	(0.058)	(0.057)
Married	0.045	–0.029	–0.015
	(0.065)	(0.048)	(0.047)
High School	0.057	0.055	0.061
	(0.052)	(0.038)	(0.038)
College	0.146[b]	0.108[b]	0.087
	(0.083)	(0.061)	(0.060)
More than College	0.254[a]	0.170[b]	0.176[a]
	(0.101)	(0.074)	(0.073)
Long Job Tenure_{t-1}	–0.223[a]	–0.142[a]	–0.038
	(0.053)	(0.039)	(0.042)
Union Status	–0.220[a]	–0.118[a]	–0.099[a]
	(0.044)	(0.033)	(0.032)
Blue Collar	–0.173[a]	–0.057	–0.069[b]
	(0.050)	(0.037)	(0.036)
Agriculture, Mining, and Construction	0.044	0.038	0.024
	(0.095)	(0.070)	(0.068)
Manufacturing, Transportation, and Communication	–0.052	–0.011	–0.020
	(0.063)	(0.046)	(0.045)
Wholesale and Retail Trade	–0.051	0.007	–0.028
	(0.084)	(0.062)	(0.061)

College education significantly increases the likelihood of a quit leading to wage advancement but has no effect on the likelihood of a quit that leads to a wage decrease.

The tenure effect in Table 6 provides further evidence on the importance of labor market sorting and the resolution of uncertainty regarding the match. The powerful negative effect of tenure on promotions, terminations, and quits indicates that workers are much less likely to change jobs after their first two years of job experience.

The lagged jump and fall variables enable us to link discontinuous wage changes with discrete job movements. Consider first the case of a wage fall in the previous year. Workers who experienced a wage fall get branded as less productive. They are less likely to be promoted and more likely to quit their job, but exhibit no differential termination rate.[22] Wage falls may substitute for terminations as a labor market contest tool to address poor performance. For example, a quit induced by a wage fall may be less expensive to the firm than a termination, which brings with it severance and unemployment compensation costs.

The only significant effect of the lagged wage jump variable is a positive effect of "wages-down quits." Wage fall histories likewise lead to quits involving a wage decrease, but also generate quits involving a wage increase. One of the strongest results in Table 6 is that workers with substantial experience at a job are less likely to experience any of the job events. Presumably, uncertainty about the match gets resolved over time, leading to the expected empirical result.

Finally, it is noteworthy that real wages influence only one discrete job movement, "wages-up" quits. Workers with higher real wages are less likely to quit and secure a job that pays more, which is contrary to the common view that there is more mobility at the top than at the bottom of the wage spectrum. This effect also contrasts with theoretical results in the literature on quit behavior, which find that wages generally do not affect overall quit behavior.[23] Our estimates are the first we know of that take the logical step of distinguishing between quit behavior that leads to a wage increase and quit behavior that leads to a wage decrease. Not surprisingly, we find that individuals with high wages are much less likely to quit for higher wages.

V. JOB EVENTS, WAGE VARIATION, AND WAGE GROWTH

How important are wage jumps and falls in determining the variation and growth in workers' wages over time? How strong is their effect compared to that of demographic characteristics? If jumps and falls play a significant role, do they primarily accompany terminations, quits, and promotions? If so, changes in job, rather than within-job changes in wage, would be the principal factor explaining wage variability. Is it important, as is frequently alleged, to switch employers if one wishes to advance economically?

A. Wage Variation

To isolate the role of wage jumps and falls, we calculated the coefficient of wage variation for each worker over the 10 years of data. The dependent variable in the analysis is the log of the coefficient of wage variation for the particular worker in the sample. Equation (1) in Table 7 regresses this variable against the standard components of a wage equation. Experienced workers and unionized workers have lower wage variation; black workers have more.

The second column in Table 7 indicates the importance of jumps and falls in explaining wage variability. This equation adds variables indicating the number of jumps and number of falls experienced by the worker during the sample period. As we would expect, both variables have a strong positive effect on the variation in wages. The coefficients dwarf their standard errors. The most striking effect of introducing these variables is the fourfold increase in the explanatory power of the model, with more than 40 percent of the wage variation explained by the jump and fall variables. The addition of the numbers of terminations, quits, and promotions experienced by the worker in the third column of Table 7 adds only marginally to the explanatory power of the model (though the quit and fire variables are positive and statistically significant).[24] A wage jump has an effect nine times as great as a promotion and about three times as great as a fall, a quit, or a termination in determining the variation in future wages.

We also examine the influence of jumps and falls throughout the sample period on the worker's wage in the final year examined. To what extent are worker wages determined by the traditional human capital variables, the starting wage that a worker has in the firm, or by the worker's jump history? If human capital and the individual's entry level wage are the driving force, then there is less additional room for labor market incentive devices, such as contests and promotions. The regressions in Table 8 assess the determinants of the log wage rate in the last sample year. Equation 1 includes only the standard background variables. Equation 2 adds the worker's entry wage rate in the initial survey year examined, 1977. Equation 3 also includes the jump and fall history of variables for the worker, and equation 4 omits the entry wage level to obtain a better assessment of the incremental effect of entry level wages and wage jumps.

If jumps and falls were primarily due to measurement error, their effects should disappear over time. Another popular explanation for jumps and falls is that they are jerky corrections for a wage-setting process that has high inertia. For that model as well, jumps and falls should have little long-term impact. The results of Table 8 seem to indicate that jumps and falls are real and persistent phenomena, not spurious happenings or catch-up corrections.

We now compare the explanatory power of the different regressions. The basic personal characteristic and job characteristic variables set in equation 1 produces an $\bar{R}^2$ value of 0.39. This value can be increased to 0.50 through the addition of the jump and fall history variables, but the incremental increase from adding the entry

Table 8. The Determinants of the Logarithm of the Wage Rate in the Terminal Sample Year

	Coefficient (Standard Error)			
	1	*2*	*3*	*4*
Constant	2.129	1.451	1.284	2.170
	(0.062)	(0.060)	(0.047)	(0.058)
Black	–0.145	–0.054	–0.038	–0.140
	(0.028)	(0.023)	(0.017)	(0.025)
Female	–0.327	–0.134	–0.114	–0.349
	(0.047)	(0.039)	(0.029)	(0.043)
Married	–0.011	–0.036	–0.040	–0.003
	(0.039)	(0.031)	(0.023)	(0.036)
High School	0.210	0.122	0.076	0.196
	(0.031)	(0.025)	(0.019)	(0.028)
College	0.413	0.216	0.121	0.375
	(0.050)	(0.041)	(0.031)	(0.045)
More than College	0.438	0.187	0.083	0.398
	(0.060)	(0.050)	(0.037)	(0.055)
Long Job Tenure	0.056	0.043	0.024	0.029
	(0.032)	(0.026)	(0.019)	(0.029)
Union Status	0.126	0.039	0.035	0.126
	(0.026)	(0.022)	(0.016)	(0.024)
Blue Collar	–0.146	–0.090	–0.058	–0.146
	(0.030)	(0.024)	(0.018)	(0.027)
Manufacturing, Transportation, and Communication	0.065	0.025	0.033	0.074
	(0.032)	(0.026)	(0.019)	(0.029)
Wholesale, Retail Trade	–0.181	–0.125	–0.068	–0.138
	(0.047)	(0.038)	(0.028)	(0.043)
Services	–0.124	–0.088	–0.031	–0.096
	(0.039)	(0.032)	(0.023)	(0.036)
Real Wage 1977	—	0.001	0.001	—
		(0.000)	(0.000)	
$Jump_t$	—	—	0.166	0.157
			(0.023)	(0.035)
$Jump_{t-1}$	—	—	0.146	0.104
			(0.021)	(0.033)
$Jump_{t-2}$	—	—	0.103	0.110
			(0.022)	(0.034)
$Jump_{t-3}$	—	—	0.147	0.076
			(0.023)	(0.035)
$Jump_{t-4}$	—	—	0.147	0.102
			(0.022)	(0.034)
$Jump_{t-5}$	—	—	0.181	0.125
			(0.024)	(0.037)

(continued)

Table 8. Continued

	Coefficient (Standard Error)			
	1	*2*	*3*	*4*
$Jump_{t-6}$	—	—	0.160 (0.021)	0.087 (0.033)
$Jump_{t-7}$	—	—	0.140 (0.023)	0.006 (0.035)
$Jump_{t-8}$	—	—	0.160 (0.021)	0.014 (0.032)
$Fall_t$	—	—	–0.219 (0.022)	–0.224 (0.035)
$Fall_{t-1}$	—	—	–0.217 (0.026)	–0.206 (0.040)
$Fall_{t-2}$	—	—	–0.156 (0.026)	–0.096 (0.039)
$Fall_{t-3}$	—	—	–0.157 (0.026)	–0.110 (0.040)
$Fall_{t-4}$	—	—	–0.150 (0.027)	–0.129 (0.041)
$Fall_{t-5}$	—	—	–0.133 (0.023)	–0.066 (0.036)

level wage rate is even greater, as this $\overline{R}^2$ value is 0.61. However, even adding the entry level wage also leaves a role for the additional explanatory power of the jump and fall variables, which increased the $\overline{R}^2$ value to 0.79 in equation 3, compared to 0.61 for equation 2.

The patterns of statistical significance suggest that both entry wages and jump and fall variables are consequential. The real wage rate in the base year has a strong and statistically significant effect on the workers' terminal wage with a t value of 20.5 (equation 2). The final period wage variation is quite sensitive to the worker's jump and fall history as well. In equation 3 in Table 8, for example, every jump and fall variable meets the usual significance level with the expected sign. Discontinuous job events are a major contributor to the terminal wage variation observed for the workers in this sample—jumps and falls have a long-term effect that diminishes little, if at all, over time.

The magnitudes of the long-run wage effects implied by the results in Table 8 are substantial. The average long-run effect (based on an average of the coefficients over a nine-year period) is that jumps have a 15 percent long-run impact on wage after controlling for entry level wage (9 percent without control); for falls there is a −17 percent effect (−14 percent without control).

B. Wage Growth

The determinants of wage growth are the focus not only of the human capital literature,[25] but also of the more recent literature focusing on individual job histories. In particular, McCue (1992), Gibbs (1993), and Baker, Gibbs, and Holmstrom (1994) find a positive relationship between promotions and wage growth. Here we extend the focus to consider a broader range of discontinuous job events and their implications for wage growth within our national sample.

Table 9 reports estimates of a wage growth regression. The equation includes the four discontinuous job event variables. All four prove statistically significant and economically substantial. A promotion leads to a 4 percent wage increase, whereas a termination leads to a 9 percent decrease in wages. "Wages-up" quits are associated with a 16 percent wage increase, whereas "wages-down" quits are associated with a 21 percent wage decrease. The external labor market offers greater positive and negative wage growth effects than do internal promotions. Moreover, "wages-down" quits have over twice the adverse effect on wages as do terminations, suggesting that some of the former may be misreported terminations.

Table 9. Wage Growth Regression Results

	Coefficient (Standard Error)
Constant	0.080
	(0.017)
Black	–0.002
	(0.006)
Female	–0.002
	(0.010)
Married	–0.003
	(0.008)
High School	0.007
	(0.007)
College	–0.001
	(0.011)
More than College	–0.003
	(0.015)
High Job Tenure_{t-1}	–0.026
	(0.008)
Union Status	–0.002
	(0.006)
Blue Collar	–0.002
	(0.007)
Agriculture, Mining, and Construction	–0.011
	(0.015)
Manufacturing, Transportation, and Communication	–0.007
	(0.008)

(continued)

Table 9. Continued

	Coefficient (Standard Error)
Wholesale and Retail Trade	–0.012
	(0.010)
Services	–0.001
	(0.009)
Year 1979	–0.014
	(0.011)
Year 1980	–0.011
	(0.011)
Year 1981	–0.046
	(0.011)
Year 1982	–0.020
	(0.012)
Year 1983	–0.015
	(0.012)
Year 1984	–0.029
	(0.012)
Year 1985	–0.022
	(0.012)
Year 1986	–0.042
	(0.012)
Promotion	0.067
	(0.016)
Quit—Wages Up	0.205
	(0.018)
Quit—Wages Down	–0.238
	(0.020)
Termination	–0.095
	(0.026)
$\bar{R}^2$	0.052

Job event variables are the driving forces influencing wage growth. The only other variable of substantial import is the long tenure variable. Workers with long job tenure experience 3 percent less wage growth than those who are newer to their positions. This effect is consistent with our earlier results; it suggests that uncertainty with respect to ability resolves itself, with more able people getting rewarded as they are discovered. The net result is wage growth that moderates over time.

VI. CONCLUSION

Earnings discontinuities—jumps and falls—have attracted economists' attention because of the salience of these phenomena in various theories of structures and

rewards in labor markets. Here we demonstrated the practical importance of these events, and examined their determinants.

Over a 10-year period, at least three-fifths of total wage increases each year went to individuals in the top quartile of those receiving increases. Jumps and falls are not temporary corrective events. A wage jump in any given year leads to a permanently higher wage on the order of 15 percent after correcting for entry wage; a wage fall leads to a continuing 17 percent reduction.[26]

Jumps and falls appear to perform two distinct roles: they sort workers with substantial unobserved heterogeneity and they offer substantial prizes as incentive mechanisms. Both processes presumably help to retain capable workers. The internal wage structures of firms consequently are not institutional artifacts; they play important economic functions.

The evidence presented here is consistent with a world where there is considerable unobserved heterogeneity among various classes of workers—well-educated workers, blacks, and non-unionized workers, for example. This heterogeneity gets sorted out over time, resulting in significant changes in wages, and in the three key job events: promotions, quits, and terminations. As expected, as tenure at the firm lengthens, jumps and falls occur less frequently.

The evidence on wage jumps supports the important labor market role of contests and tournaments both within and when leaving a firm. In an era when productivity growth and its partner, good jobs at good wages, are significant policy concerns, it is important to determine which paths lead to high wages. Our most important finding is that wage jumps and falls play an exceedingly significant role, both economically and statistically, in enabling individuals to raise their earnings.

APPENDIX

Wage Discontinuities versus Other Determinants of Earnings

This appendix examines three different equations to assess the determinants of earnings. For each equation the dependent variable is the natural logarithm of the real hourly wage (1982 prices). The first is a standard baseline wage equation; it includes a series of demographic and job characteristics. The second equation adds measures of the worker's history of jumps and falls in earlier periods. The third equation provides a fixed-effects model, adding a dummy variable for each worker, thus controlling time-invariant unobservable worker heterogeneity.[27]

We index individuals by i and periods by t, and employ w as the wage, x as a set of demographic characteristics, α as a constant term, and α_i as a worker-specific constant term. The variables *JUMP* and *FALL* indicate whether a worker received a qualifying wage change in the indicated period. The three equations are:

$$\ln w_{it} = \alpha + \sum_{k=1}^{K} \beta_k x_{kit} + \varepsilon_{it}, \tag{A1}$$

$$\ln w_{it} = \alpha + \sum_{k=1}^{K} \beta_k x_{kit} + \sum_{j=1}^{4} \alpha_j JUMP_{i,t-j} + \sum_{j=1}^{4} \gamma_j FALL \tag{A2}$$

and

$$\ln w_{it} = \alpha_i + \sum_{k=1}^{K} \beta_k x_{kit} + \sum_{j=1}^{4} \alpha_j JUMP_{i,t-j} + \sum_{j=1}^{4} \gamma_j FALL \tag{A3}$$

Equation (A1) is a conventional wage equation. Equation (A2) adds four lags of the jump or fall dummy variable. Equation (A3) includes worker-specific fixed-effects as represented by α_i, so that time-invariant characteristics of the worker, such as ability, and the worker's job are excluded. Since we require four years of data for our lags in equations (A2) and (A3), we conduct our analyses with wages in years 1982–1987.[28]

Results for these equations are reported in Table A1. The effect of demographic and job characteristics are consistent with the extensive literature on the determinants of earnings. Black and female workers earn less, and better educated workers more. Long tenure in a job is also correlated with higher pay in the fixed-effects regression. Unions raise wages[29]; blue-collar workers receive less.

There is a significant positive relationship between wages and a jump in year $t-1$, and a negative relationship between wages and falls in $t-1$, as is seen in the estimate of equations (A2) and (A3). This is not surprising: a large increase leads to a large terminal value. Of greater interest is the relationship between jumps and falls in prior periods and current wages. If these wage jumps and falls were not permanent but, for example, were offset by counterbalancing wage declines, or if they reflected errors of measurement, then one would expect no significant relationship other than for the one-period lagged jump or fall variable. Moreover, one would expect a real wage decline immediately following a jump. The results for equation (A2) in Table A1 do not reveal such a pattern: the jump variable is positively related to higher subsequent wage levels, while wage falls are associated with significantly lower subsequent wages. Indeed, the coefficients for the lagged jump and fall values for two- and three-year lags are quite similar to those for the one-year lagged value.

A wage jump in any of the past four periods yields an average increase of the current wage of \$0.55 per hour. (This can be calibrated relative to the average size of the jump, which is about \$2.00 per hour.) A wage fall has almost twice the effect of a jump, leading to a loss of \$0.94 per hour on the current wage. This is a bit below the wage differential between black and white workers, and about 50 percent less than the wage premium enjoyed by union workers (\$1.45 per hour).

Table A1. Ln(Wage) Equation Regression Results

	Coefficient (Standard Error)		
Independent Variable	*Baseline Wage*	*Wage Equation With Jump/Fall Variables*	*Fixed-Effects Wage Equation*
Constant	2.213[a]	2.218[a]	2.157[a]
	(0.028)	(0.028)	(0.013)
Black (d.v.)	–0.130[a]	–0.126[a]	—
	(0.011)	(0.010)	—
Female (d.v.)	–0.348[a]	–0.348[a]	—
	(0.021)	(0.020)	—
Married (d.v.)	0.010	0.015	0.008
	(0.016)	(0.016)	(0.013)
High School (d.v.)	0.199[a]	0.193[a]	—
	(0.011)	(0.011)	—
College (d.v.)	0.390[a]	0.373	—
	(0.018)	(0.018)	—
More than College (d.v.)	0.414[a]	0.406[a]	—
	(0.029)	(0.028)	—
Long Job Tenure	0.005	0.003	0.021[a]
	(0.012)	(0.012)	(0.006)
Union Status (d.v.)	0.154[a]	0.155[a]	0.050[a]
	(0.009)	(0.009)	(0.010)
Blue Collar (d.v.)	–0.160[a]	–0.159[a]	–0.030[a]
	(0.011)	(0.011)	(0.009)
Agriculture, Mining, Construction (d.v.)	–0.121[a]	–0.110[a]	—
	(0.025)	(0.025)	—
Manufacturing, Transportation, Communication (d.v.)	0.002	0.002	—
	(0.013)	(0.013)	—
Wholesale or Retail Trade (d.v.)	–0.210[a]	–0.205[a]	—
	(0.020)	(0.019)	—
Services (d.v.)	–0.169[a]	–0.164[a]	—
	(0.016)	(0.015)	—
Year 1981	–0.072[a]	–0.073[a]	—
	(0.016)	(0.027)	—
Year 1982	–0.051[a]	–0.044[a]	—
	(0.016)	(0.016)	—
Year 1983	–0.022	–0.016	—
	(0.016)	(0.016)	—

(*continued*)

4. Ehrenberg (1990) explores incentive mechanisms in golf tournaments. More generally, see Lazear and Rosen (1981), Green and Stokey (1983), Nalebuff and Stiglitz (1983), O'Keeffe, Viscusi, and Zeckhauser (1984), and Rosen (1981, 1982). McLaughlin (1988) surveys this literature.

5. Organizational structure influences the possible structure of contests through the number of promotion prizes that can be awarded. For further discussion of organizational issues, see Rosen (1972, 1982), Doeringer and Piore (1972), and Brown, Hamilton, and Medoff (1990). Gibbs (1993) analyzes the effect of promotions on the wages of middle managers.

6. Rosen (1986) analyzes the superstar phenomenon. Frank and Cook (1995) consider a wide range of instances, what they label winner-take-all markets. A situation where winners get a wage jump, and losers retain their wage or receive some decrease are consistent with a tournament formulation. The prize is a big increase, perhaps accompanied by promotion.

7. Hence, extending the period of study would have reduced the sample size. The Survey of Economic Opportunity portion of the PSID is not included in the sample so that low income workers will not be over represented.

8. Similar results were obtained using a larger set of workers for whom yearly observations were available over a shorter period, such as 1,552 workers tracked over the 1982–1987 period.

9. The GDP deflator inflation rates, in percentage terms, were: 8.6 (1979), 9.2 (1980), 9.4 (1981), 6.2 (1982), 4.1 (1983), 4.4 (1984), 3.7 (1985), and 2.6 (1986).

10. It would be instructive to explore these issues using case study or firm-specific data such as that examined by Baker, Gibbs, and Holmstrom (1994).

11. An interesting comparison considers the link between wage increases and promotions. In a study of promotion behavior, also using the Panel Study of Income Dynamics, McCue (1992) found that 20 percent of white males' wage growth was due to promotions.

12. We explored a variety of percentile cutoffs for defining wage jumps and falls. The results were not sensitive to the particular cutoff used. We selected the 75th percentile and the 90th percentile because of their salience, the desire to have a cutoff above the median, and the need not to make the cutoff too high lest few workers would meet the test.

13. Chi-square tests for jumps and falls give values of 30.7 and 57.7, which for four degrees of freedom reject the null hypothesis beyond the 99.5% point of 14.86.

14. The data on extreme wage changes showed a continuous distribution up to $20 for both jumps and falls, but only scattered and very large observations beyond that value. A small number of workers report their hourly wage as "99.99 or more," rendering it impossible to impute wage changes for these workers. Missing data on the reported or computed hourly wage also resulted in the deletion of some observations.

15. Analyses of jump and fall equations in which the percent real wage increase must exceed that of 90 percent of the wage gainers in the sample, and results for which the percent real wage decrease is in the bottom 10 percent of all real wage decreases yielded results similar in character, but since these events were less frequent, the estimates were less precise.

16. An alternative explanation, drawing on the human capital model, would posit that human capital grows the most early in one's career. Moreover, if workers pay for training, as most human capital enthusiasts believe, the gains in early years would be particularly great.

17. The role of unions in providing job security and higher wages is well-known. See Freeman and Medoff (1984).

18. See Freeman and Medoff (1984) for an elaboration of this view.

19. See McCue (1992) for a detailed analysis of the effects of promotions on wage growth. Bartel and Borjas (1981) discuss a related phenomenon, the effect of turnover. See also Gibbs (1993), as well as Baker, Gibbs, and Holmstrom (1994a,b), who analyzed changes in jobs and wages within firms.

20. The terminated worker will have a better story to tell if his firm (or his industry, should the firm be difficult to monitor) has incurred a substantial downturn, suggesting a general rather than a specific phenomenon.

21. Although our analysis does not distinguish between layoffs and fires, an in-depth analysis of the PSID indicates that these terminations consist overwhelmingly of layoffs. For a review of the various PSID data quality issues, see Brown, Duncan, and Stafford (1996), Duncan and Hill (1989), and Mathiowetz and Duncan (1988).

22. We leave aside whether firms use wage falls to signal to workers that they should leave, that is, to push them out.

23. See Viscusi (1979) for empirical evidence on such independence, and Mortensen (1978, 1986) for a theoretical rationale.

24. Reversing the order in which these variables entered the wage equation did not substantially affect their relative contribution to $\bar{R}^2$.

25. The human capital literature is quite substantial; three contributions particularly concerned with the growth of earnings are Becker (1964), Rosen (1972), and Lazear (1976).

26. These estimates are based on column 3 of Table 7.

27. Only four lags of the jump and fall variables are included in order to conserve data. The results are not sensitive to this restriction. Since the lagged jump and fall variables are functions of the lagged wage, the fixed effect estimates will suffer from the bias described by Nickell (1981). This bias is of order $1/T$ so that, with $T = 9$, we expect it to be negligible.

28. In results not shown, we recalculated the results for the second and third specification using eight years of jumps and falls. The size of the coefficients on jumps and falls did not change significantly.

29. Over half of the union differential appears to be due to worker-specific differences based on the estimates of equation (3).

REFERENCES

Altonji, J. G. (1982). Intertemporal substitution in labor supply: Evidence from micro data. *Review of Economic Studies*, *49*(5), 783–824.

Baker, G., Gibbs, M., & Holmstrom, B. (1994a). The internal economics of the firm: Evidence from personnel data. *Quarterly Journal of Economics*, *109* (4) (November), 881–919.

Baker, G., Gibbs, M., & Holmstrom, B. (1994b). The wage policy of a firm. *Quarterly Journal of Economics*, *109*(4) (November), 921–955.

Bartel, A., & Borjas, G. (1981). Wage growth and job turnover: An empirical analysis. In S. Rosen (Ed.), *Studies in labor markets* (pp. 65–90). Chicago: University of Chicago Press.

Becker, G. (1964). *Human capital*. New York: National Bureau of Economic Research.

Brown, C. (1992). Wage levels and method of pay. *Rand Journal of Economics*, *23*(3) (Autumn), 366–375.

Brown, C., Duncan, G. J., & Stafford, F. P. (1996). The panel study of income dynamics. *Journal of Economic Perspectives*, *10*(2) (Spring), 155–168.

Brown, C., Hamilton, H., & Medoff, J. (1990). *Employers large and small*. Cambridge: Harvard University Press.

Card, D., & Hyslop, D. (1996). Does inflation "grease the wheels of the labor market"? *NBER Working Paper*, *5538* (April).

Carmichael, L. (1983). Firm-specific human capital and promotion ladders. *Bell Journal of Economics*, *14*, 251–258.

Chamberlain, G. (1984). Panel data. In Z. Griliches & M. Intriligator (Eds.), *Handbook of econometrics* (Vol. 2, pp. 1242–1318). Amsterdam: North-Holland.

Doeringer, P., & Piore, M. (1972). *Internal labor markets and manpower analysis*. Lexington, MA: DC Heath.

Duncan, G., & Hill, D. H. (1989). Assessing the quality of household panel data: The case of the panel study of income dynamics. *Journal of Business and Economic Statistics*, *7*(4) (October), 441–452.

Ehrenberg, R. (1990). The incentive effects of tournaments revisited: Evidence from the European PGA tour. *Industrial and Labor Relations Review, 43*(3), S74–S88.

Frank, R., & Cook, P. (1995).*The winner take all society.* New York: Free Press.

Freeman, R., & Katz, L. F. (Eds.) (1995). *Differences and changes in wage structures.* Chicago: University of Chicago Press.

Freeman, R., & Medoff, J. (1984). *What do unions do?* New York: Basic Books.

Gibbons, R. (1991). Layoffs and lemons. *Journal of Labor Economics, 9*(4), 351–380.

Gibbs, M. (1995). Incentive compensation in a corporate hierarchy. *Journal of Accounting and Economics, 19*(2–3)(April), 247–277.

Gottschalk, P., & Moffitt, R. (1994). The growth of earnings instability in the U.S. labor market. *Brookings Papers on Economic Activity*, No. 2, 217–272.

Green, J. R., & Stokey, N. L. (1983). A comparison of tournaments and contracts. *Journal of Political Economy, 91*(3), 349–364.

Jovanovic, B. (1979). Job matching and the theory of turnover. *Journal of Political Economy, 87*, 972–990.

Lazear, E., & Rosen, S. (1981). Rank-order tournaments as optimum labor contracts. *Journal of Political Economy, 89*, 841–864.

Mathiowetz, N. A., & Duncan, G. J. (1988). Out of work, out of mind: Response errors in retrospective reports of unemployment. *Journal of Business and Economic Statistics, 6*(2) (April), 221–229.

McCue, K. (1992). *Promotions and wage growth.* Working Paper, Texas A&M University.

McLaughlin, K. J. (1988). Aspects of tournament models: A survey. In R. Ehrenberg (Ed.), *Research in labor economics.* Greenwich, CT: JAI Press.

McLaughlin, K. J. (1994). Rigid wages? *Journal of Monetary Economics, 34*, 383–414.

Medoff, J., & Abraham, K. (1980). Experience, performance, and earnings. *Quarterly Journal of Economics, 95*(4), 703–736.

Mortensen, D. T. (1978). Specific capital and labor turnover. *Bell Journal of Economics, 9*(2), 572–586.

Mortensen, D. T. (1982). Property rights and efficiency in mating, racing, and related games. *American Economic Review, 72*(5), 968–979.

Mortensen, D. T. (1986). Job search and labor market analysis. In O. Ashenfelter & R. Layard (Eds.), *Handbook of labor economics.* Amsterdam: North-Holland.

Nalebuff, B., & Stiglitz, J. E. (1983). Prizes and incentives: Towards a general theory of compensation and competition. *Bell Journal of Economics, 14*(1), 21–43.

O'Keeffe, M., Viscusi, W. K., & Zeckhauser, R. J. (1984). Economic contests: Comparative reward schemes. *Journal of Labor Economics, 2*(1), 27–56.

Rosen, S. (1972). Learning and experience in the labor market. *Journal of Human Resources, 7*(3), 326–342.

Rosen, S. (1981). The economics of superstars. *American Economic Review, 71*(5), 845–858.

Rosen, S. (1982). Authority, control, and the distribution of earnings. *Bell Journal of Economics, 13*, 311–323.

Rosen, S. (1986). Prizes and incentives in elimination tournaments. *American Economic Review, 76*(4), 701–715.

Salop, J., & Salop, S. (1976). Self-selection and turnover in the labor market. *Quarterly Journal of Economics, 90*, 619–628.

Viscusi, W. K. (1979). *Employment hazards: An investigation of market performance.* Cambridge: Harvard University Press.

Viscusi, W. K. (1980a). Sex differences in worker quitting. *Review of Economics and Statistics, 62*(3), 388–398.

Viscusi, W. K. (1980b). Self-selection, learning-induced quits, and the optimal wage structure. *International Economic Review, 21*(3), 529–546.