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ABSTRACT

We study strike durations and outcomes for some 2000 disputes that occurred between 1881 and 1886. Most post-strike bargaining settlements in the 1880s fell into one of two categories: either a union "victory", characterized by a significant wage gain or hours cut, or a union "defeat", characterized by the resumption of work at the previous terms of employment. We find a strong negative relation between strike duration and the value of the settlement to workers, reflecting the declining probability of a union victory among longer strikes. For the subset of strikes over wage increases we estimate a structural model that includes equations for the capitulation times of the two parties and a specification of the wage increase conditional on a union victory. This framework provides a simple index of employees' relative bargaining power, based on the relative time to a union capitulation. Employees' relative bargaining power was higher in disputes involving fewer workers and in union-ordered strikes, but substantially lower after the Haymarket Square incident in Chicago in 1886.

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Bargaining Power, Strike Duration and Wage Outcomes: An Analysis Of Strikes in the 1880s

Definitions of union bargaining power usually center on the ability of a union to achieve higher wages, improved benefits, or better working conditions.[1] In an industrial relations system built around firm-level bargaining and business unionism, the fundamental source of this power is the ability to withhold labor services and impose a costly strike on an employer. The legal framework established in the 1930s by the National Labor Relations Act narrowly circumscribes the activities of a union to raise the costs of a strike, and the activities of an employer to avoid these costs. While such restrictions may be socially desirable, they greatly limit the range of observable strike outcomes, making it difficult to identify the bargaining power of a union and measure the effect of this power on negotiated outcomes.

In the labor market of the 1880s there were many fewer constraints on the actions of strikers or employers. Secondary boycotts, sympathy strikes and the use of strike replacements were all commonplace. This environment routinely produced a full range of strike outcomes, ranging from outright union victories to the permanent replacement of the workforce. Compromise settlements, which characterize most collective bargaining agreements today, were the exception rather than the rule.

This paper presents a detailed examination of the outcomes of over 2000 strikes from the period 1881-1886. We exploit the natural distinction between successful and unsuccessful strikes in the labor market of the 1880s to identify the determinants of union bargaining power and study the connection between the parties' abilities to withstand a strike, on the one hand, and the wage outcomes achieved by a successful strike, on the other.

Several features of this time period and the available data are important to

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[1] See for example, Kochan and Katz (1988, p. 54).

our study.[2] The years 1881-1886 correspond to the period of ascendancy of the Knights of Labor. For the first time in North America, unskilled workers from many industries joined the ranks of organized labor and participated in strikes. The wide range in skills and organizing histories of workers involved in strikes creates an ideal opportunity to study the sources of variation in strike outcomes. During the spring of 1886 a drive by radical and traditional labor organizations for an 8-hour working day lead to an unprecedented level of strike activity (see David (1936) and Avrich (1984)). Workers in many cities participated in a "nationwide" strike on May 1 1886. In Chicago, the demonstrations culminated in a violent confrontation between police and strikers at Haymarket Square. Public reaction to this incident bolstered a new wave of employer opposition to union organizing. Comparisons of strike outcomes before, during, and after the Haymarket incident allow us to assess the effects of global events and attitudes on individual-level bargaining outcomes.

Most important, however, is the quantity and quality of data on strikes in the 1880s. As a result of the widespread "labor problems" of 1885 and 1886, the Bureau of Labor, under commissioner Carroll Wright, undertook an unprecedented effort to enumerate every strike and lockout in the US between 1881 and 1886. The results of this inquiry, including detailed strike listings for over 5000 individual strikes, were published in the Third Annual Report of the Commissioner of Labor. These listings provide an extraordinarily rich portrait of strike activity in the period.

Our analysis reveals an important characteristic of disputes in the late 19th century. Post-strike wage settlements (and post-strike hours changes, in strikes over hours) were distinctly bimodal. The Bureau of Labor's classification of

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[2]Many comprehensive histories of the period are available, including Commons et al (1926) and Ware (1929).

strikes into union "successes" and "failures" reflected the nature of strike outcomes at the time. In strikes over a wage increase, for example, union "failures" almost always resulted in no change in wages. The vast majority of union "successes", on the other hand, achieved a significant wage gain. From this observation we derive and test a simple structural model of strike durations and outcomes, based on the abilities of employers and employees to endure a strike. We apply this model to the subset of strikes initiated over demands for a wage increase. We specify equations for the capitulation times of the firm and the workers, and estimate the effects of various observable variables in raising or lowering these times. We then add a specification for the wage settlement in the event of a union victory. Our findings point to a strong link between wage increases in the event of a union victory and the relative bargaining powers of the parties (as measured by their expected capitulation times). Factors that shift worker's relative ability to withstand a strike also raise the wage settlement in the event of a successful strike.

II. Strikes in the 1880s: A Descriptive Overview

Information on strikes and lockouts for the period from January 1 1881 to December 31 1886 was assembled retrospectively by the Bureau of Labor in 1886 and 1887. Working from a list of disputes reported in newspapers and trade magazines, the Bureau assigned field agents to record the details of known disputes and to gather information on other strikes or lockouts during the period. According to the Commissioner, ..."the parties instigating a strike were consulted...and the agent, after considering all the evidence to be gained on either side, reported what the facts seemed to be." (p. 10).[3]

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[3]We have no direct evidence on how many field agents were employed by the Bureau, or in what fraction of cases the field agents managed to successfully interview the parties to a strike.

By modern standards, the data collection effort underlying the preparation of the Third Report was extraordinary.[4] Nevertheless, a recent study of the accuracy of the strike listings suggests that the Bureau of Labor did not achieve a complete census of disputes. Bailey (1991) compares the strikes recorded by the Bureau of Labor with the set of disputes mentioned in local newspapers in Terre Haute Indiana between 1881 and 1894.[5] His results suggest that only about one half of disputes were actually recorded in the Third Report. This undercount poses no particular problem for our statistical analysis, provided that the Bureau enumerated a random sample of disputes. To the extent that uncounted strikes differ from the ones recorded by the Bureau, however, the available sample may present a biased picture of strike activity and outcomes in the 1880s.

The available information for each dispute includes the location and industry of the employer or employers, the number of employees affected by the dispute, the number of strikers directly involved, average wages and hours before and after the dispute, the cause of the dispute, and information on the use of strike replacements. Individual employer identities and the name of the union(s) involved in the dispute are unavailable, although an indicator is available for strikes that were ordered by a labor organization.[6]

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[4]An earlier study of strikes in 1880 was compiled as part of the 10th Census. The Tenth Report of the Commissioner of Labor reported similar information for strikes occurring between 1887 and 1894.

[5]Bailey assesses the combined accuracy of the Third Report and the later Tenth Report of the Commissioner of Labor, which reported strikes from 1887-1894.

[6]It is possible to identify many of the well-known strikes from this period: for example, the 1883 telegraphers' strike (Ware (1929, p. 129-130)) or the 1886 lockout of collar laundresses in Troy New York (Filipelli (1990, pp. 542-546)). Limited checking suggests that the facts of the identifiable strikes in the Third Report are compatible with information from other sources.

Information is also provided on the beginning date and length of each strike. As in modern data, the duration of a labor dispute in the 1880s is potentially ambiguous. The Bureau of Labor's procedures for defining the end of a dispute are not described in the Third Report. The procedures used in the Tenth Report of the Commissioner of Labor (also written under Wright's supervision) suggest that a strike was deemed to be over when the establishment was "open and operating as usual" (Tenth Report p. 15), either with the former striking employees or with strike replacements.

A second (and related) issue is the reporting of multi-establishment disputes. The general principle underlying the Third Report was to treat the establishment as the unit of analysis, and to aggregate only those multi-establishment strikes that ended at the same time with a similar resolution. As a result of this convention there are many examples of related disputes that differ only in their duration.[7]

One measure of the degree of interdependence of the listings in the Third Report can be obtained by comparing the strike totals presented in the Twenty-First Annual Report of the Commissioner of Labor. By the early 1890s the Bureau had moved to a broader definition of a strike: strikes that started at (roughly) the same time over similar issues were treated as a single dispute.[8] To obtain comparable data for the 1881-1886 period the Bureau re-analyzed the earlier strike reports. Whereas the Third Report lists 5809 strikes and lockouts from 1881-1886, the Twenty-First Report enumerates only 4211 independent disputes. These figures imply a 30 percent overcount in the Third

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[7]For example, the Third Report lists 16 strikes of bakers in Albany New York that all began on May 2 1885 (one involved 6 establishments, one involved 5 establishments, a third involved 2 establishments, and the remainder were single-establishment strikes). The strikes varied in length from 1 to 275 days in duration.

[8]See Griffin (1939, pp. 22-27).

Report. The interdependence of many of the strikes in our data set should be kept in mind in interpreting our empirical results.

From the available data in the Third Report we have elected to analyze strikes from Illinois, New York, and Massachusetts. These 3 states accounted for 41 percent of all disputes (strikes and lockouts) in the US in the early 1880s. During this time period lockouts represented only 6 percent of total disputes, and for convenience we have excluded them from our analysis.[9]

The Third Report lists 2256 individual strikes in Illinois, Massachusetts and New York between 1881 and 1886. Initial analysis of the data suggested a series of typographic errors affecting 77 strikes in Illinois. Exclusion of these strikes generates a usable sample of 2179 observations.[10] Table 1 presents some simple descriptive statistics for the sample, including breakdowns by state and year. Just over one-half of the strikes occurred in New York state, while 30 percent occurred in Illinois and 15 percent in Massachusetts. The annual number of strikes is fairly stable from 1881-1885 and then shows a dramatic increase in 1886. Much of this increase grew out of the "8 hour day" campaign launched in the Spring of 1886 by the Federation of Trades and Labor Unions. Figure 1 plots the number of strikes in each month of the sample period. The number of strikes in March and April of 1886 was over twice the average for these months in the previous years. In May 1886 there were as many strikes as in all of 1881 and 1882 combined.

Rows 2-6 of Table 1 show the average number of workers involved per strike, the average fraction of workers at each establishment involved in the

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[9]A cursory examination suggests that lockouts were longer than strikes (mean duration 38 days versus 20 days) and were less likely to be sanctioned by a labor union (51 percent versus 77 percent), but were equally likely to result in a union "success" (49 percent versus 47 percent).

[10]These strikes all involved laborers and wharf hands in the Chicago shipping industry. A list of excluded strikes is available on request.

strike, the average daily pre-strike wage of strikers, and the percent of strikes that are recorded as having been ordered by a labor organization (for simplicity we refer to these as "authorized" strikes). The mean size of strikes is relatively large (245 workers), reflecting the presence of a few very large disputes. The median strike is much smaller (50 workers). For this reason, we also report the mean logarithm of strike size and use the transformed variable in our statistical analysis below. On average, 80 percent of employees at affected establishments participated in the strike.

The average wage of strikers in the 1880s was approximately $2.00 per day, although the wage ranges from under $0.75 to over $4.00 per day. These rates are comparable to other data for the period. For example, Long's (1960) tabulations of manufacturing wages for 1880 show average daily wage rates of $2.20 - $2.45 for skilled occupations and $1.32 for laborers. There is some variation across years, particularly in 1884. The upward drift in average wages over the sample period is consistent with overall wage trends during the 1880s. Lebergott's wage index (Historical Statistics of the United States, Table D-735) shows a 10 percent rise in nominal wages from 1881 to 1886.

On average three-quarters of the strikes were ordered by a union. The fraction of authorized strikes is higher in New York state, lower in Massachusetts, and shows an upward trend from 1881-1886, paralleling the steady growth of labor organizations during the early 1880s (Wolman (1936)).

Rows 7-9 of the Table report the fractions of strikes attributable to 3 major causes: workers' demands for a wage increase, employers' demands for a wage cut, and workers' demands for a reduction in hours. Together these issues accounted for 77 percent of all strikes. The remainder are attributable to such considerations as changes in work rules, protests over employee discharges, and sympathy strikes. The importance of the 8-hour day campaign in 1886 is illustrated by the unusually high fraction of hours-related strikes in that year. Relative to earlier years, at least 300 extra hours-related strikes were reported in 1886.

Information on the duration of strikes is presented in rows 10 and 11. The distribution of strike lengths is right-skewed, implying a mean duration considerably in excess of the median duration. The most frequent duration is 1 day (12 percent of all strikes). Comparisons of mean and median durations suggest that strikes were relatively longer in Massachusetts than the other two states, and longer in 1885 than in the other years.

Finally, the last five rows of Table 1 present information on strike outcomes. The authors of the Third Report (and later Bureau of Labor reports) coded strikes as union successes, failures, or partial successes. Close to one-half of all strikes were successful, while 40 percent were failures. Perhaps surprisingly, only a small fraction of strikes were coded as partially successful. Although the classification of strikes outcomes may seem artificial from a modern perspective, earlier observers made extensive use of the classification (see for example Moore (1911, chapter 5)). As we show below, examination of the wage and hours changes associated with the different outcomes suggests that the distinction is relatively clear-cut.

Another measure of strike success is the extent to which new employees were recruited to replace the strikers. In 40 percent of strikes at least some replacements were on hand at the end of the dispute, and in 7 percent of strikes all the strikers were replaced (or the employer closed down).[11] In most cases where strike-breakers were used, however, they accounted for only a small fraction of post-strike employment.

Information on the industry distribution of strikes and the characteristics of strikes in different industries is presented in Table 2. Most strikes in our data

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[11] Unfortunately, we have no information on the timing of the decision to employ strike replacements.

set occurred in the manufacturing industries, although building trades and transportation also accounted for many disputes. In part, the industry composition in Table 2 reflects the states included in our sample: the apparel and textile industries were highly concentrated in New York state in the 1880s, while the boot and shoe industry was concentrated in Massachusetts.[12] Comparisons of average size, average wages, and the causes and outcomes of strikes reveal many differences across industries. For example, strikes in the building trades typically involved relatively high-wage workers, were usually authorized by a labor organization, were relatively short, and enjoyed an above-average success rate. Strikes in the textile industry, on the other hand, often involved relatively low-wage workers (over 60 percent female), were typically unauthorized, were relatively long, and had relatively low success rates.

The last three rows of Table 2 show the varying importance of the events in Spring 1886 across different industries. For two industries (machines and wood products) one-half of all strikes in our data set occurred in the first week of May 1886. In some other industries (for example, building trades and food) there were relatively few strikes in 1886 prior to the Haymarket incident but a relatively high number afterward.

Table 3 provides descriptive information on strikes by the cause of the dispute. The largest single category of strikes are those over wage increases. The characteristics of these strikes are generally similar to the overall sample, although far fewer wage-related strikes occurred in the period from May 1 to May 7 1886. Strikes against wage cuts tend to be longer than wage increase strikes, but about equally as likely to result in a union success. Strikes over

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[12]See chapter 12 of U.S. Department of Commerce and Labor Manufactures 1905 (Part 1). In 1890 Massachusetts accounted for 53 percent of the output of the boot and shoe industry, while New York State accounted for 45 percent of the output of clothing industries.

hours were heavily concentrated in the second quarter of 1886, and tended to be less successful (from the union's perspective) than other disputes.

Rows 11-13 show the average changes in wages and hours associated with different strikes. The wage change measure here is the difference between the post-strike and pre-strike wage rate of striking employees. The hours change measure is a similar difference in the hours of workers affected by the strike. For strikes over wage increases, the average wage change is relatively large and positive, while for strikes against wage cuts the average wage change is negative. For a significant fraction of strikes in either category, however, the wage was unchanged.

More insight into this pattern is provided by Figures 2a and 2b. Here we have plotted the distributions of wage changes for strikes in favor of wage increases and against wage cuts, respectively. The overall distributions are bimodal, reflecting a mixture of strikes that ended with no change in wages and strikes with mainly positive (in Figure 2a) or mainly negative (in Figure 2b) wage changes. Among the sample of strikes over wage increases, those with no wage change are almost exclusively union losses. Wage gains for the successful and compromise strikes tend to be strictly positive. Among the sample of strikes against wage cuts, those with no wage change are almost exclusively union successes, while the compromises and union losses have uniformly negative wage changes.

These plots suggest that a majority of strikes in the 1880s were resolved by a "winner-take-all" settlement. If the strike was successful, a strictly positive and often sizeable wage gain was achieved (in wage increase cases) or the wage rate was maintained (in wage cut cases). If the strike failed, no wage gain was achieved (in the wage increase cases) or a significant wage cut was enacted (in the wage cut cases). Among strikes initiated for wage increases, for example, the average wage change for a successful strike was 13 percent, while the average change for an unsuccessful strike was 0. A similar pattern is evident in the hours-related strikes. Among the failed strikes, virtually all the hours changes are 0. Among the successful strikes, the distribution of hours changes is centered around -8 hours.

Table 4 presents information on wage outcomes by strike duration for the three major categories of strike causes. All three types of strikes show a declining success rate with longer durations, accompanied by an increasing use of strike replacements. The entries in columns 5-7 of the table show the conditional probabilities of a strike settlement in each duration interval, and the division of the overall settlement rate into union successes and other outcomes (losses and compromises). Over the broad duration intervals in the table there is a uniformly decreasing conditional probability of strike settlements. A major factor in this decreasing hazard rate is the declining probability of a union victory: from 5-7 percent per day during the first 3 days of a strike to less than 1 percent per day after a month or more.

The average wage or hours change associated with strikes in each duration category is presented in the right-hand column of the table. The pattern of wage changes for the wage increase strikes reveals a negative association between strike duration and wage increases. A similar negative correlation between strike duration and the strike outcome (as viewed by workers) is also evident for strikes over wage cuts and hours cuts.

The relationship between wage changes and strike durations is illustrated in Figure 3 (for wage increase strikes only). This figure presents wage distributions similar to Figure 2a for each of the duration categories in Table 4. As in the pooled data, wage settlements following strikes of different lengths are bimodal. For longer strikes, the probability of a union failure is higher, resulting in a bigger spike at the 0 wage change ordinate. Perhaps surprisingly, however, the distribution of wage increases conditional on a positive increase is not much different for shorter or longer strikes.

This pattern raises the question of whether the negative correlation between strike durations and wage increases is solely attributable to the decline in the likelihood of a union success, or whether the average wage change conditional on a union success is also correlated with strike duration. A related question is whether the correlation of wage settlements and strike durations is affected by the characteristics of the strikes in different duration categories. Both questions are addressed by the multivariate regression models in Table 5.

Column 1 of this table presents the estimated coefficients from a linear regression of the average percentage wage settlement on 9 duration class indicators. A similar linear probability model for the incidence of a successful strike is presented in column 3. Both models are estimated on the subset of strikes over wage increases. Comparable models for strikes over wage cuts are presented in columns 6 and 8. Columns 2, 4, 7, and 9 present similar models that include other control variables, including 11 industry dummy variables (corresponding to the industries listed in Table 2), 5 year dummy variables, measures of the size of the strike and the fraction of workers involved in the walkout, and indicators for the location of the strike, whether it was authorized by a labor organization, and whether it occurred in the first week of May 1886 or after May 7, 1886.[13]

Comparisons of the estimated duration coefficients in columns 1 and 2 (and columns 6 and 7) suggest that <u>some</u> of the negative relation between wage increases and strike duration is attributable to a compositional effect. Nevertheless, there is still strong evidence of a negatively-sloped "resistance curve". Relative to 1-day strikes, wage increase strikes settled in the second month (29-60 days) have 4 percent lower wage changes. This decline is

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[13]For simplicity we refer to the strikes after the first week of May 1886 as "post-Haymarket" strikes.

considerably larger than the one estimated by McConnell (1989) for strikes in major U.S. labor contracts from 1970-81.

The linear probability models for the likelihood of a successful strike (in columns 3 and 8) also show a strong negative effect of strike duration. Again, the addition of other control variables dampens the duration effect. Even with a fairly rich set of controls, however, a strike of 1-2 months duration is estimated to have a 30 percentage point lower probability of success than a 1-day strike. Finally, columns 5 and 10 present models for the wage settlement conditional on a union success. Although several of the other covariates have significant effects, the duration coefficients in these models are small and jointly insignificant. Evidently, the effect of strike duration on observed wage increases works through the probability of a union victory, rather than through the wage settlement conditional on a successful strike.

The coefficients of the control variables reveal several interesting patterns. Increases in the size of a strike are associated with lower average wage increases. Comparisons of columns 4 and 5 suggest that this difference is associated with a reduction in the wage increase conditional on a union victory, rather than with any effect on the likelihood of a union success. On the other hand, an increase in the fraction of the firm's employees involved in the strike increases both the probability of success and the wage increase conditional on a success.

In the 1880s, union-authorized strikes ended with larger wage increases or smaller wage cuts than unauthorized strikes. Most of this effect is attributable to a strong positive correlation between union authorization and the probability of a successful strike. (See Moore (1911) and Friedman (1988) for earlier analyses of this correlation). Although part of this correlation may reflect the ability of unions to affect strike outcomes, another explanation is that unions were unwilling to sanction strikes with a low probability of success.[14] Janes (1916) and Ulman (1955) describe various mechanisms established by the fledgling national unions of the 1880s and 1890s to prevent local union leaders and/or members from engaging in strikes. A reasonable interpretation of these anti-strike policies is that workers tended to under-value the externality created by the continued existence of their union local. To union leaders, on the other hand, the risk of possible extinction of the union local may have been an important additional cost of a strike, leading them to discourage strikes.

Finally, the coefficients in rows 13 and 14 suggest that the probability of successful strikes was significantly affected by the events of May 1886. Relative to earlier disputes in the same year, strikes beginning during the first week of May 1886 had a 10 percent lower success rate, while those after May 7 had a 4.5 percent lower success rate. According to these estimates, employers' relative bargaining power was permanently strengthened by the public, judicial, and governmental reaction to the Haymarket incident.[15]

This descriptive evidence points to three tentative conclusions. First, the classification of strikes as successes or failures apparently reflected the nature of strike outcomes in the late 19th Century. Wage and hours settlements associated with successful and unsuccessful strikes show a complete bifurcation of outcomes. Second, close to one-half of strikes were successful. Although

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[14]Throughout the late 19th century union leaders had an ambivalent public attitude toward strikes. For example, in the 1886 Annual Report of the FOTLU (Federation of Organized Trades and Labor Unions) Gompers stated that .... "we do not, as a Federation, or as individuals, wish to be understood as advocates of strikes. On the contrary, it is well-known that the best regulated Trade Union has the least strikes" (FOTLU (1886), p.7).

[15]Avrich (1984, chapter 15) describes reactions to the Haymarket bombing in Chicago and elsewhere in the country.

the gains achieved by a successful strike were potentially short-lived[16], participation in a strike was by no means an exercise in futility. Third, as predicted by a variety of theoretical models (Ashenfelter and Johnson (1968); Hayes (1983); Sobel and Takahashi (1983)) longer strikes were associated with lower average wage increases or smaller hours reductions. Most of the duration effect is attributable to a decreasing likelihood of union success. Strike outcomes conditional on a union success were not highly correlated with strike duration.

III. A Structural Model of Strike Durations and Strike Outcomes

Building on this descriptive evidence, we turn to a simple structural model of strike durations and strike outcomes. The model is motivated by the distinction between successful and unsuccessful strike outcomes in the 1880s. For simplicity, we restrict our attention to strikes over wage increases. These strikes accounted for one-half of all disputes in the 1881-86 period and are broadly representative of other strikes in terms of durations and the likelihood of a union success. They also have the advantage that the strike outcomes are easily quantified.

The building blocks of our model are equations for the maximum strike durations that the employer and the workers can withstand.[17] In light of the possibility of a partially successful strike, we also specify a time until the parties agree to a compromise. We assume that a strike ends when one of the

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[16]For example, David (1936, pp. 139-140) notes that the hours reductions won by successful 8-hour day strikes in the spring of 1886 were largely reversed by the end of the year.

[17]We do not mean to imply that either parties' maximum strike duration is fixed ex ante. For example, employers may observe the level of support for the strike in the first few days of picketing and then decide whether to hold out or capitulate.

maximum durations is exceeded. For example, if the maximum duration of the workers is smaller than either the time to a compromise or the maximum duration of the firm, then the strike ends as a failure (or the union capitulates). Likewise, a successful strike is concluded when the employer's maximum duration is less than either the time to a compromise or the workers' maximum duration. Finally, a compromise is reached when the time to a compromise is shorter than either of the maximum durations of the employer or the workers.

Formally, we specify three equations for the latent random variables D_u, D_f, and D_c, representing the maximum strike durations until the union capitulates, the firm capitulates, or a compromise is reached:

$$(1)\ D_u = X\beta_u + \epsilon_u$$

$$(2)\ D_f = X\beta_f + \epsilon_f$$

$$(3)\ D_c = X\beta_c + \epsilon_c$$

Here, X is a vector of observed attributes (industry and year effects, for example) and $(\epsilon_u, \epsilon_f, \epsilon_u)$ is a triplet of random error terms. Observed strike duration is:

$$(4)\ D = \min[D_u, D_f, D_c].$$

Equations (1)-(4) specify a competing risks model with 3 (possibly correlated) risks.[18]

In this framework each party's bargaining power is summarized by its relative ability to withstand a strike. Factors that increase D_u relative to D_f increase the relative bargaining power of workers, and increase the likelihood of a successful strike. Note that knowledge of which party won a particular strike is critical to identifying the determinants of the parties' bargaining power. A strike of duration D, for example, provides an observation on the firm's maximum duration D_f if the union won the strike, and an observation

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[18]See Kalbfleisch and Prentice (1980, chapter 7).

on the worker's maximum duration D_u if the firm won. If the identity of the "winner" were unknown (or if strikes always ended in a compromise) there would be no way to associate observed durations with D_u or D_f.

While the econometric model represented by equations (1)-(4) is a natural descriptive framework, it also corresponds more or less directly to the structure suggested by a war-of-attrition model.[19] In a war-of-attrition model, two parties with linear costs of delay fight over a fixed prize. A standard version of the model posits that each side knows its own delay cost, but is uncertain about its opponent's costs. A strike continues as long as each party is sufficiently optimistic that it has the lower cost. Eventually, one side concedes, leading to a winner-take-all settlement. One difficulty with a pure war-of-attrition model is the presence of compromise settlements. In light of this complication, and the inherent difficulty in distinguishing alternative theoretical models with the available data, we prefer to interpret the competing risks model as a convenient statistical tool rather than as a parameterization of any particular model.

Given (1) - (4), the likelihood function for a random sample of strikes is:

$$(5)\ L = \prod_{FWIN=1} P(D = X_u\beta_u + \epsilon_u,\ D < X_f\beta_f + \epsilon_f,\ D < X_c\beta_c + \epsilon_c)$$

$$\prod_{UWIN=FWIN=0} P(D = X_c\beta_c + \epsilon_c,\ D < X_u\beta_u + \epsilon_u,\ D < X_f\beta_f + \epsilon_f)$$

$$\prod_{UWIN=1} P(D = X_f\beta_f + \epsilon_f,\ D < X_u\beta_u + \epsilon_u,\ D < X_c\beta_c + \epsilon_c)$$

[19]See Kennan and Wilson (1989, 1992), and Craig (1989) for an attempt to fit a war-of-attrition model to 1881 and 1891 strike data from New York state.

where UWIN = 1 if the firm capitulates, FWIN = 1 if the union capitulates, and P( ) is the appropriate probability statement. We begin by assuming that (ϵ_u, ϵ_f, ϵ_u) have a joint normal distribution, and that D_u, D_f, and D_c represent the logarithms of the respective latent durations. In the special case where ϵ_u, ϵ_f, and ϵ_u are independent, the likelihood function reduces to three independent Tobit equations, where the duration information for a particular failure time is censored if the strike ends with one of the other two possible outcomes. At the other extreme, if the three error terms are perfectly correlated and $\beta_u = \beta_f = \beta_c$, the model reduces to a simple regression of log duration on the measured X variables. Perfect colinearity and equality of the β's implies that the classification into union successes, partial successes, or failures is uninformative with respect to the determinants of strike duration.

The assumption that the latent determinants of strike duration are jointly normal yields a tractable model that allows for arbitrary correlations between the unobserved determinants of the firm's and the union's capitulation times. A model with correlated heterogeneity is especially attractive in light of the numerous unobservable characteristics of the bargaining pairs and the bargaining environment. Another advantage of the joint-normality assumption is that it allows us to extend the model to include the wage settlement in the event of a union success (see Section V below). On the negative side, a log-normal duration model imposes a strong functional form assumption on the hazard rate of strike settlements (see Kalbfleisch and Prentice (1980, pp. 24-25)). To check the sensitivity of our empirical findings to the log-normality assumption we present estimates from an uncorrelated competing risks model with semi-parametric baseline hazards in the next section.

The components of the X vector are the same control variables used in the regressions reported in Table 5. The model is also estimated with and without a dummy variable indicating the presence of strike replacements at the end of the strike. As noted earlier, replacements were used in about 40 percent of strikes in the 1880s. We hypothesize that the use of replacement workers allowed firms to operate during a strike, lowering the costs of a dispute and raising the firm's maximum strike duration. Strike replacements may have also been used as a threat to workers, with the goal of weakening workers' resolve and increasing the probability of a union capitulation. The problem with including this variable in equations (1)-(3) is that unless all the determinants of strike duration observed by the firm are included in X, the decision to hire replacements is likely to be endogenous with respect to the error terms (ϵ_u, ϵ_f, ϵ_u). For example, if a firm is more likely to hire replacements when it faces a stronger union, the estimated effect of replacements on the union's capitulation time is positively biased. A full investigation of the effect of strike replacements would require data on the timing of the decision to hire replacements, and some identifying information on which firms make this choice. Such an undertaking is beyond the scope of this paper and the available data. In the empirical results that follow, we report estimates both with and without the replacement variable, and allow the reader to evaluate both specifications.

a. Estimates of the Log-Normal Competing Risk Model

Tables 6 and 7 report OLS estimates of a linear regression model for the log of completed strike duration, and maximum likelihood (ML) estimates of the log-normal competing risks model described by equations (1)-(4). The models in Table 7 include the strike replacement dummy whereas the models in Table 6 exclude this variable. The linear regression models in the first column of each table describe the determinants of strike durations without regard to the ultimate success or failure of the strike. The next three columns present the coefficients of the same explanatory variables in equations for the log of the firm capitulation time, the log of the union capitulation time, and the log of the time to a compromise settlement.

If the distinction between strike outcomes is uninformative, then the estimated coefficients in all 4 columns of each table should be similar. Inspection of the tables suggests that this is not the case. For example, the estimates in column 1 of Table 6 show that union-authorized strikes were about 80 percent longer than unauthorized strikes. The coefficients in columns 2-4 show that most of this effect is attributable to the positive effect of union authorization on the expected times to a union capitulation or a compromise. By raising the times to a union capitulation or compromise, authorization increases average strike duration and increases the likelihood of a successful strike. This conclusion is confirmed by the linear probability models in Table 5, which show a 24 percent higher probability of a union success in authorized strikes.

Analogous differences emerge in the effects of the other covariates. For example, an increase in the fraction of the firm's employees involved in a strike lowers the time to a firm capitulation and raises the time to a union capitulation, implying a strong positive effect on the probability of a union victory but no significant effect on mean log strike duration. The industry dummies (not reported in the Table) also show different effects on the three latent duration variables. We defer a discussion of the industry patterns to Section V.

The coefficients in rows 5 and 6 of Tables 6 and 7 show the effects of events in May 1886.[20] Specifications with and without replacements show an increase in employer and employee capitulation times for strikes after May 1 1886, and a further increase for strikes beginning in the tumultuous first week of May. Relative to strikes earlier in the year, firm capitulation times

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[20]The normalization of the coefficients in this table is different than in Table 5. The coefficients in row 6 show the effect for strikes that began on or after May 1 1886, while the coefficients in row 5 give the additional effect of strikes initiated between May 1 and May 6 of that year.

in the post-Haymarket period were 40-45 percent longer, while union capitulation times were 20 percent longer. Firm and union capitulation times for strikes that began in the first week of May were even further elevated: an additional 45-50 percent for firm times and 20 percent for union times.[21] As in Table 5, these estimates suggest that the nationwide eight-hour day strikes and the Haymarket incident in Chicago toughened employer resistance to union wage demands, and that part of this effect persisted to the end of 1886.

To summarize the effects of the major explanatory variables in the 3-equation competing risks model, Table 8 contains predicted mean and median capitulation times for alternative values of the exogenous variables. The fifth column of the table also gives the implied probabilities of a successful strike. The upper panel of the table presents results based on the model without the replacement dummy variable, while the lower panel presents results from the model that includes this variable. Line (a) of the table shows the predicted mean and median capitulation times for an average union-authorized strike in New York State. The log-normality assumption implies that median capitulation times are shorter than the corresponding mean times: the mean and median union capitulation times for an average strike are 36 and 20 days, respectively. Line (b) reports the means and medians for an unauthorized strike. As noted, union authorization has a strong positive effect on the union capitulation time, and a 22 percentage point effect on the likelihood of union

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[21] It is possible that the estimated coefficients for strikes in the first week of May 1886 simply reflect a seasonal effect common to all six years. To check we estimated independent Tobit models for the firm and union capitulation times that included quarterly dummy variables, and other models that included a May dummy. While there is a slight seasonal effect on the firm's capitulation time in the years before 1886, controlling for this effect does not change the estimated effect associated with strikes in the first week of May 1886.

success. Line (c) shows the capitulation times for a strike involving more workers. An increase in the size of the dispute increases both firm and union capitulation times, leading to an increase in mean observed durations and a reduction in the probability of a union success. In contrast to strike size, a change in the fraction of workers involved in the strike has opposite effects on the capitulation times of the parties (see row (d)).

Lines (e) and (f) illustrate the dramatic differences between strikes in Chicago and the rest of Illinois. Judged by their expected capitulation times, employers and employees in Chicago were fairly similar to those in New York. In other parts of Illinois, however, employers were much tougher whereas unions were much weaker.

The estimated effects of replacement workers on strike durations and outcomes are reported in row 2 of Table 7. The replacements coefficient in the linear duration model (column 1) suggests that strikes were significantly longer when replacements were used. In the competing risks model this effect is decomposed into a positive impact on the firm's capitulation time (column 2), a small negative effect on the union capitulation time (column 3) and a positive effect on the time to a compromise (column 4). A comparison of rows (g) and (i) of Table 8 shows that the use of replacements in union-authorized strikes raised employers' median capitulation times by 14 days and lowered employees' median capitulation times by 4 days. Rows (h) and (j) show similar effects for unauthorized strikes.

The estimated correlations of the error terms in the three latent risks are presented in rows 12-14 of Tables 6 and 7. These correlations are all positive, although only the correlation between firm and union capitulation times is statistically significant at conventional levels. The positive correlation of ϵ_u and ϵ_f suggests that unobserved characteristics of the bargaining parties (or the bargaining environment) shift the capitulation times of both parties in the same direction. Such factors could include omitted labor or product market characteristics or, perhaps, differences in the parties' bargaining skill or experience".[22]

While many of the observed strike characteristics have significant effects on employer and employee capitulation times, only the union authorization variable has a statistically significant effect on the time to a compromise. The industry and year dummies in the compromise equation are also poorly determined. Three variants of the models in Tables 6 and 7 were estimated to gain some further insights into the compromise settlements. First, we included only a constant term and the union authorization variable in the compromise equation. Second, the parameters of the compromise equation (β_c) were constrained to equal those in the union capitulation equation (β_u). Third, the parameters of the compromise equation were constrained to equal the parameters of the firm capitulation equation (β_f). All three sets of constraints are strongly rejected. Although the individual coefficients in the compromise equation are imprecisely estimated, these findings suggest that compromise settlements are significantly different from either successful or failed strikes.

One important distinction between strikes that end in compromise and other disputes is the duration of the compromise strikes. For the average strike used in the calculations in Table 8 the median time to a compromise is 54 days -- twice the median time to a firm capitulation and 5 times the median time to a union capitulation.[23] This relative ranking is surprisingly different from contemporary experience. Most modern strikes are settled quickly with a compromise between the demands of the union and the employer. An outright victory for one side or the other is extremely rare, and typically emerges only

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[22]Ashenfelter, Currie, Farber and Spiegel (1990) find strong evidence of unobserved pair effects in experimental bargaining situations.

[23]These values are for the model without replacements.

after a protracted dispute.[24] In the 1880s, the reverse was true. Most strikes ended with a winner-take-all settlement. Compromises only emerged after a lengthy dispute.

b. Simulation Tests of Model Specification

The models estimated in Tables 6 and 7 impose the strong assumption of multivariate normality on the underlying disturbance terms (ϵ_u,ϵ_f,ϵ_c). Although this is a convenient assumption, it implies a particular time pattern for the conditional settlement probabilities that may not fit the data very well. We have two concerns with this specification. First, as shown in Table 4, the empirical hazard rates show a uniformly decreasing probability of settlement as the strike progresses. A log-normal specification cannot easily capture this feature of the data, since the hazard rate for a log-normal duration model necessarily follows an inverse U-shape (Kalbfleisch & Prentice, 1980). Second, examination of the daily settlement patterns shows clustering at strike durations of 7, 14, 21,... days. These spikes presumably reflect some combination of recall errors and actual behavior tending to generate strike durations of exactly 1, 2, 3,... weeks duration.[25] Whatever their source, the smooth hazard function of the log-normal distribution cannot accommodate irregular spikes in the settlement rates.

We pursue two strategies to assess these potential problems. First, we use a simulation to directly check the ability of the multivariate normal model to

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[24]A classic example is the 6-year-long strike of the United Automobile Workers against the Kohler Company. See Uphoff (1966).

[25]Since the data were collected by the Bureau of Labor retrospectively in 1886 and 1887, we would expect to see more clustering in the early years of our sample period if recall errors are the main source of the concentration at week-long duration intervals. Checks of the data did not reveal significantly less clustering in the strikes from 1886 than in the 1881-1882 strikes.

reproduce the observed hazard rates. Second, in the next section of the paper we report results from a proportional hazard model with a non-parametric baseline hazard, and contrast the estimates from this model and the multivariate normal model.

To evaluate the goodness-of-fit of the normal model we simulated 30 strikes for each observation using the maximum likelihood parameter estimates and the actual values of the exogenous variables for each observation.[26] We then compared the actual distribution of strike durations to the one generated by the simulation. In the data the mean strike duration is 15.5 days and the median is 7 days, whereas the simulated mean and median are 15.3 and 7.2 days, respectively. Likewise, the simulated union and firm win-rates (55.1 and 33.3 percent, respectively) are very close to the observed 54.5 and 33.7 percent win rates.[27]

Figures 4a-4d plot the actual daily settlement hazards for the sample and the implied hazards from the simulation exercise. The combined hazard rate for all settlements is shown in Figure 4a, while outcome-specific hazards are given in Figures 4b, 4c, and 4d. A comparison of the actual and simulated hazards in Figure 4a shows that the normal model substantially under-predicts the settlement rate on the first day of a strike. The model estimates imply a 6 percent settlement rate on the first day, whereas the actual settlement rate is over 15 percent. As shown in Figure 4b, most of the bias arises from under-predicting the likelihood of a union victory on the first day of a strike. The

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[26]For each observation the predicted mean log duration times were calculated using the estimates in Tables 6 and 7. Random error terms were then added to each predicted duration value by drawing from an appropriate trivariate normal distribution. The outcome of the strike and the observed duration were determined by the minimum of the three latent duration times.

[27]These comparisons are for the model without the strike replacements variable. The model with strike replacements gives very similar results.

model also has some difficulty reproducing the dip in the settlement rate in the 4th and 5th days of a strike. Apart from these shortcomings, however, the multivariate normal model seems to provide a reasonable fit to the observed distribution of strike durations.

IV. Semi-Parametric Estimates of Firm and Union Capitulation Times

To further investigate the limitations of the normality assumption we estimated a proportional hazards competing risks model with non-parametric baseline hazards. Although it is unlikely that either the multivariate normal model or a proportional hazard model is the "true" model generating the strike data, a comparison of the two models provides a useful check on the extent to which our conclusions are driven by functional form assumptions, rather than by the data.

Our specification of the proportional hazards model is similar to Moffitt (1985), and includes an unrestricted set of baseline parameters for each risk up to some maximum strike duration. In contrast to the normal model, we assume that capitulation times are mutually independent. This allows us to estimate the parameters of the union and firm capitulation times independently (treating the other settlements as censored observations). The probabilities that the union and firm concede on day t (conditional on not conceding before t) are assumed to follow a pair of equations:

(7a) $\lambda_{ut} = \lambda_u(t) \exp(X\beta_u)$

(7b) $\lambda_{ft} = \lambda_f(t) \exp(X\beta_f)$,

where $\lambda_u(t)$ and $\lambda_f(t)$ represent the baseline capitulation rates for the union and the firm, and deviations from these day-specific settlement rates are proportional to the values of the exogenous variables. Because the baseline probabilities are unrestricted, this specification can handle arbitrary patterns (including spikes) in the settlement hazards. On the other hand, it does not allow for unobserved heterogeneity in the hazard rates, and it also abstracts from any correlation between the unobserved components of the union and firm capitulation rates.[28]

Equations (7a) and (7b) were estimated separately for the union and firm capitulations, using information on strikes lasting up to 21 days.[29] Eighty percent of wage increase strikes were settled within 21 days. After this point the number of surviving strikes is small and the daily settlement rates are low, making it difficult to estimate unrestricted daily baseline parameters.

Table 9 and Figures 5a and 5b present the estimates of the β's and the baseline parameters for the firm and union capitulation equations. As before we have estimated the models with and without a variable indicating the presence of replacement workers. For ease of interpretation of the baseline parameters, we have re-scaled the variables measuring the size of the strike and the fraction of the firm's workforce on strike to represent deviations from the sample means. The baseline parameters graphed in Figures 5a and 5b therefore represent the daily settlement rates for an unauthorized "average size" strike in New York State in 1881 in the miscellaneous industry category.

Since a higher hazard rate implies a lower expected capitulation time, the signs of all the coefficients in Table 9 are reversed relative to the estimates in Tables 6 and 7. The magnitudes of the estimated coefficients, however, are generally similar to those of the normal competing risks model.[30] The statistical significance of the individual coefficients is also similar in the two

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[28]Both limitations can be relaxed by modelling unobserved components in the daily hazards.

[29]The full likelihood function is presented in Appendix A.

[30]This is readily explained by the fact that $E(\log y) = c - X\beta$ (where c is a known constant) if y is exponentially distributed with hazard $X\beta$. Thus if the baseline parameters were all constant, the coefficients of the proportional hazards model would give the effects of the covariates on the mean log duration of the latent failure times, as in the log-normal model.

specifications. An interesting exception is the coefficient of the strike replacement variable in the union capitulation equation. This coefficient is relatively small and statistically insignificant in the normal competing risks model (see column 3 of Table 7) but larger and highly significant in the proportional hazards model (see column 4 of Table 9). The difference is attributable to different assumptions on the correlation of the firm and union capitulation times. When the normal model is re-estimated under the assumption of independent capitulation times (as is maintained in the proportional hazards model) the resulting coefficient estimate is much closer to the estimate in Table 9.

The plots of the baseline hazards in Figures 5a and 5b show prominent spikes at weekly anniversary dates. As noted earlier, we suspect that these spikes represent a combination of reporting errors and institutional considerations such as the scheduling of union strike votes. Apart from these spikes the firm capitulation hazard is decreasing while the union capitulation rate is more nearly constant.

There is no simple way to compare the estimated coefficients from the log-normal competing risks model and the semi-parametric proportional hazard model. Furthermore, it is impossible to translate the semi-parametric hazard estimates into expected capitulation times, since the model only uses information on strikes lasting up to 21 days. Nevertheless, it is possible to use both models to calculate the probability of a capitulation before the 21st day of a strike, and the expected capitulation time, given that the strike ends in the first 21 days. We can also calculate how changes in the exogenous variables alter these predictions in the two different models. This analysis is shown in Table 10.

Columns 1-4 give the expected log capitulation times (for the firm and the union) assuming that a capitulation occurs within 21 days, while columns 5-8 give the probabilities of holding out for at least 21 days. Predictions from the proportional hazards model are presented in the odd-numbered columns; predictions from the normal competing risks model are presented in the even-numbered columns. For example, the entries in the first two columns show the predicted logarithm of the firm's capitulation time (given that the capitulation time is $\leq$ 21 days). For a base-case strike (an unauthorized strike in New York in 1881) these predictions are 1.53 from the proportional hazards model and 1.47 from the normal model.

Rows (b)-(h) report the changes in the predicted means (and the changes in the probability of holding out for at least 21 days) for a strike identical to the base case strike except for the change described by the row label. For example, row (b) shows the effect of union authorization. Rows (i) and (j) show the derivatives of the conditional means (and the derivatives of the probability of holding out at least 21 days) with respect to the number of strikers and the fraction of the workforce on strike.

Examination of the entries in Table 10 suggests that the implications of the two specifications are fairly similar. Relative to the proportional hazards model the log-normal model under-predicts the durations for the base-case strike and under-predicts the probabilities of continuing for at least 3 weeks. However, most of the predicted effects of changes in the characteristics of the base-case strike are similar in the two specifications. We conclude that a normal competing risks model and a proportional hazards model with a flexible baseline specification have similar implications with respect to the effects of the observed characteristics on strike durations and outcomes.[31]

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[31] In fact, Table 10 may overstate the differences between the proportional hazard and the normal competing risks estimates. The log-normal competing risks models underlying this table were estimated using information on all strikes, whereas the proportional hazard model is estimated by ignoring information on strikes that settled after 21 days (other than the fact that they lasted over 21 days). If the normal model were fit using the same restricted information we suspect it would yield implications closer to the proportional

V. Wage Settlements In the Event of a Successful Strike

Figure 2a shows that virtually all the wage gains associated with strike activity in the 1880s came from strikes that ended with a firm capitulation or a compromise. In cases where the union capitulated, the strikers almost always returned to work at their previous wage. Thus, to model wage changes associated with strikes in the 1880s we need only explain the wage increase conditional on a union success or a compromise. In view of the small number of compromises, we focus in this section on modelling wage settlements following a union success (i.e., a firm capitulation).

We proceed by expanding the statistical model of the previous section to include wage changes in the event of a firm capitulation. The structural wage equation is:

$$(8)\quad \Delta\ln(W_f) = X\beta_w + \nu_w,$$

where $\Delta\ln(W_f)$ represents the change in the logarithm of wages if the firm concedes the strike. One possible interpretation of (8) is as the union's wage demand, which is fixed at the outset of the strike but only realized in the event of a successful strike (i.e. a firm capitulation). In this interpretation $\Delta\ln(W_f)$ is a "prize" that is either won or lost by the striking parties (ignoring compromises). Such a structural equation is suggested by a war-of-attrition model (see Kennan and Wilson (1988, 1992)), but has a variety of alternative interpretations.

Equation (8) can only be estimated without bias on the subset of successful strikes if ν_w is uncorrelated with the unobserved determinants of duration. Otherwise, the conditional expectation of the wage change, given a union victory, is:

$$(9)\quad E(\Delta W_f) = X\beta_w + E(\nu_w \mid D = X_f\beta_f + \epsilon_f,\ D < X_u\beta_u + \epsilon_u,\ D < X_c\beta_c + \epsilon_c)$$

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hazards model.

There are several approaches to dealing with the selection bias implied by the second term in this equation. One simple approach is the two-step procedure suggested by Heckman (1978). Since the results reported in Tables 6 and 7 imply that ρ_{uc} is approximately 0, Heckman's procedure in this case amounts to adding two selection terms to the OLS regression equation, corresponding to the means of two truncated univariate normal distributions. The values of these two selection terms were calculated using the estimates reported in Tables 6 and 7 and then used to estimate a selection-corrected version of Equation (8). These corrected estimates are very similar to the OLS estimates and provide no evidence of correlation between υ_w and either ϵ_u or ϵ_c.

An alternative "full information" approach is to add equation (8) to the system of equations (1)-(3). This approach has the advantage of providing an estimate of ρ_{wf}, the correlation between unobserved factors that influence the wage settlement given a union win and unobserved factors that determine how long the firm will hold out before capitulating. An important disadvantage of a full information approach is computational complexity: the system of (1)-(3) and (8) has over 100 parameters if we include unrestricted year and industry effects in all 4 equations. Since ρ_{uc} and ρ_{fc} are statistically insignificant in Tables 6 and 7, a reasonable compromise is to drop the equation for the time to a compromise settlement and treat the "partially successful" strikes as independently censored observations. Following this approach it is possible to estimate β_w, β_f, β_u and the correlations between ϵ_u, ϵ_f and υ_w using the entire sample of wage increase strikes.[32]

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[32]Appendix B gives the complete expression for the likelihood of this extended model.

The second columns in Tables 11 and 12 report maximum likelihood (ML) estimates of β_w based on the system of (1), (2) and (8).[33] For comparison we also report OLS estimates of the wage change equation (fit to the subset of successful strikes). The ML estimates are similar to the OLS estimates, although generally bigger in magnitude, as would be expected if the OLS estimates are biased by nonrandom selection. The estimated correlations between ϵ_u, ϵ_f and υ_w are presented in rows 12-14 of the tables. These show a positive correlation between the union capitulation time and the error in the wage change equation ($\rho_{uw} > 0$) and a negative correlation between the wage equation and the firm capitulation time ($\rho_{fw} < 0$). As in Tables 6 and 7 the estimated correlation of the union and firm capitulation times (ρ_{uf}) is positive.

The coefficients of the conditional wage settlement equation show an interesting pattern. Strike characteristics with a positive wage effect are those that tend to raise the capitulation time of the union more than the capitulation time of the firm. For example, union authorization (which has a positive wage effect) raises the capitulation times of both parties, but the effect on the union time is substantially larger. To illustrate this pattern we report in the third columns of Tables 11 and 12 the <u>difference</u> in the estimated effects of each variable on the union and firm capitulation times. Reading down the rows of the tables it is clear that variables for which (β_u - β_f) is positive tend to have positive β_w's.

This pattern suggests that characteristics which increase relative union bargaining power lead to bigger wage increases in the event of a successful strike. A similar relation holds between the <u>unobserved</u> determinants of

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[33] The estimates of β_u and β_f are not reported but available from the authors. The estimates are virtually identical to the estimates reported in Tables 6 and 7.

relative bargaining power and the unobserved determinants of a conditional wage settlement. Unobserved factors that raise the union's capitulation time tend to raise the wage settlement ($\rho_{uw}>0$), whereas unobserved factors that raise the firm's capitulation time tend to lower the wage settlement ($\rho_{fw}<0$).

a. Union Bargaining Power and Wages Across Industries

The relationship between relative bargaining power and conditional wage increases extends to the pattern of the industry effects in equations (1), (2) and (8). The estimated values of the industry dummies in the union and firm capitulation time equations are presented in columns (1) and (2) of Tables 13 and 14. Their differences (and their associated standard errors) are reported in the third column of each table. Finally, the industry effects from the wage equations are presented in the 4th column of each table. The correlation across industries between the entries in columns (3) and (4) is approximately 0.6 in both tables. As is true for the other determinants of strike duration and wages, the industry effects reveal a simple "relative bargaining power" pattern.

This pattern is illustrated in Figure 6a, which plots the industry effects from the wage settlement equation in Table 13 against the corresponding estimates of β_u-β_f. The 12 points in the figure correspond to the eleven industry effects and the omitted industry group.[34] The diameter of the circle used to graph each industry is proportional to the industry's share of strikes in our sample. Apart for the tobacco industry, the points lie on a positively sloped line, confirming the link between workers' relative ability to withstand a strike and their expected wage gain conditional on a union victory.

The unusual character of the tobacco industry is potentially attributable to several factors. Technological changes in the industry during the 1880s lead

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[34]For the omitted industry, β_u - β_f is the difference in the constant terms in the two capitulation equations.

to the gradual replacement of highly-skilled cigar rollers by less skilled cigar molding operatives (see Ware (1929, chapter 11)). This trend could account for the relatively low wage increases for tobacco workers, even after a successful strike. Another idiosyncratic factor in the tobacco industry was the bitter rivalry between two different cigar makers unions in New York City -- the Cigar Makers International Union (lead by Adolph Strasser and later Gompers), and the Progressive Cigar Makers (backed by the Knights of Labor). In any case, the industry is clearly an outlier with regard to the patterns of wage increases and measured bargaining power.

One of the important insights from Tables 13 and 14 is that average wage increases for a successful strike are correlated with the difference in capitulation times of employers and employees, rather than with strike duration per se. In fact, there is no significant inter-industry relationship between the average duration of strikes and the average industry wage effect conditional on a successful strike. This is shown in Figure 6b, which plots the industry effects from the wage equation against the industry effects from a model for mean log strike duration.[35]

Finally, it is interesting to compare the interindustry pattern of wage and strike duration coefficients in Tables 13 and 14 with the predictions from a simple war-of-attrition model in which the wage settlement conditional on a union success is interpreted as an exogenous prize to be captured by the winner of the dispute. Higher wage settlements conditional on a union victory imply a bigger gain to workers if they win, and a bigger gain to the firm if it wins. Hence, in industries with larger wage settlements conditional on a union success, a simple war-of-attrition model predicts that both firms and workers

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[35]Industry effects for mean log duration are estimated from a simple Tobit model that treats compromise settlements as censored. Estimated effects from a simple OLS equation estimated to all the strike observations are very similar.

will hold out longer in order to win the dispute. It follows that overall strike durations in an industry should be related to the average size of the wage settlement. Similarly, any other characteristic that raises the wage settlement conditional on a union win should raise both the firm and union capitulation times. Examination of the industry effects and many of the other coefficients in the duration and wage equations shows little support for this prediction.

VI. Summary and Conclusion

This paper explores the determinants of strike durations and outcomes for a large sample of labor disputes from 1881 to 1886. The early 1880s were critical years in American labor history, coinciding with the rise of the Knights of Labor, the founding of the American Federation of Labor, and the wave of labor unrest before and after the Haymarket affair. Our data, taken from the Third Annual Report of the Commissioner of Labor, provide an extraordinarily rich portrait of strike activity in this period.

The authors of the Third Report followed contemporary practice in classifying strikes as successes or failures. Although winners and losers seldom emerge from modern-day labor disputes, our analysis of strike outcomes from the 1880s suggests that the distinction was a valid one in the institutional setting of the period. Wage and hours settlements associated with successful and unsuccessful strikes were completely bifurcated. Among strikes initiated by workers' demands for higher wages, for example, successful strikes generated sizeable wage increases whereas failed strikes ended with a return to work at the previous wage.

The clear distinction between the winner and loser of a strike suggests a natural framework for measuring the relative bargaining power of the parties to a dispute, based on their relative abilities to withstand a strike. We implement this idea through a competing risks model of the capitulation times of workers and employers. Our results suggest that the relative bargaining power of strikers was enhanced by having a larger fraction of employees involved in a strike but lowered by having a greater total number of strikers. We also find that workers' bargaining strength was higher in strikes that were ordered by a labor organization, although we suspect that some of this advantage reflected union leaders' reluctance to sanction a strike with a low probability of success. On the firms' side, the use of replacement workers was associated with a sharp increase in employers' relative bargaining power. Again, a causal interpretation is problematic, since firms may have been able to recruit strike-breakers more easily when the strikers' bargaining power was inherently weaker.

We also find employees' relative bargaining power varied over different regions of the country, across different industries, and over time. Workers enjoyed greater bargaining power in New York than Massachusetts and in Chicago relative to other parts of Illinois. Striking employees in building trades, food preparation, and boots and shoes were relatively stronger than those in apparel, wood products, and furniture. Finally, the aftermath of the Haymarket disturbances lead to a long-run decrease in employees' relative bargaining power (at least through the end of 1886).

While information on the success or failure of a strike is sufficient to identify the components of relative bargaining power, there is still substantial variation in the wage settlements associated with successful strikes. We therefore extend our models to include an equation for the wage change in the event of a union victory. The estimation results reveal a strong correlation between the determinants of relative capitulation times, on the one hand, and the determinants of wage outcomes conditional on a successful strike, on the other. The same basic factors that determined workers' relative ability to endure a strike also dictated the magnitude of wage increases conditional on a successful strike.

What general lessons do we draw from the nature of labor disputes in the 1880s? A first important message is that models of bargaining and strike behavior must be carefully tailored to the institutional environment under study. The winner-take-all aspect of strike settlements in the 1880s is quite different from the usual characterization of contemporary disputes, and implies the need for a different class of theoretical and econometric models. Second, despite the many differences between unions in the 1880s and today, the basic determinants of workers' bargaining power are perhaps unchanged. The inter-industry patterns of relative bargaining power in the 1880s, for example, are surprisingly similar to the inter-industry patterns of union relative wage effects in modern data. Finally, the sharp increase in employers' relative bargaining power after the Haymarket affair suggests that politically-directed changes in public and employer opinion can have important effects on individual bargaining outcomes. This lends historical credence to the hypothesis that changes in political attitudes in the 1980s (symbolized by the Federal Government's firing of striking air-traffic controllers) led to a decline in union power throughout the economy.

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Appendix A

To estimate equations (7a) and (7b) we consider all strikes still in progress after 21 days as censored at 21 days. The probability of a union capitulation on day T (T< =21 days) is:

$$\Pr(D_u=T) = \lambda_u(T)\exp(X\beta_u)\prod_{j=1}^{T-1}[1-\lambda_u(j)\exp(X\beta_u)].$$

If the union capitulation time is censored because the strike lasted longer than 21 days, or because of a compromise settlement or firm capitulation within 21 days, we only observe that $D_u > T$. Letting C=1 if the observation is censored at T, the contribution of an individual observation to the likelihood function for the union capitulation times is:

$$L_u = \{\lambda_u(T)\exp(X\beta_u)\prod_{j=1}^{T-1}[1-\lambda_u(j)\exp(X\beta_u)]\}^{(1-C)}\prod_{j=1}^{T}\{[1-\lambda_u(j)\exp(X\beta_u)]\}^{(C)}$$

An analogous equation describes the contribution of an observation to the likelihood function for the firm capitulation times.

Appendix B

The estimates reported in Tables 11 and 12 are maximum likelihood estimates of the following four equations:

(1) $D_u = X\beta_u + \epsilon_u$

(2) $D_f = X\beta_f + \epsilon_f$

(4) $D = \min[D_u, D_f, D_c]$

(8) $\Delta\ln(W) = X\beta_w + \nu_w$ iff $D = D_f$

where the vector of error terms $(\epsilon_u, \epsilon_u, \nu_w)$ is assumed to be distributed trivariate normal. Note that the compromise equation is dropped from the model. We assume that D_u, D_f and $\Delta\ln(W)$ are censored when a compromise settlement occurs. The likelihood function for this model is

$$L = \prod_{FWIN=1} \Pr(\epsilon_u = D\text{-}X\beta_u)\Pr(\epsilon_f > D\text{-}X\beta_f \mid \epsilon_u = D\text{-}X\beta_u)$$

$$\prod_{UWIN=1} \Pr(\epsilon_u > D\text{-}X\beta_u \mid \epsilon_f = D\text{-}X\beta_f, \upsilon_w = \Delta Ln(W)\text{-}X\beta_w)$$

$$\Pr(\epsilon_f = D\text{-}X\beta_f, \upsilon_w = \Delta Ln(W)\text{-}X\beta_w)$$

$$\prod_{FWIN=UWIN=0} \Pr(D < X\beta_u + \epsilon_u, D < X\beta_f + \epsilon_f)$$

Figure 1
Number of Strikes by Month

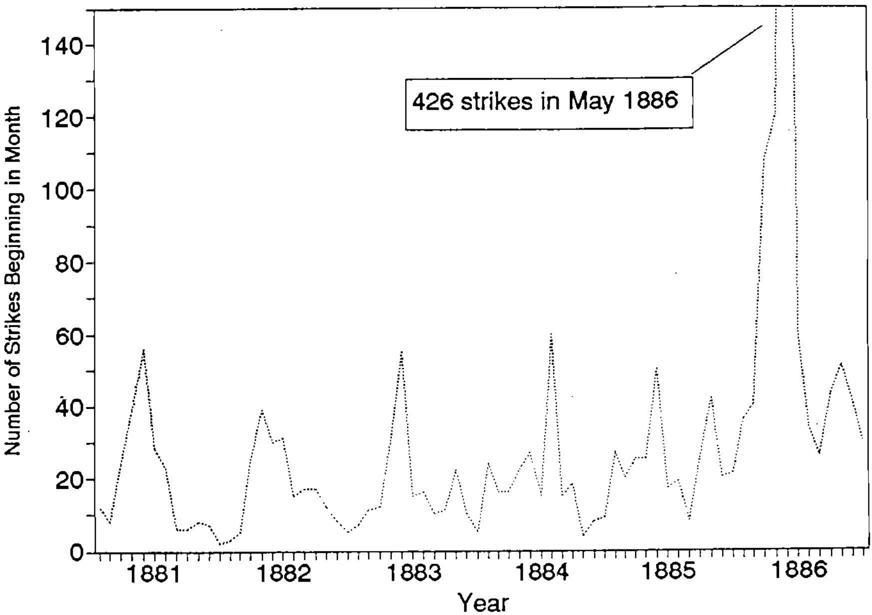

Figure 2a
Distribution of Wage Increases

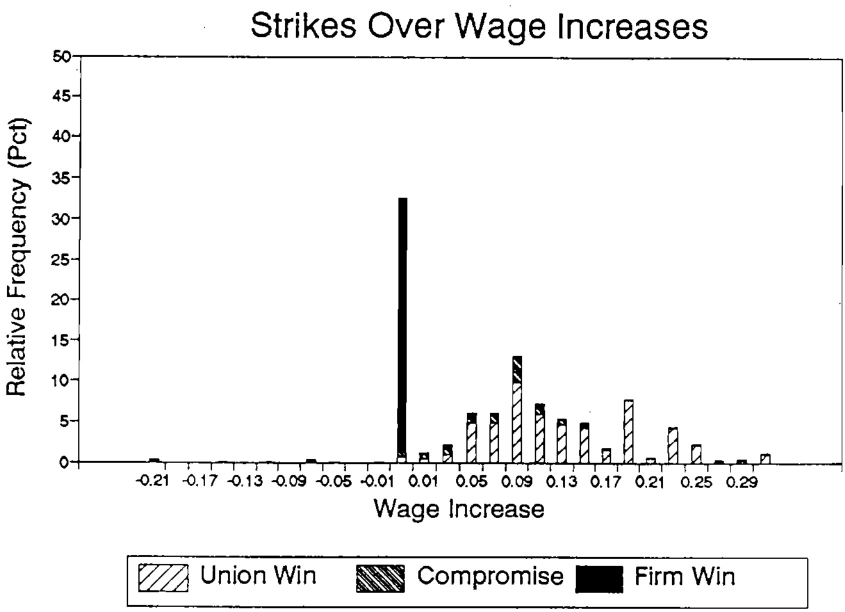

Figure 2b
Distribution of Wage Increases

Strikes Over Wage Cuts

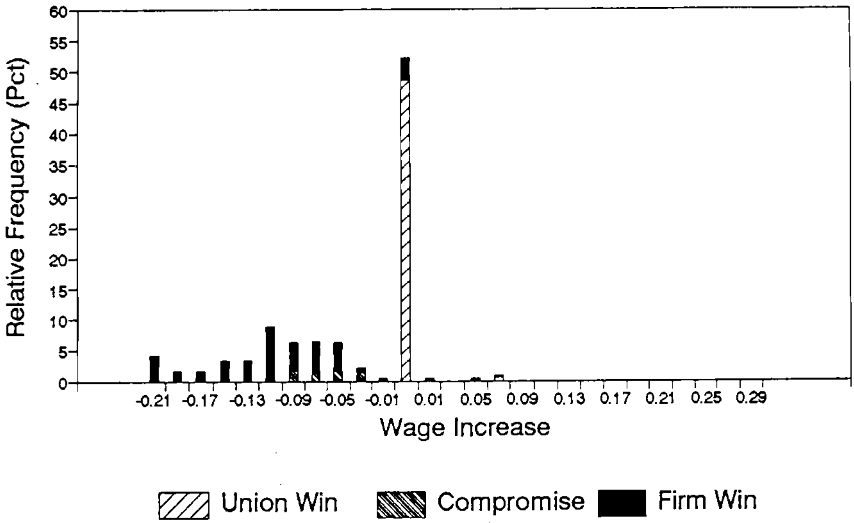

Figure 3

Distribution of Wage Settlements By Strike Duration: Wage Increase Cases

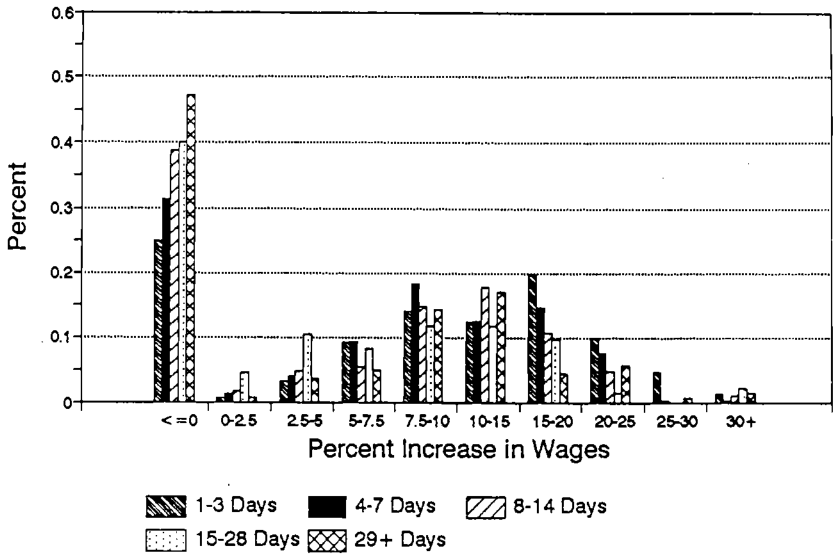

Figure 4a
Simulated and Actual Hazard Rate For All Settlement Types

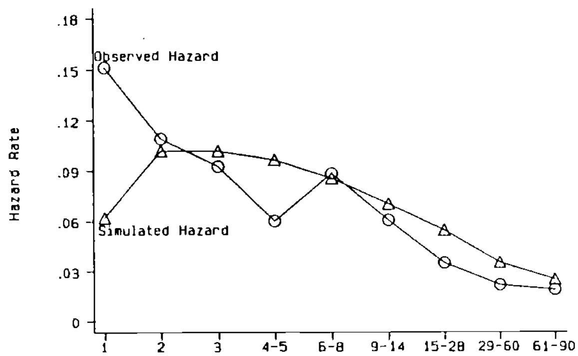

Figure 4b
Simulated and Actual Hazard Rate For Union Wins

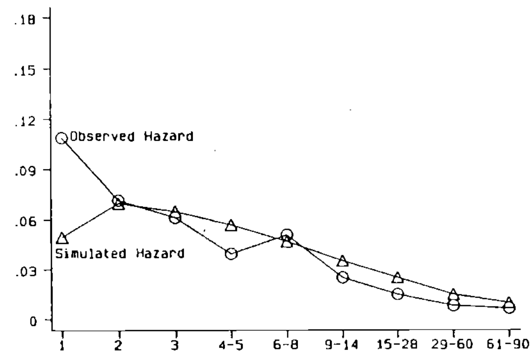

Figure 4c
Simulated and Actual Hazard Rate For Firmn Wins

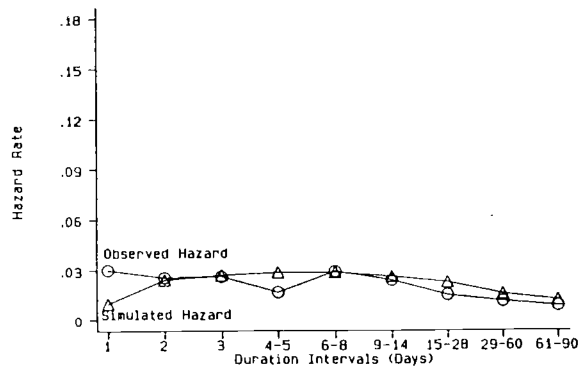

Figure 4d
Simulated and Actual Hazard Rate For Compromises

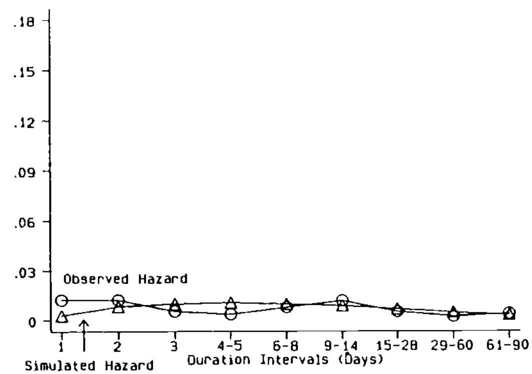

Figure 5a
Baseline Hazard For Firm Capitulation

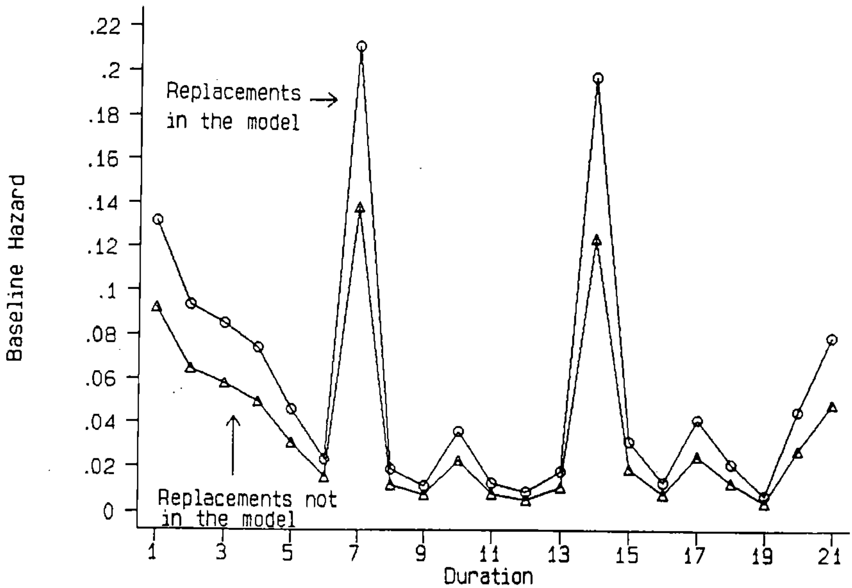

Figure 5b
Baseline Hazard For Union Capitulation

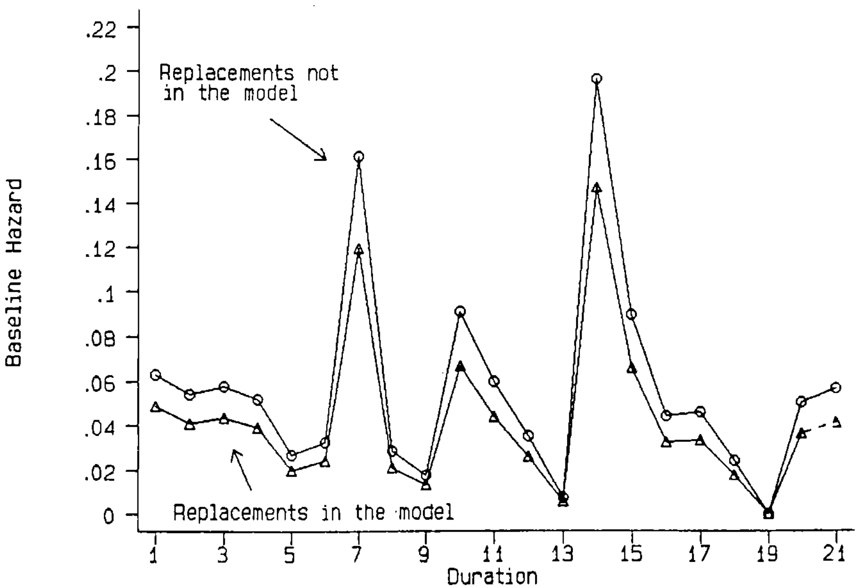

Figure 6a
Relative Union Strike Power & Wage Gains Across Industries
(rho=.627)

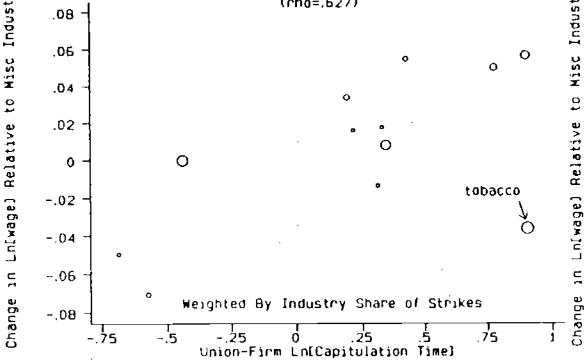

Figure 6b
Differences in Strike Duration & Wage Gains Across Industries
(rho=-.186)

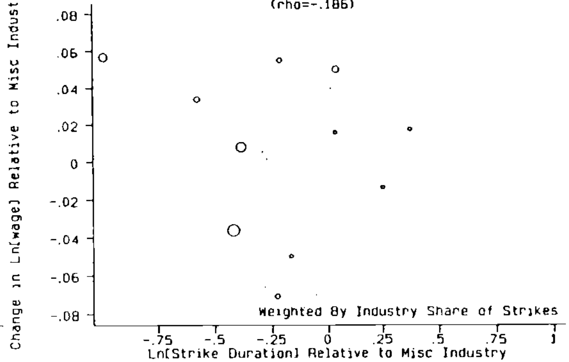

Table 1

Mean Characteristics of Strikes, By State and Year

	All	By State:			By Starting Year:					
		Illinois	Mass	New York	1881	1882	1883	1884	1885	1886
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. Number Strikes	2179	705	300	1174	219	207	205	234	299	1015
2. Average Size	245	238	122	281	188	230	330	180	218	267
3. Average Log Size	4.04	4.44	3.66	3.90	4.25	4.29	4.27	3.63	4.10	3.98
4. Average Fraction Involved (%)	80.6	89.7	41.9	85.0	84.4	83.4	84.6	83.9	75.7	79.1
5. Avg Prev Wage ($/day)	2.12	1.99	2.01	2.22	1.97	2.15	2.12	2.43	2.08	2.08
6. Pct Authorized	76.8	74.0	57.7	83.3	69.4	67.6	79.0	77.8	73.6	80.5
Causes of Strike:										
7. For a Wage Increase (%)	47.1	38.2	54.0	50.7	69.4	63.3	53.7	39.3	50.8	38.4
8. Against a Wage Cut (%)	11.6	12.1	15.7	10.2	10.0	11.6	18.5	24.8	18.4	5.4
9. For a Change in Hours (%)	18.3	30.9	3.3	14.6	5.4	4.3	1.0	11.5	1.0	34.1
Duration:										
10. Mean (days)	20.0	19.8	29.9	17.7	12.7	19.0	19.0	23.2	33.7	17.2
11. Median (days)	9.0	10.0	14.0	7.0	7.0	7.0	8.0	7.0	11.0	10.0
Outcomes:										
12. Union Win (%)	46.9	31.2	41.7	57.7	52.1	52.7	57.6	58.1	55.9	37.2
13. Union Loss (%)	43.8	56.6	49.0	34.8	34.2	41.1	37.1	39.3	40.5	49.9
14. Compromise (%)	9.2	12.2	9.3	7.3	13.7	6.3	5.4	2.6	3.7	12.7
15. Strike Breakers Employed (%)	38.7	38.6	33.0	40.3	41.0	36.7	47.8	34.6	37.1	38.2
16. All Strikers Replaced (%)	6.9	0.9	12.0	9.2	5.0	3.9	9.3	12.0	5.4	6.7

Notes: Sample is drawn from Third Annual Report of the Commissioner of Labor, and includes all strikes in Illinois, Massachussetts, and New York occurring between 1881 and 1886. See text for further discussion.

Table 2

Mean Characteristics of Strikes, By Industry

	Apparel (1)	Bldg Trades (2)	Food (3)	Machine (4)	Metals (5)	Mining (6)	Shoes (7)	Textiles (8)	Tobacco (9)	Transp (10)	Wood Prods (11)	Miscell (12)
1. Number Strikes	98	268	84	92	260	144	143	77	240	122	226	425
2. Average Size	545	275	433	201	116	200	91	283	320	524	150	198
3. Average Fraction Involved (%)	76.6	93.3	82.1	72.8	77.9	94.1	46.6	33.1	84.9	94.4	90.0	80.7
4. Avg Prev Wage ($/day)	2.03	2.95	2.01	2.34	2.29	1.80	2.07	1.38	1.82	1.83	2.03	2.12
5. Pct Authorized	78.6	92.9	88.1	87.0	74.6	55.5	87.4	15.5	95.8	50.8	94.2	65.2
Causes of Strike:												
6. For a Wage Increase (%)	60.2	32.1	40.5	31.5	53.8	34.7	55.2	40.3	58.3	62.3	30.5	55.1
7. Against a Wage Cut (%)	14.3	3.7	3.6	5.4	10.0	27.1	9.8	26.0	24.2	5.7	0.9	12.7
8. For a Change in Hours (%)	4.1	25.4	38.1	50.0	21.2	0.0	2.1	0.0	1.7	8.2	58.8	10.4
Duration:												
9. Mean (days)	15.2	13.1	22.9	20.8	21.7	25.8	32.7	27.1	14.0	11.6	17.6	23.0
10. Median (days)	7.5	5.0	3.0	14.0	7.0	14.0	14.0	14.5	7.0	5.0	14.0	7.0

Table 2 - Continued

Mean Characteristics of Strikes, By Industry

	Apparel (1)	Bldg Trades (2)	Food (3)	Machine (4)	Metals (5)	Mining (6)	Shoes (7)	Textiles (8)	Tobacco (9)	Transp (10)	Wood Prods (11)	Miscell (12)
Outcomes:												
11. Union Win (%)	32.7	69.8	71.4	31.5	41.2	34.7	53.8	28.6	75.0	41.0	21.2	42.4
12. Strike Breakers Employed (%)	55.1	32.5	44.0	32.6	33.1	47.2	26.6	41.6	27.5	52.5	40.3	44.9
13. All Strikers Replaced (%)	8.2	10.1	8.3	3.3	4.2	1.4	11.2	6.5	8.8	9.8	3.1	7.3
Geographic Distribution:												
14. Illinois (%)	11.2	8.2	16.7	57.6	45.0	100.0	4.9	1.3	12.1	42.6	49.1	33.9
15. Mass (%)	8.2	3.7	1.2	1.1	10.8	0.0	67.8	72.7	11.7	4.9	1.8	14.3
16. NY City (%)	74.4	79.5	59.5	35.9	31.9	0.0	21.7	13.0	65.4	39.3	48.7	37.6
Timing:												
17. In 1886 (%)	67.4	42.9	58.3	65.2	41.1	25.0	55.2	40.3	27.9	42.6	76.5	42.3
18. Jan-April 1886 (%)	39.8	10.1	17.9	6.5	13.1	6.9	18.2	28.6	9.2	23.8	7.5	13.2
19. May 1-7 1886 (%)	15.3	6.7	9.5	48.9	17.7	4.9	10.5	0.0	4.2	13.1	50.9	9.9

Notes: See note to Table 1.
Apparel industry includes clothing (men's and women's), tailors, and furriers.
Food industry includes bakeries, butchers and meat packing establishments, and confectioners.
Machine industry includes agricultural equipment, metal fabrication, rolling stock, and shipbuilding.
Metal industry includes iron and steel foundries, hardware, nail, and wire works, and brass and copper foundries.
Textile industry includes cotton, wool and silk spinning and weaving.
Transportation industry includes railroads, streetcars, and longshoring.
Wood products industry includes furniture and box making and planing mills.

Table 3

Mean Characteristics, By Cause of Strike
(standard errors in parentheses)

	Cause of Strike:			
	Wage Increase	Wage Cut	Chg in Hours	Miscell
1. Number Strikes	1026	252	399	502
2. Average Log Size	4.02	4.24	4.11	3.90
3. Average Fraction Involved (%)	78.6	80.3	89.3	77.9
4. Avg Prev Wage ($/day)	2.01	2.06	2.27	2.24
5. Pct Authorized	74.1	67.9	93.0	73.9
Timing (Percent of Strikes):				
7. Jan-April 1886	17.8	6.7	6.8	15.2
8. May 1-7 1886	8.0	2.0	57.1	4.4
9. Rest of 1886	12.2	13.1	22.8	25.1
Duration:				
6. Mean (days)	15.7	35.1	16.9	24.2
7. Median (days)	7.0	14.0	11.0	9.0
Outcomes:				
8. Union Win (%)	51.9	48.0	32.6	47.5
9. Strike Breakers Employed (%)	37.0	31.7	31.3	51.7
10. All Strikers Replaced (%)	5.4	8.7	4.8	10.8
11. Avg Chg Log Wage (%)	8.36 (0.28)	-4.94 (0.44)	0.10 (0.37)	0.58 (0.33)
12. Wage Change = 0 (%)	31.2	47.6	79.0	74.7
13. Avg Chg in Hours	-0.5 (0.1)	-0.1 (0.1)	-3.8 (0.3)	-0.1 (0.1)

Note: See note to Table 1.

Table 4
Strike Outcomes by Duration and Settlement Rates by Duration
(standard errors in parentheses)

	Number Strikes	Pct Union Wins	Use of Strikebreakers: Percent Replaced 1-25%	>25%	Average Daily Settlement Rates Union Win	Other	Total	Average Percent Chg in Log Wage
I. Strikes Over Wage Increases:								
All	1027	51.9	21.0	16.0	--	--	--	8.36 (0.28)
1-3 days	360	59.4	15.0	17.2	0.069	0.047	0.117	10.76 (0.54)
4-7 days	224	61.6	17.9	8.4	0.052	0.032	0.084	8.26 (0.54)
8-14 days	168	41.7	29.8	13.1	0.023	0.032	0.054	7.16 (0.61)
15-28 days	135	43.0	28.9	17.8	0.015	0.020	0.035	6.44 (0.71)
29-90 days	121	37.2	19.8	24.0	0.005	0.009	0.014	6.26 (0.81)
90+ days	19	42.1	47.4	42.1	--	--	--	8.77 (2.40)
II. Strikes Over Wage Cuts:								
All	252	48.0	12.3	19.4	--	--	--	-4.94 (0.44)
1-3 days	60	60.0	5.0	35.0	0.048	0.032	0.079	-2.08 (0.88)
4-7 days	45	55.5	17.8	8.9	0.033	0.026	0.059	-4.45 (1.00)
8-14 days	42	50.0	9.5	9.5	0.020	0.020	0.041	-4.38 (1.11)
15-28 days	35	42.9	20.0	14.3	0.010	0.014	0.024	-4.94 (0.98)

Table 4 - Continued
Strike Outcomes by Duration and Settlement Rates by Duration
(standard errors in parentheses)

	Number Strikes	Pct Union Wins	Use of Strikebreakers: Percent Replaced		Average Daily Settlement Rates			Average Percent Chg in Log Wage
			1-25%	>25%	Union Win	Other	Total	
III. Strikes Over Hours Changes: Hours/Wk								Average Chg
All	399	32.6	17.0	14.3	--	--	--	-3.80 (0.34)
1-3 days	114	54.4	11.4	11.4	0.052	0.043	0.095	-7.00 (0.76)
4-7 days	67	38.8	22.4	7.5	0.023	0.036	0.059	-4.77 (0.79)
8-14 days	84	20.2	15.5	13.1	0.011	0.044	0.055	-2.20 (0.52)
15-28 days	80	16.3	21.3	15.0	0.007	0.036	0.043	-1.64 (0.48)
29-90 days	46	15.2	19.6	28.3	0.002	0.012	0.014	-0.28 (0.41)
90+ days	8	62.5	12.5	37.5	--	--	--	-10.40 (5.63)

Table 5

Estimated Resistance Curves, Strikes Over Wage Issues
(standard errors in parentheses)

	Strikes Over Wage Increases:					Strikes Over Wage Cuts:				
	Change in Log Wage of Strikers:		Probability of Union Win:		Wage Chg, Union Win	Change in Log Wage of Strikers:		Probability of Union Win:		Wage Chg, Union Win
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Strike Duration Classes:										
1. 2 Days	-.023 (.011)	-.027 (.01D)	-.066 (.065)	-.103 (.059)	-.015 (.010)	-.021 (.027)	-.007 (.028)	-.175 (.192)	-.177 (.183)	-.005 (.006)
2. 3 Days	-.032 (.013)	-.017 (.011)	-.059 (.071)	-.042 (.065)	-.013 (.011)	-.000 (.026)	.022 (.027)	-.042 (.182)	.037 (.176)	-.013 (.005)
3. 4-5 Days	-.023 (.012)	-.023 (.011)	-.059 (.067)	-.031 (.061)	-.021 (.011)	-.017 (.026)	-.004 (.026)	-.057 (.189)	.032 (.173)	-.003 (.005)
4. 6-8 Days	-.051 (.010)	-.033 (.009)	-.140 (.056)	-.146 (.052)	-.009 (.009)	-.033 (.020)	-.025 (.022)	-.403 (.143)	-.396 (.141)	-.010 (.005)
5. 9-14 Days	-.047 (.010)	-.026 (.009)	-.307 (.055)	-.254 (.053)	-.006 (.011)	-.029 (.020)	-.024 (.021)	-.375 (.141)	-.373 (.137)	-.000 (.004)
6. 15-28 Days	-.057 (.010)	-.047 (.010)	-.291 (.058)	-.299 (.054)	-.019 (.011)	-.034 (.020)	-.020 (.022)	-.446 (.144)	-.326 (.142)	-.003 (.005)
7. 29-60 Days	-.059 (.011)	-.039 (.010)	-.340 (.063)	-.307 (.060)	.006 (.012)	-.051 (.021)	-.025 (.023)	-.616 (.151)	-.419 (.147)	-.007 (.006)
8. 61-90 Days	-.058 (.019)	-.050 (.017)	-.388 (.106)	-.368 (.098)	-.025 (.023)	-.055 (.022)	-.032 (.024)	-.440 (.155)	-.347 (.155)	-.005 (.005)
9. Over 90 Days	-.029 (.022)	-.037 (.019)	-.277 (.121)	-.340 (.111)	-.037 (.024)	-.064 (.022)	-.029 (.024)	-.525 (.160)	-.263 (.157)	-.004 (.006)

Table 5 - Continued

Estimated Resistance Curves, Strikes Over Wage Issues
(standard errors in parentheses)

	Strikes Over Wage Increases:					Strikes Over Wage Cuts:				
	Change in Log Wage of Strikers:		Probability of Union Win:		Wage Chg, Union Win	Change in Log Wage of Strikers:		Probability of Union Win:		Wage Chg, Union Win
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Other Control Variables:										
10. Authorized by Union	--	.041 (.006)	--	.237 (.036)	.018 (.008)	--	.024 (.011)	--	.091 (.072)	-.002 (.003)
11. Fraction of Workers on Strike	--	.036 (.009)	--	.133 (.053)	.040 (.011)	--	.007 (.021)	--	-.189 (.134)	-.010 (.005)
12. Log of Number of Strikers Involved	--	-.006 (.002)	--	-.014 (.010)	-.007 (.002)	--	-.003 (.004)	--	-.076 (.024)	.001 (.001)
13. Strike in First Week of May 1886	--	-.031 (.011)	--	-.099 (.061)	-.012 (.015)	--	.025 (.036)	--	.016 (.233)	-.007 (.012)
14. Strike Post-Haymarket	--	-.010 (.009)	--	-.045 (.054)	-.013 (.011)	--	-.009 (.019)	--	.042 (.125)	.002 (.005)
15. Illinois	--	-.049 (.011)	--	-.302 (.061)	-.027 (.016)	--	-.017 (.018)	--	-.208 (.115)	-.006 (.005)
16. Massachusetts	--	-.010 (.011)	--	.023 (.065)	-.003 (.012)	--	-.011 (.023)	--	-.152 (.152)	-.020 (.006)
17. Chicago	--	.037 (.012)	--	.294 (.067)	.021 (.017)	--	-.012 (.021)	--	-.203 (.138)	.003 (.006)
18. 11 Industry and 5 Year Effects	NO	YES	NO	YES	YES	NO	YES	NO	YES	YES
19. R-squared	.052	.297	.067	.275	.335	.071	.268	.129	.427	.355
Sample Characteristics:										
20. Mean (std dev) of Dependent Variable	.084 (.089)		.545 (.498)		.136 (.072)	-.049 (.068)		.504 (.501)		.002 (.011)
21. Sample Size	971		1049		529	230		230		116

Note: Samples exclude strikes in which all the strikers were permanently replaced. Omitted duration class is 1 day strikes. Models in columns (5) and (10) are fit to subset of strikes which ended in a union "win" -- see text.

Table 6

OLS and Competing Risk Tobit Estimates of Time to Different Strike Outcomes for Strikes Over Wage Increases

Variable	OLS Estimates	Competing Risk Tobit Estimates of Log(Duration Times)		
	Log(Duration)	Log(Firm Capitulation Time)	Log(Union Capitulation Time)	Log(Time to a Compromise)
	(1)	(2)	(3)	(4)
Authorized by Union	.600 (.026)	.284 (.162)	.945[a] (.141)	.804 (.248)
"1" if Strike Replacements				
Log(No. of Strikers)	.164 (.026)	.201 (.035)	.122[a] (.032)	.078 (.066)
Fraction of Workers on Strike	-.202 (.142)	-.473 (.216)	.247[a] (.193)	-.487 (.416)
Strike in 1st week of May, 1886	.252 (.179)	.518 (.275)	.228 (.251)	-.023 (.321)
Strike on or after 1st week of May, 1886	.377 (.144)	.453 (.201)	.208 (.175)	.157 (.263)
Illinois	-.041 (.163)	.560 (.279)	-.552[a] (.209)	-.313 (.372)
Massachusetts	.310 (.174)	.315 (.221)	.210 (.197)	.613 (.397)
Chicago	.155 (.180)	-.434 (.297)	.514[a] (.219)	.477 (.401)
11 Industry & 5 Year Dummies	Yes	Yes	Yes	Yes
σ	1.172	1.339 (.077)	1.080 (.051)	1.333 (.259)
ρ_{UF}			.604 (.281)	
ρ_{UC}			.435 (.521)	
ρ_{FC}			.366 (.497)	
R^2	.171			
-Log L			2254 92	

N=971

Standard errors in parentheses.

[a] Difference between column (2) and Column (3) is significant at the 05 level

Table 7

OLS and Competing Risk Tobit Estimates of Time to Different Strike Outcomes for Strikes Over Wage Increases

	OLS Estimates	Competing Risk Tobit Estimates of Log(Duration Times)		
	Log(Duration)	Log(Firm Capitulation Time)	Log(Union Capitulation Time)	Log(Time to a Compromise)
Variable	(1)	(2)	(3)	(4)
Authorized by Union	.5955 (.0935)	.1618 (.1580)	1.0534[a] (.3195)	.6377 (.2692)
"1" if Strike Replacements	.6146 (.0825)	1.1747 (.1518)	-.1572[a] (.1729)	.9163 (2766)
Log(No. of Strikers)	.1453 (.0253)	.1667 (.0338)	.1122 (.0352)	.0461 (.0680)
Fraction of Workers on Strike	-.1020 (.1391)	-.3599 (.2011)	.4112[a] (.1964)	-.5658 (.3851)
Strike in 1st week of May, 1886	.1920 (.1741)	.4521 (.2795)	.2086 (.2777)	-.1441 (.3384)
Strike on or after 1st week of May, 1886	.3612 (.1405)	.3973 (.1925)	.1837 (.1945)	.1604 (.2677)
Illinois	-.0831 (.1586)	.7146 (.2877)	-.6798[a] (.2104)	- 0932 (.4089)
Massachusetts	.4057 (.1693)	.4740 (.2168)	.1273 (.2267)	7716 (4054)
Chicago	.2796 (.1758)	-.4220 (.2991)	.5799[a] (.2254)	4640 (.4410)
11 Industry & 5 Year Dummies	Yes	Yes	Yes	Yes
σ	1.1393	1.2817 (.0649)	1 1345 (.0639)	1 3401 (2250)
ρ_{uf}			4151 (.2340)	
ρ_{uc}			.1145 (3821)	
ρ_{fc}			.4107 (.4623)	
R^2	.2170			
-Log L			2182.586	

N=971

Standard errors in parentheses.

[a] Difference between column (2) and Column (3) is significant at the 05 level.

Table 8
Predicted Mean and Median Capitulation Times
and Probability of Successful Strike
for Alternative Strike Characteristics

	Mean Capitulation Times:		Median Capitulation Times:		Prob. Successful Strike
	Workers	Firm	Workers	Firm	
	Based on Estimates for Model Without Replacements				
Strike Description:					
a. Basis Case[a]	36.3	23.2	20.3	9.5	0.70
b. Unauthorized Strike	14.1	17.5	7.9	7.1	0.48
c. Log No. Strikers + 1 std. dev.	44.4	32.4	24.8	13.2	0.65
d. Fraction Workers Involved - 1 std. dev.	33.4	27.2	18.7	11.1	0.64
e. Strike in Chicago	34.9	26.4	19.5	10.8	0.66
f. Strike in Illinois Outside Chicago	20.9	40.7	11.7	16.6	0.33
	Based on Estimates for Model With Replacements				
g. Basis Case, Authorized, No Replacements	58.5	14.5	30.7	6.4	0.77
h. Unauthorized, No Replacements	20.4	12.3	10.7	5.4	0.56
i. Authorized, Replacements Used	50.0	47.0	26.3	20.7	0.48
j. Unauthorized Replacements Used	17.4	40.0	9.2	17.6	0.24

Notes: Entries are based on simulations using paramenter estimates from models described in Tables 6 and 7. See text.

[a]Basis case is authorized strike in New York state in miscellaneous industry with log of number of strikers and fraction of workers involved in the strike set to their sample averages.

Table 9

Semi-Parametric Estimates of the Hazard Rate For Union and Firm Capitulation Time

Variable	Firm Capitulation Hazard (1)	Union Capitulation Hazard (2)	Firm Capitulation Hazard (3)	Union Capitulation Hazard (4)
Authorized by Union	-.0162	-1.2416	-.0381	-1.2889
	(.1307)	(.1493)	(.1329)	(.1520)
"1" if Strike Replacements			-1.0459	.6032
			(.1273)	(.1384)
Log(No. of Strikers)	-.1371	-.1276	-.1256	-.1496
	(.0290)	(.0505)	(.0290)	(.0510)
Fraction of Workers on Strike	.5485	-.7642	.4880	- 7129
	(.1919)	(.2248)	(.1815)	(.2242)
Strike in 1st week of May, 1886	-.4838	-.0945	-.3986	-.1393
	(.3013)	(.2962)	(.3117)	(.3130)
Strike on or after 1st week of May, 1886	-.4870	-.1921	-.4213	-.1373
	(.1918)	(.2366)	(.1875)	(.2413)
Illinois	-1.0866	.5639	-1.0055	.5733
	(.2814)	(1869)	(.2826)	(.1873)
Massachusetts	-.2608	-.5112	-.3454	-.4482
	(.2198)	(.2833)	(.2179)	(2788)
Chicago	1.0155	-.4477	.8546	-.2943
	(.3003)	(.2467)	(.3014)	(.2444)
11 Industry & 5 Year Dummies	Yes	Yes	Yes	Yes
-Log L	1568.25	945.63	1523.68	935.95

Standard errors in parentheses.
N=971
The estimates of the baseline hazard rates are shown in Figures 5a and 5b

Table 10
Comparison of Model Implications:
Semi-Parametric Proportional Hazards vs. Normal Competing Risks Model

	Expected Log Capitulation Time Given Capitulation in First 21 Days				Probability of Capitulation Time $\geq$ 21 Days			
	Firm		Union		Firm		Union	
	S-P (1)	Normal (2)	S-P (3)	Normal (4)	S-P (5)	Normal (6)	S-P (7)	Normal (8)
a. Base Case	1.53	1.47	1.93	1.84	0.28	0.18	0.40	0.27
<u>Change in Capitulation Time or Probability From Base Case:</u>								
b. Authorized By Union	0.01	0.10	0.14	0.42	0.01	0.04	0.38	0.35
c. Replacements Used	0.23	0.56	-0.17	-0.08	0.37	0.32	-0.22	-0.04
d. Begin First Week May 1886	0.10	0.24	0.00	0.00	0.13	0.10	0.00	0.00
e. Begin Afer April 30 1886	0.02	0.21	0.00	-0.01	0.14	0.09	0.00	-0.01
f. Illinois (outside Chicago)	0.21	0.37	-0.22	-0.41	0.36	0.18	-0.21	-0.16
g. Massachusetts	0.01	0.26	0.07	0.06	0.13	0.11	0.16	0.04
h. Chicago	0.05	0.17	-0.07	-0.05	0.06	0.07	-0.11	-0.03
<u>Derivative of Mean or Probability:</u>								
i. Log of Number of Strikers	0.05	0.10	0.03	0.06	0.05	0.03	0.06	0.03
k. Fraction of Workforce on Strike	-0.17	-0.22	0.15	0.21	-0.19	-0.07	0.27	0.12

Notes: The base case is an unauthorized strike in New York state in 1881 in which replacements were not hired. S-P refers to predictions from a semi-parametric proportional hazards model. Normal refers to predictions from a normal competing risks model. See text.

Table 11

Estimates of Change in Log(wage) When the Union Wins Strikes Over Wage Increases

Variable	ΔLnW OLS Estimates (1)	ΔLnW MLE Estimates (2)	$(\beta_u - \beta_f)$ (3)
Authorized by Union	.0184 (.0080)	.0367 (.0089)	.6611 (.2190)
"1" if Strike Replacements			
Log(No. of Strikers)	-.0069 (.0018)	-.0083 (.0023)	-.0792 (.0400)
Fraction of Workers on Strike	.0380 (.0108)	.0534 (.0132)	.7205 (.2691)
Strike in 1st week of May, 1886	-.0026 (.0162)	-.0126 (.0189)	-.2902 (.2566)
Strike on or after 1st week of May, 1886	-.0145 (.0113)	-.0176 (.0111)	-.2442 (.2129)
Illinois	-.0252 (.0163)	-.0659 (.0149)	-1.1119 (.3602)
Massachusetts	-.0048 (.0121)	-.0044 (.0160)	-.1044 (.2291)
Chicago	.0190 (.0172)	.0595 (.0170)	.9482 (.3396)
11 Industry & 5 Year Dummies	Yes	Yes	Yes
σ_w	.0611	.0700 (.0029)	
ρ_{uw}		.2837 (.1742)	
ρ_{fw}		-.2365 (.0607)	
ρ_{uf}		.7971 (.2834)	
R^2	.3209		
-Log L		1138.51	
Sample Size	529	971	

Standard errors in parentheses.
The results shown in column 4 are based the estimates reported in Table 6.

Table 12

Estimates of Change in Log(wage) When the Union Wins Strikes Over Wage Increases

Variable	ΔLnW OLS Estimates (1)	ΔLnW MLE Estimates (2)	$(\beta_u - \beta_f)$ (3)
Authorized by Union	.0184 (.0081)	.0341 (.0091)	.8916 (.2213)
"1" if Strike Replacements	.0000 (.0073)	-.0242 (.0098)	-1.3320 (.2653)
Log(No. of Strikers)	-.0069 (.0018)	-.0073 (.0023)	-.0544 (.0430)
Fraction of Workers on Strike	.0380 (.0109)	.0456 (.0134)	.7711 (.2628)
Strike in 1st week of May, 1886	-.0026 (.0164)	-.0083 (.0192)	-.2435 (.3150)
Strike on or after 1st week of May, 1886	-.0145 (.0114)	-.0165 (.0105)	-.2136 (.2431)
Illinois	-.0252 (.0164)	-.0574 (.0155)	-1.3944 (.3689)
Massachusetts	-.0048 (.0122)	-.0088 (.0159)	-.3467 (.2818)
Chicago	.0190 (.0172)	.0481 (.0172)	1.0019 (.3530)
11 Industry & 5 Year Dummies	Yes	Yes	
σ_w	.0612	.0662 (.0026)	
ρ_{uw}		.4158 (.1597)	
ρ_{fw}		-.2031 (.0633)	
ρ_{uf}		.6326 (.2371)	
R^2	.3209		
-Log L		1078.22	
Sample Size	529	971	

Standard errors in parentheses.
The estimates shown in the third column are from Table 7.

Table 13
Industry Effects in Worker and Firm Capitulation Times
and Wage Increase Conditional on Successful Strike

Model Without Strike Replacements

	Estimated Industry Effects In:			
	Capitulation Time Equations:			
	Workers (β_u)	Firm (β_f)	Workers - Firm (β_u-β_f)	Wage Increase Equation (β_w)
Industry:				
Apparel	-0.48	0.21	-0.69	-0.050
	(0.26)	(0.33)	(0.32)	(0.015)
Building Trades	-0.32	-1.22	0.90	0.057
	(0.27)	(0.23)	(0.34)	(0.012)
Food	0.04	-0.39	0.43	0.055
	(0.27)	(0.26)	(0.35)	(0.018)
Machines	0.29	-0.03	0.31	-0.013
	(0.28)	(0.29)	(0.31)	(0.033)
Metals	-0.15	-0.49	0.35	0.008
	(0.16)	(0.18)	(0.19)	(0.013)
Mining	0.56	0.23	0.33	0.018
	(0.24)	(0.33)	(0.33)	(0.023)
Shoes and Boots	0.42	-0.36	0.78	0.050
	(0.26)	(0.23)	(0.32)	(0.012)
Textiles	0.11	-0.11	0.21	0.016
	(0.25)	(0.34)	(0.31)	(0.023)
Tobacco	0.22	-0.68	0.90	-0.036
	(0.24)	(0.20)	(0.30)	(0.015)
Transportation	-0.38	-0.58	0.19	0.034
	(0.22)	(0.21)	(0.23)	(0.013)
Wood Products	-0.52	0.05	-0.57	-0.071
	(0.25)	(0.25)	(0.29)	(0.020)
Other Industries	--	--	--	--

Notes: Standard errors in parentheses. Estimates are from system composed of capitulation times for workers and firms, together with wage increase conditional on successful strike. See text.

Table 14
Industry Effects in Worker and Firm Capitulation Times and Wage Increase Conditional on Successful Strike

Model With Strike Replacements

	Estimated Industry Effects In:			
	Capitulation Time Equations:			
	Workers (β_u)	Firm (β_f)	Workers - Firm (β_u-β_f)	Wage Increase Equation (β_w)
Industry:				
Apparel	-0.56 (0.26)	0.07 (0.31)	-0.63 (0.32)	-0.040 (0.015)
Building Trades	-0.15 (0.27)	-1.03 (0.22)	0.88 (0.32)	0.048 (0.012)
Food	0.17 (0.31)	-0.34 (0.25)	0.51 (0.39)	0.053 (0.016)
Machines	0.37 (0.31)	0.04 (0.30)	0.33 (0.37)	-0.022 (0.036)
Metals	-0.07 (0.18)	-0.45 (0.18)	0.38 (0.22)	0.004 (0.013)
Mining	0.56 (0.27)	0.17 (0.34)	0.39 (0.39)	0.013 (0.024)
Shoes and Boots	0.61 (0.26)	-0.08 (0.22)	0.68 (0.31)	0.041 (0.012)
Textiles	0.20 (0.27)	-0.06 (0.35)	0.26 (0.35)	0.014 (0.023)
Tobacco	0.38 (0.23)	-0.42 (0.19)	0.80 (0.27)	-0.046 (0.014)
Transportation	-0.33 (0.24)	-0.67 (0.21)	0.34 (0.28)	0.036 (0.012)
Wood Products	-0.53 (0.28)	0.04 (0.24)	-0.57 (0.33)	-0.067 (0.021)
Other Industries	--	--	--	--

Notes: Standard errors in parentheses. See note to Table 13.