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Firm Investment Behavior and Collective Bargaining Strategy

by

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Abstract

This paper utilizes survey data on labor union coverage at the firm level to examine union-nonunion differences in investment activity among 706 U.S. companies during the 1970s. Consistent with a model of union rent seeking, firm-level collective bargaining is associated with significantly lower physical capital and R&D investment, even following extensive control for firm and industry characteristics. Deleterious union effects on investment are sizable throughout the 1972-1980 period, but vary considerably across industries. In the absence of significant changes in collective bargaining power or strategies, diminished investment activity by unionized companies is likely to exacerbate the already considerable decline in U.S. union coverage.

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Introduction

Sustained growth in productivity, employment, and output requires regular infusions of physical capital and the development of product and process innovations. Who controls the returns emanating from such tangible and intangible capital is a crucial determinant of investment activity. If unions appropriate a share of the quasi-rents[1] accruing to long-lived capital, then union coverage, bargaining power, and strategy are likely to influence firm investment behavior. Unions and management may develop incentive-compatible, long-run bargaining protocols so that collective bargaining coverage has a relatively small impact on factor mix and investment behavior. On the other hand, noncooperative behavior and incentive incompatibility between unions and management are likely to increase the negative effects of unionization on investment and may also undercut the already dwindling power of unions in the workplace.

This paper presents a model of union rent seeking in which collective bargaining coverage acts as a tax on quasi-rents accruing to long-lived, firm-specific capital. Assessing the effects of collective bargaining on investment behavior requires empirical evidence. Previous empirical studies, however, have been seriously limited by the absence of a firm-level measure of the extent of union coverage. This study overcomes that problem by using firm-specific, union coverage data collected by the author. The study then examines investment behavior on the part of 706 publicly traded U.S. companies over the 1972-80 period. In addition to estimating the effect of collective bargaining coverage on physical capital and R&D investment, the analysis delineates direct and indirect union effects, examines the stability of union-nonunion investment differences over time, and identifies differences in union investment effects across broad industry categories.

Following an outline of the theoretical framework, the data, descriptive evidence, and empirical model are presented. Regression results provide evidence of union effects on capital and R&D investment. Union investment effects persist even in equations estimated separately by year and industry group. The implications of these findings for collective bargaining strategy are discussed.

[1] Quasi-rents are the returns to capital exceeding its opportunity costs; they provide what are largely the normal returns to previous R&D and capital investment.

Union Rent Seeking, Bargaining, and Investment Behavior1

When a union and management bargain over the level and mix of pecuniary and nonpecuniary compensation, work conditions, and workplace governance structures, management can be assumed to be striving to maximize the value of the firm (the discounted stream of future earnings). The union maximand is less clear; presumably, the union seeks contract provisions that will provide compensation-employment combinations more highly valued by its members than those available in alternative jobs.[2] Since each party has some degree of monopoly or monopsony power, short- and long-run bargaining outcomes indeterminate. The parties engage in repeated bargaining (typically, every three years) and may arrive at either cooperative (i.e., jointly maximizing) or noncooperative bargaining outcomes. In either case, investment decisions are likely to differ between union and nonunion companies.

Union monopoly power derives from a combination of the rights granted to workers by U.S. labor law, and the costs a union can impose on a firm through a strike or other systematic reduction in labor input. Management must bargain in good faith with a union that has won recognition in an NLRB representation election, but neither side is required to arrive at a contractual agreement. To the degree that it is costly for a firm not to reach an agreement or to substitute a nonunion workforce, monopoly power accrues to the union. The union's bargaining power is constrained, however, by the level and elasticity of labor demand (although settlements need not be on the demand curve) and by the legal rules and enforcement surrounding the NLRB union representation process. The firm accrues monopsony power to the degree that its employees possess firm-specific skills not easily transferred to other firms and because workers face fixed costs associated with job changes.

Union rent seeking will be distortionary in the long run if firms respond to union demands by altering their investment in tangible and intangible capital. Recent studies have provided diverse theoretical

[2] This section is based on discussion in Hirsch (1990a). Potential principal-agent problems between shareholders and management and between union leaders and the rank and file are deliberately ignored. On the latter, see Faith and Reid (1983).

models of the union bargaining process in a dynamic setting.[3] Here, a game-theoretic rent-seeking model is presented. The model assumes the following:

1. The firm cannot, without cost, substitute nonunion for union labor (or plants).

2. The firm has (or would have, without the union) long-lived intangible or physical capital providing quasi-rents. Stated alternatively, once in place, the costs of capital are partly fixed and capital is relationship-specific.

3. The time horizon over which the union rank and file evaluates its utility is shorter than the horizon over which shareholders evaluate earnings. Or, similarly, the union discounts future returns more highly than do shareholders[4]

Such assumptions are reasonable. Substitution of nonunion for union labor is costly, owing to the union's strike threat and workers' possession of firm-specific skills. The productive life of innovative or physical capital (often emanating from past R&D) typically exceeds the life of a union contract and such capital cannot be transferred without cost. The union (or rank and file with median preferences) is also likely to have a more limited time horizon than do shareholders. Whereas the shareholders should have an unlimited horizon because ownership shares are transferable (the future, of course, may be highly discounted), union members are unable to sell or transfer their positions in the union.

In the case of noncooperative bargaining outcomes, once long-lived capital is in place, the union can appropriate or tax some share of the quasi-rents deriving from that capital. As long as the union maintains a credible strike threat and the firm can recover its variable costs, the firm will "voluntarily" share with the union its returns on capital rather than severely curtail production. The union can appropriate a larger share of the quasi-rents the more firm-specific is the innovative and physical capital and the longer is its productive life. The union places a wedge between the private and social rates of return so that in response to the union tax, the firm reduces its investment in long-lived capital until the postunion marginal rate of

[3] See Baldwin, 1983; Grout, 1984; Bronars and Deere, 1988; van der Ploeg, 1987; and Tauman and Weiss, 1987. Empirical evidence bearing on these models is provided in Connolly, Hirsch, and Hirschey, 1986; Hirsch, 1990a, 1990b; Bronars and Deere, 1988; Bronars, Deere, and Tracy, 1988; Abowd, 1989a; and Wadhwani and Wall, 1989.

[4] The possibility of opportunistic behavior in which firms appropriate worker rents associated with relation-specific skills is ignored because such behavior is typically limited by reputational effects. For an analysis of this issue, see Williamson, Wachter, and Harris (1975), Klein, Crawford, and Alchian (1978), and Crawford (1988).

return is equal to the opportunity costs of funds. Investment in all forms of vulnerable capital will decrease; in the most extreme case, the firm ceases investment and eventually shuts down its union operations. Baldwin (1983) suggests an alternative scenario: Union firms maintain some inefficient capital (or plants) in order to mitigate high union wage demands by shutting down low-productivity plants, thus decreasing union employment.[5]

As long as there are a limited number of bargaining periods, noncooperative bargaining outcomes are likely and investment activity will be restricted. To encourage the firm to invest in long-lived capital, a union could announce a low future wage demand. This wage commitment would be neither credible nor binding beyond the contract period, however, because once the capital was in place, the union could increase wage demands in the final bargaining period. Knowing this, the firm would not commit to a nonunion investment level. The union could make its wage commitment credible by offering a "bond" or "hostage" that it would forfeit if it reneged on its promise. But unless the bond is held by a third party, the firm would have an incentive to default on the bond and could not make a credible commitment to the union. Such bonds do not have obvious real world counterparts.

Because collective bargaining is characterized by repeated bargaining, current behavior by both the firm and the union will affect each party's reputation and credibility in future bargaining rounds.[6] This limitation on the scope for opportunistic behavior increases the likelihood of cooperative bargaining outcomes. A cooperative outcome is defined here as one that maximizes the joint value of the firm and the union.[7] This joint value is the sum of the firm's market value (the present value of future earnings to shareholders) and the present value of union members' rents.

Holding the capital stock fixed, the possibility of cooperative outcomes from repeated union-management bargaining implies that union representation has no distortionary effects on output, price, or

[5] Baldwin's model implicitly assumes that the contract wage is similar across all union plants and the firm is free to vary employment. Hence, union wage demands based on productivity in a firm's efficient plants would lead to layoffs or shutdowns at the firm's inefficient plants.

[6] An exception is where a firm is expected to shut down operations. Initially, union wage demands and the union-nonunion wage differential may increase in a declining industry with long-lived specific capital. For similar arguments along these lines, see the analysis of the U.S. steel industry by Lawrence and Lawrence (1985).

[7] Abowd (1989b) refers to this joint value as the value of the enterprise. .

factor usage. This is the strong efficiency or vertical contract curve case (Brown and Ashenfelter, 1986; Clark, 1984) in which the firm and union maximize the size of the pie and bargain over the distribution of returns to labor and to shareholders.[8] In the long run, however, union rent seeking will be distortionary relative to an otherwise similar nonunion environment. Specifically, union rent seeking is likely to lead to reduced investment in long-lived, relation-specific capital.[9] Such underinvestment results from the limited time horizon over which a democratically controlled labor union evaluates its future returns and the nontransferability (i.e., incomplete property rights) of union membership. Union leaders respond to rank-and-file with median preferences. Typically, these are relatively senior members with a relatively short expected remaining tenure at the firm. Moreover, senior workers may make relatively high wage demands if they face relatively low probabilities of permanent (seniority-based) layoff and perceive little threat to their pension payments.[10] Largely unweighted in the union calculus are preferences of relatively junior members, or of unobserved workers who could be future union members were the union's compensation demands lower. Thus, the union will attach great weight to current rents, while heavily discounting potential future rents.

Although efficient (cooperative) contracting in this situation maximizes the sum of owner and union member "wealth," rational union myopia results in lower investment than obtains in a nonunion firm, shifting returns more heavily toward the present and away from the highly discounted future. There are few obvious mechanisms by which to make union goals more fully incentive-compatible with those of the firm

The rent-seeking model predicts that collective bargaining coverage changes investment decisions because firms respond to a rationally myopic union by decreasing investment in vulnerable capital. In contrast to the prediction of the conventional on-the-demand curve model, firms facing a rent-seeking union

[8] Strong efficiency implies that the firm's employment level is a function of the opportunity cost wage, and not the "own" wage as implied by settlements on the labor demand curve. This prediction has formed the basis for empirical tests of on-the-demand curve versus off-the-demand curve bargaining models.

[9] Crawford (1988) argues that governing long-term relations with short-term contracts will in general lead to inefficient contracts and underinvestment in relation-specific fixed-cost capital. The argument here is that even if efficient (jointly maximizing) contract settlements obtain, there still will be lower investment by union than by similar nonunion companies.

[10] Government pension guarantees may actually worsen union myopia. Unionized companies, on the other hand, have incentive to underfund their pension plans as a means of making the union more forward looking; on this point, see Ippolito (1985).

may decrease both the capital level and the capital-labor ratio. Firms will decrease investment most in long-lived relation-specific capital whose returns are most easily appropriated, while either increasing or decreasing investment in capital whose returns are less easy to appropriate. Even the prediction that unionized firms will invest relatively more than nonunion firms in labor-saving capital need not follow. If the union can retain its preinvestment strike threat with a reduced workforce (e.g., through the ability to shut down a plant), then the returns from labor-saving capital are no less appropriable than those from factor-neutral investment. On the other hand, if the union's strike threat and bargaining power are functions of the size of the organized workforce, then the prediction of labor-saving investment more readily follows.

Returns from investment in R&D and non-R&D innovative activity may accrue over a shorter time span than returns from physical capital, but such capital may still be relatively long-lived and appropriable. Relatedly, knowledge about products or processes emanating from R&D projects may lead to investment in physical capital whose returns in turn face a high union tax rate. That is, the decision to lower future investment in physical capital may decrease current investment in R&D. For these reasons, unionized firms are less likely to invest in innovative activity than are similar nonunion firms. This decrease in innovation is likely to be most notable for relatively factor-neutral product or process innovation. Labor-saving process innovation may be less affected since the substitution effect of a wage increase may heighten the relative importance of labor-saving innovation.[11]

The union rent-seeking model presumes that union coverage will have both direct and indirect effects on capital and on R&D investment. Union firms in general experience lower rates of profit than do otherwise similar nonunion firms.[12] Because current profits provide a primary (and possibly low-opportunity cost) source for funding investment, decreased profitability leads "indirectly" to lower rates of R&D and capital investment, independent of any direct union effects. The "direct" effect of unionization

[11] Lach and Schankerman (1989) provide evidence that R&D "Granger causes" capital investment, but investment doesn't Granger cause R&D. Most company-financed R&D expenditures are for product rather than process innovations, although product innovations by companies selling intermediate products make up a major source of process innovations to purchasers.

[12] Unions may capture profits associated not only with quasi-rents, but also those emanating from product market power or from disequilibrium. For an examination of these issues, empirical evidence on union profit effects, and references, see Hirsch (1991a; 1991b) and Becker and Olson (1987).

results because the union tax is likely both to be distortionary and to decrease investment in capital whose returns are most vulnerable to union appropriation, even in the event of cooperative or efficient long-run contracting between firms and unions. Union companies reduce investment until the postunion marginal rate of return equals the opportunity cost of funds. Lower investment by union firms in physical capital and R&D will be observed, unless offset by particularly strong wage (substitution) effects.

Because high union wage rates in part reflect a tax on the returns to tangible capital investment, it is not possible to observe relative factor prices facing union firms. It is therefore difficult to estimate a labor demand curve for union firms since the observed wage rate overstates the cost of labor relative to capital. The finding that unions have relatively little effect on the capital-labor ratio (Clark, 1984), commonly interpreted as implying efficient bargaining outcomes off the labor demand curve, may in fact result because unions have little effect on relative factor prices. That is, union firms may use factor mixes similar to what they would use if they were nonunion, but still be operating on their labor demand curves (unions are more likely to be organized in capital-intensive firms). Union rent seeking has an output effect, leading to lower investment and employment, but may have little effect on factor mix.

Data and Descriptive Evidence

A few empirical studies have examined the effects of union coverage on the investment behavior of firms. These studies have been hampered, however, by the limited availability of company-specific information on union coverage. Past research has relied on the industry as the unit of observation (Abowd, 1989a) or has matched three-digit industry union membership figures to individual firm data (Connally, Hirsch, and Hirschey, 1986; Bronars and Deere, 1988). Both approaches fail to account for the considerable intraindustry variation in unionization, and both necessarily entangle union and industry effects on investment.

The information on company union coverage used here is drawn from the author's survey (conducted during late 1987 and 1988) of firms included in the National Bureau of Economic Research's *R&D Master File*. The NBER file consists of all publicly traded U.S. manufacturing-sector companies

operating in 1976 that were included on Compustat tapes during 1976-78.[13] Beginning with the 1,904 companies listed in the *File*, all that could be located were contacted by phone and/or mail. Representatives at the largest 1,100 firms received a follow-up questionnaire if they did not respond initially. They were asked to respond to the following question for 1977 and 1987: "To the best of your knowledge, approximately what percentage of your corporation's total North American workforce is covered by collective bargaining agreements?"[14]

A measure of 1977 union coverage was obtained for 723 firms; 578 of these firms supplied usable 1977 union coverage data. Coverage was estimated for 20 additional firms that reported figures for 1987 but not for 1977.[15] Coverage figures for another 125 firms were estimated based on data from an independent 1972 Conference Board Survey. Among all of the companies for which union coverage data were available, 706 had sufficiently complete information on other variables to be included in subsequent empirical analysis.[16]

Means and standard deviations of firm-level union coverage by manufacturing industry category are presented in Table 1. Company union coverage in 1977 averaged 33 percent among this sample of firms. The substantial interindustry and intraindustry variation in coverage evident in the table underscores the importance of measuring unionization at the firm level to obtain reliable estimates of union effects on firm investment behavior. Except for the primary metals category, all industries have at least one nonunion firm, while all categories except office, computers, and accounting equipment have at least one firm with union coverage above 60 percent. The least highly organized industry categories are office, computers, and

[13] Cummins et al. (1985) describe the *R&D Master File*. Access to these data was kindly provided by Zvi Griliches.
[14] Union data for 1977 correspond to the firm as it existed in 1977. In cases where firms had merged, efforts were made to acquire union figures for the operating units as they existed in 1977.
[15] Estimates were derived by multiplying the 1987 figures by 1.21, based on the ratio of 1977-to-1987 coverage figures among the 567 firms for which both years of data were available. The correlation between 1977 and 1987 coverage was 0.87.
[16] No obvious response bias is evident. Investment intensities in capital and R&D are highly similar among those companies that responded to the survey and those that did not respond. The 1972 union data were kindly provided by David C. Hershfield, who developed the figures from data collected in a 1972 survey by the Conference Board. For an analysis of companies in the Conference Board Survey, see Hirsch (1990a). Details on the conversion of the 1972 figures to 1977 values are available from the author on request.

accounting equipment; electrical equipment and supplies; professional and scientific equipment; and drugs and medical instruments.

The data set was constructed by matching firm and industry data with the firm-level union coverage survey information. The investment behavior of the 706 companies from the *R&D Master File* is analyzed for the years 1972-80. Complete data are available for all firms in 1976; missing observations increase as one moves away from 1976. The data set includes information on annual capital investment and the gross and net capital stock, R&D investment and stocks, patents, sales, employment, debt, and advertising expenditures. Data on company age (years since incorporation) were obtained from *Ward's Business Directory* or *Moody's Industrial Manual.* Four-digit industry data on shipments and payrolls were drawn from the Bureau of Industrial Economics' tape-consolidating data from the Annual Survey of Manufactures. Four-digit data on industry concentration (adjusted for imports and regional concentration) and import penetration for 1972 and 1977 were taken from data assembled by Weiss and Pascoe (1986). Industry union coverage data for 1976-78 at an approximate three-digit level was obtained from Kokkelenberg and Sockell (1985), based on estimates from the May Current Population Survey (CPS) tapes. Industry data are matched to the firm at the two-, three-, or four-digit level, based on Compustat's SIC-code designation of the firm's principal industry in 1976.

Table 2 presents evidence on differences in firms' rate of return on capital, capital investment intensity, the ratios of capital stocks to sales and employment to sales, the average age of capital, R&D investment intensity, the ratio of the patent stock to sales, advertising intensity, and company age, all cross-tabulated by union status over the nine-year 1972-80 period. Total sample sizes are less than nine times 706, however, owing to missing data in years other than 1976. "Nonunion" is defined as firms with no union coverage; "low" union as covered firms with less than 30 percent coverage; "medium" union as firms with coverage of at least 30 but less than 60 percent; and "high" union as firms with coverage 60 percent or higher.

The rate of return to capital, $\eth_k$, measured by earnings divided by the gross inflation-adjusted capital stock, decreases as one moves from the nonunion to the high union categories. Unionized companies are

more capital-intensive and less labor intensive than nonunion companies, as seen by the ratios of the capital stock, K/S, and employees to sales, L/S. Although unionized companies have larger capital stocks, investment intensity (measured by the ratio of investment to sales, INV/S, and investment to the capital stock, INV/K), is lower among highly unionized than among nonunion companies. Consistent with these figures is the finding that the average age of capital, CAPAGE, proxied by accumulated depreciation divided by annual depreciation, increases with respect to unionization, ranging from an average of 5.7 years in nonunion companies to 8.6 years among high-coverage companies.

Table 2 also includes measures of R&D intensity (company-financed R&D expenditures divided by sales) for two samples of firms. $R\&D_1/S$ includes R&D-active firms, that is, those reporting positive R&D expenditures. The second measure, $R\&D_2/S$, includes not only R&D-active firms in the sample, but also nonreporting firms, which are assumed to have zero R&D expenditures (see Bound et al., 1984, for a discussion of this issue). Both measures of investment intensity decrease markedly with union coverage. The drop is particularly sharp between the nonunion and low union groups. Patent intensity exhibits a pattern similar to R&D intensity. The stock of patents granted per dollar of (deflated) sales, PAT/S, declines sharply with union coverage. The ratio is about three times higher among the nonunion than among the high union companies. Among those companies that reported annual advertising expenditures, advertising intensity, ADV_1/S, is about 3 percent of sales among the nonunion and low union sample of firms, as compared with about 2 percent among the high coverage firms. Finally, nonunion companies are significantly younger than are union companies, averaging 43 years since incorporation, as compared with an average of about 61 years for unionized companies.

The descriptive data presented in Table 2 are suggestive, but they do not allow reliable inferences regarding partial correlations or causal effects. Subsequent analysis therefore examines in detail the relationship between company-level union coverage and firm investment behavior during the 1970s.

Union Effects on Capital and R&D Investment: Specification and Results

Profit-maximizing firms invest in physical and R&D capital in order to obtain capital stocks that provide optimal flows of capital services. Investment is thus determined by factors influencing product

price, output, production technology, and relative factor costs. Physical capital and R&D investment equations are estimated here for companies over the period 1972-80. The following general form of an investment equation is estimated:

(1) $I_{it} = \alpha + \Sigma \hat{a}_j X_{jit} + \Sigma \tilde{a}_k Z_{kit} + \Sigma \ddot{a}_m YEAR_{mt} + \phi UN_i + e_{it}$,

where I_{it} is investment of firm i in year t, measured alternatively by the log of annual capital investment, ln(INV), and by the log of annual R&D expenditures, ln(R&D). The coefficient á is an intercept; X_j represents j firm-specific variables and $\hat{a}_j$ are the attaching coefficients; Z_k represents k industry variables, and $\tilde{a}_k$ are the attaching coefficients; $YEAR_m$ represents m year dummies, and $\ddot{a}_m$ are the corresponding coefficients; UN_i measures union coverage in firm i during 1977, and ø is its coefficient (measurement of unionism is discussed below); and e_{it} is a random error term assumed (at this stage of the analysis) to have zero mean and constant variance.

Optimal investment is a function of output (and thus product price) and relative factor prices, *inter alia*. To account for output (or scale), an investment-intensity equation can be estimated by dividing both sides of the equation by sales or, alternatively, by including output on the right-hand side (a log-intensity equation is equivalent to a double log levels model in which the log output coefficient is constrained to equal unity). Here, double log models are estimated in which input variables measuring employment and the capital stock (and the R&D stock in the case of R&D investment) are included on the right-hand-side. Output is some linear combination of the included input variables. Product price should vary little between union and nonunion companies competing in the same market. (The inability of union companies to fully pass forward higher costs is evinced by the substantial union-nonunion differential in profitability). Firm-specific price differences owing to, for example, demand shifts, are accounted for by firm profitability and growth rate variables. Industry differences in price are accounted for by industry sales growth, industry dummies, and other industry-level variables.

Since firms in a cross section face similar investment costs, a direct measure of the capital costs facing individual firms is not essential and is not used here (such a measure is not available). Year dummies can account for differences in costs over time, while industry dummies may capture industry-specific cost

and price differences. To the extent that retained earnings provide a lower cost source of funds, investment should be positively related to current firm profitability, which is included as a regressor. A direct measure of the labor costs facing most firms in the sample is not available, but a measure of industry labor costs is concluded. The industry wage provides a measure of the opportunity cost wage facing the firm, which is more important than the firm's own wage in determining investment if cooperative bargaining outcomes obtain. Moreover, to the extent that union appropriation of firm quasi-rents takes the form of higher wage costs, inclusion of a firm-specific wage variable might capture much of what is in fact a union effect on investment.

The Data Appendix provides definitions for all variables used in the regression equations. The control variables differ slightly between the ln(INV) and ln(R&D) equations. Included among the firm variables X in the ln(INV) equations are firm profitability, $\eth_k$, measured by the company's gross rate of return on capital; firm size, ln(L), measured by the log of employment; the current capital stock net of new investment, ln(K)(-1), measured by the log of the inflation-adjusted capital stock minus current investment; company age, AGE, measured by years since incorporation; and company-specific sales growth, GROWTH, measured by annualized logarithmic growth in sales between years t and t-2 (firm-years with GROWTH less than -1.0 or greater than 1.0 are excluded from the sample). Industry variables are matched to firms at the two-, three-, or four-digit level, depending on the firm's designated primary industry code in Compustat. Included among the industry variables Z are industry sales growth, I-GROWTH, measured by the annualized logarithmic growth in constant dollar shipments between years t and t-4; industry average earnings, I-EARN, measured by the log of the average compensation per worker in the industry; industry concentration, I-CR, measured by the four-firm concentration ratio adjusted for regional markets, imports, and exports; foreign competition, I-IMPORT, measured by the share of imports in total domestic sales; industry union coverage, I-UN; and industry dummies IND at an approximate two-digit level.

Included in the ln(R&D) equations are the current capital stock, ln(K), and a variable measuring the R&D stock minus current R&D expenditures, ln(R&D Stock)(-1). All other variables are identical to those

included in the ln(INV) equations, listed above. The R&D investment equation includes only R&D-active firms; that is, company-years with positive reported R&D expenditures.

Union rent seeking is likely to have both direct and indirect effects on firm investment behavior. The union tax on the returns or quasi-rents to non-transferable capital will directly decrease capital and R&D investment, as firms adjust investment to equate their marginal post-union tax rate of return with their marginal financing cost. Marginal rates of return for union and nonunion firms will be equivalent only if firms face identical and perfectly elastic marginal supply of funds schedules. Union rent seeking also will have an indirect effect on investment. By lowering current company profitability, the unionized company typically will have higher marginal financing costs and a concomitant decrease in investment.

Subsequent empirical work will distinguish between unionism's direct and indirect effects. The direct union effect on investment is measured by ø, the coefficient on UN in equation (1) with the rate of return on capital, $ð_k$, included as a control variable. The total union investment effect, comprised of the sum of the direct and indirect effect, can be measured by the coefficient on UN in investment equations with $ð_k$ excluded.

Table 3 presents regression results for capital investment equations, with the log of annual real investment expenditures, ln(INV), as the dependent variable. Results are presented for specifications with and without industry dummies and the profitability measure, $ð_k$. Results on variables other than unionization are briefly examined. The lagged capital stock variable can be considered a scale or output variable, with the coefficient close to unity. The variable ln(L) may also serve as a scale variable; its positive coefficient indicating a positive relationship between size and investment, ceteris paribus. Investment is significantly lower among older companies. Both company-specific and industry sales growth, intended to proxy demand shifts, are positively and significantly related to current capital investment. Capital investment is positively related to the opportunity cost of labor, proxied by I-EARN, measuring the log of average industry compensation in a firm's principal industry. Capital investment is not significantly related to industry concentration, but is negatively related to import penetration in the

company's principal industry. Following inclusion of industry dummies, industry union density (I-UN) and capital investment are positively related.

The relationship between union coverage and investment behavior is examined by including in the regression equations three categorical variables corresponding to low, medium, and high levels of union coverage, with nonunion the omitted reference group (UN-LOW=1 if [0<UN<.30], UN-MED=1 if [.30 UN<.60], and UN-HIGH=1 if [UN .60]). The evidence in Table 3 indicates that firm-level union coverage is negatively and significantly related to capital investment. Coefficients on the union variables in column (2) indicate that unionized companies invest from 10 to 16 percent less than do otherwise similar nonunion companies.[17] The magnitude of the union coefficients suggests a nonlinear relationship between the log of capital investment and the extent of union coverage. Companies with medium coverage display the most deleterious effects of unionization on capital investment. Including the union dummies is thus preferable to using the single union coverage variable UN.

The union coefficients in columns (1) and (2) provide estimates of the direct effect of unionization on capital investment resulting from the union tax on quasi-rents that makes up the normal return to investment. Unions also have an indirect effect on investment by decreasing the earnings that provide a source of funds for investment.[18] The total (direct plus indirect) effect of unions on annual capital is shown in columns (3) and (4), where δ_k is excluded as a control variable. Based on the results in column (4), the total union investment effect is -14.6, -22.9, and -17.2 percent for the three union categories, respectively. Comparisons of coefficients in columns (2) and (4) indicate that approximately one-third of the this total for low and medium union companies is an indirect effect, whereas for high-coverage firms, about half is an indirect effect owing to lower profits in highly unionized companies.[19]

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[17] Letting $\hat{O}$ be the coefficient or logarithmic differential, the percentage difference is approximated by [exp($\hat{O}$)-1]100. See Giles (1982) for comparison of alternative approximations.

[18] A profitability variable can also be included in an investment equation in order to proxy product demand shifts. The specifications estimated here, however, already include firm and industry sales growth variables intended to capture demand shifts.

[19] Estimates of the total, direct, and indirect effects also are obtained by calculation of:

$$d\ln I/dUN = \partial \ln I/\partial UN\,|_{\delta} + (\partial \ln I/\partial \delta)\,|_{UN}\ (\partial \delta/\partial UN),$$

Union-nonunion differences in R&D investment are examined in a matter largely analogous to the analysis of capital investment.[20] Table 4 presents regression results for the sample of R&D-active firms. The dependent variable is the log of real annual expenditures on R&D; specifications are presented with and without inclusion of industry dummies and δ_k. Coefficient estimates on variables other than union coverage can be summarized briefly. R&D investment is positively related to firms' current earnings, measured by the gross rate of return on capital. The lagged R&D stock (net of current investment), physical capital stock, and log of employment variables jointly act to control for scale (output) and firm size. All three have positive and significant coefficients, although that on ln(R&D stock)(-1) is well below unity.[21] Investment in R&D is significantly lower in older firms. R&D investment is positively related to both firm- and industry-specific sales growth, as well as to labor costs as proxied by I-EARN. R&D investment appears to be stimulated by a competitive market structure: It is negatively related to industry concentration and positively related to import competition. Industry union density (I-UN) is negatively related to company R&D investment.

The coefficients on the firm union coverage variables provide support for the thesis that unionization significantly decreases investment in innovative activity. Estimates from column (2) indicate that R&D investments are 25, 27, and 35 percent lower at low, middle, and high coverage firms, respectively, than at similar nonunion company. These substantial union-nonunion differentials measure only the direct union effect, however. Total union effects are estimated (from coefficients in column 4) to be 25, 29, and 37 percent, indicating that indirect union effects on R&D expenditures are rather small.[22]

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where the term ($\partial \delta / \partial$ UN) was obtained from estimation of an auxiliary profitability equation and the other terms were obtained from investment equation coefficients. Estimates obtained in this manner are highly similar to those obtained by the simpler method described in the text.

[20] For other empirical evidence on unions and R&D, see Connolly, Hirsch, and Hirschey (1986), Hirsch (1990a; 1990b), and Bronars, Deere, and Tracy (1988); for evidence on other forms of innovative capital, see Hirsch and Link (1987) and Acs and Audretsch (1988).

[21] The sum of the coefficients on the logs of the R&D stock, capital stock, and employment is a little above unity. Coefficients summing to unity would imply that, e.g., 10 percent increases in labor, the R&D stock, and the physical capital stock are associated with a 10 percent increase in current R&D expenditures.

[22] Similar conclusions are reached when an R&D intensity (R&D/Sales) equation is estimated. When the sample is expanded to include non-R&D active firms, Tobit estimates indicate a somewhat lower union effect on investment. Note also that past unionization has lowered the size of the current R&D stock, which in turn lowers current expenditure.

These results show that there are large differences in physical capital and R&D investment behavior between union and nonunion companies. These results are investigated further below, first, by considering the possibility that union coefficients capture in part industry effects and, second, by examining the possibility of bias arising from union endogeneity.

Investment behavior varies significantly across industries, independent of union coverage. Regression equations estimated previously included industry dummies at the approximate two-digit level, coupled with relatively detailed firm and industry control variables. As a further check, we include in the investment equations 105 industry dummies defined at the two-, three-, and four-digit level (depending on the specificity of Compustat's designated principal industry code). Inclusion of the detailed dummies, however, has relatively little effect on the union coefficients. The coefficient ($|t|$) on the variable UN-DUM (a dummy variable equal to one if a firm has any union coverage) in the capital investment equation changes from -0.149 (7.08) (see Table 5, column 1), to -0.147 (6.87). In the case of R&D investment, the change is from -0.297 (11.04) (see column 3) to -0.298 (11.27). The relative insensitivity of estimated union effects to inclusion of detailed industry dummies is noteworthy because R&D opportunities and capital investment intensities vary so significantly across industries (on the former, see Levin et al., 1987).

A concern in all econometric analyses of labor unions is the possibility that collective bargaining coverage is not exogenous but, rather, is determined simultaneously with the dependent variable, thus leading to biased coefficients. A standard treatment is to employ simultaneous equation methods and examine the sensitivity of the union coefficient to the use of instrumental variables. Unfortunately, such an approach requires identification and measurement of exogenous variables that are determinants of union coverage but not of investment behavior. There are no obvious candidates in the data set. The system has been overidentified, however, by first estimating a Tobit equation with UN as a function of all exogenous variables in the investment equations, plus the detailed industry dummies at the two-, three-, and four-digit levels as instruments. Predicted UN is then included in two-stage least squares investment equations. Substitution of the predicted for actual UN variable does not support the supposition that our previous findings of negative union effects were simply the result of simultaneity bias.

In a specification of the ln(INV) equation otherwise identical to that shown in Table 3, column (2), the coefficient on UN changes from -.149 to -.757 following substitution of the UN instrument. This qualitative result is consistent with the expectation that union coverage is more likely in companies with high rates of investment and capital intensity, thus biasing toward zero ordinary least squares estimates of union investment effects. In a ln(R&D) equation similar to that shown in Table 4, column (2), the UN coefficient changes from -.446 using UN to -.422 with predicted UN. In the absence of richer data and/or theory, however, little confidence in this particular set of estimates.

Union Effects on Investment: Estimates by Industry and Year

Union effects on investment behavior are likely to vary considerably across sectors of the economy, just as do union effects on wages and other dimensions of economic performance. Table 5 presents estimates of union effects on both capital and R&D investment, disaggregated for 19 industry groupings at an approximate two-digit level. For ease of presentation, coefficient estimates are given for a single union dummy variable rather than three coverage level dummies or for a proportion covered variable. Such a restriction is not unreasonable, given the magnitude of the coefficients reported in the previous section.[23] Separate coefficient estimates are provided for specifications with and without the inclusion of δ_k in order to distinguish between direct and total union investment effects. The indirect effect (i.e., the difference in coefficients between the two specifications) will be largest or most negative in industries where there is a large union-nonunion differential in profitability (for evidence on profitability, see Hirsch, 1991b).

The results in Table 5 confirm that union-nonunion differences vary considerably across industries. Union coverage has negative effects on capital investment in most industries, but there is variability in the relative importance of direct and indirect union effects. In no industry is evidence found for a positive and significant relationship between union coverage and capital investment, although some union coefficients are positive and several are close to zero. Union effects on capital investment appear particularly detrimental in food and kindred products; rubber and miscellaneous plastics; stone, clay, and glass; primary

[23] In four industry categories with few nonunion firms – petroleum refining; stone, clay, and glass; primary metals; and aircraft and aerospace – UN-DUM is set equal to one if UN .10 and 0 otherwise.

metals; office, computers, and accounting equipment; other machinery, not electric; communications equipment; professional and scientific equipment; aircraft and aerospace; and lumber, wood, and paper.[24]

Estimated union effects on R&D investment also vary considerably across industries. Although union coverage has negative effects on R&D in most industries, several positive union coefficients are obtained.[25] Large negative estimates of union effects on R&D are found in the chemical, drug, nonelectrical machinery, electrical equipment, communications equipment, and professional and scientific equipment industries.

Research providing further evidence of, and explanation for, interindustry differences in union effects on R&D and capital investment is badly needed. There is no evidence on interindustry differences in union effects on R&D investment with which this study's results can be adequately compared. The results in Table 5 do not lend themselves to any simple interpretation. It would be reasonable to expect a similar pattern for capital and R&D investment, since quasi-rents emanating from either source should be appropriable in those industries with effective union rent seeking. In fact, there is a tendency for industries with large union-nonunion differences in capital expenditures to display similar differences in R&D expenditures.[26]

Table 6 provides union dummy coefficients from investment equations estimated annually for the years 1972 through 1980, with specifications including and excluding δ_k as a right-hand-side variable. Separate annual regressions have the advantage of eliminating serial correlation of within-firm error terms, which biases downward standard errors in the pooled time-series/cross-sectional models previously presented. The results reveal considerable year-to-year variability in point estimates of union effects on capital investment, along with considerable imprecision in estimating these effects (i.e., large standard errors). No discernible secular trend is evident from these results. Table 6 also provides estimates of union coefficients from separate annual R&D investment equations. Estimated union effects are found to exhibit

[24] Abowd (1989a) relates industry investment to constructed measures of the industry union environment. His results are remarkably consistent with the results presented in Table 5. Abowd finds particularly detrimental union effects in foods, rubber, steel, and communications, and finds no detrimental effect in the automobile industry. There appear to be no other studies that examine union investment effects by industry.

[25] Positive coefficients appear more likely where there are few nonunion firms. See not 23.

[26] Primary metals is an exception, but there are no firms with zero coverage in that industry group.

reasonable year-to-year stability and reinforce the previous conclusion that unionization significantly decreases R&D investment.

Implications for Collective Bargaining Strategy

The evidence presented in this paper demonstrates that unionized companies invested significantly less than did similar nonunion companies in both physical and R&D capital during the 1970s. Even after controlling for firm and industry sales growth rates and other measurable characteristics, as well as including detailed industry dummies, differences in investment behavior were substantial. Unionized companies invested roughly 20 percent less in physical capital than did similar nonunion companies. Approximately half to two-thirds of this impact appears to be a direct union effect (i.e., holding constant current earnings), owing to the union tax on the future earnings stream emanating from the capital stock (firms reduce investment until the after-union rate of return equals marginal financing cost). The remainder is an indirect effect resulting from the lower current earnings and higher financing costs among unionized companies. Union companies also invested significantly less in R&D than did their nonunion counterparts. Unionization was associated with about 30 percent lower R&D investment among R&D-active firms.

What are the implications of these findings? Perhaps the most obvious is that union-nonunion investment differences merit more extensive study. This topic should not continue to be ignored in the empirical literature on capital investment and R&D. The more important implication, however, is that lower investment by unionized companies foreshadows and reflects the continuing decline in the size of the union sector.[27] In the face of a union tax on future quasi-rents associated with fixed capital, companies decrease their investment in tangible and intangible capital until the post-tax or union rate of return is equivalent to the nonunion rate. Effective union rent seeking at the expense of long-lived specific capital lowers both profits and investment. Subsequently, it decreases employment and output growth as well.

What changes in collective bargaining strategies and outcomes might reduce the negative effects of unionization on investment? Most obvious would be a lower tax on investment returns, as reflected in

[27] See Freeman (1988c) for a discussion of the decline in private sector unionism. Linneman, Wachter, and Carter (1990) examine sectoral union and nonunion employment changes from 1973 to 1986 and relate these changes to union-nonunion wage differentials. Blanchflower, Millward, and Oswald (1989) examine British evidence and conclude that unionization is associated with slower employment growth.

smaller union-nonunion wage premiums. Despite increased domestic and international competition, most evidence suggests that union premiums were relatively constant or increased during the late 1970s and early 1980s, thus accelerating the shift toward nonunion production (Freeman 1986c; Linneman, Wachter, and Carter, 1990). Union premiums during 1986-88 were only moderately lower than during 1983-85, and they were above 1979-81 levels (Curme and Macpherson, 1991). The sluggishness with which unions have responded to a more competitive environment lends support to the thesis of "rationally" myopic union behavior. Union bargaining may be dominated by the preferences of senior members who highly discount future employment opportunities. As long as unions remain highly democratic and membership is nontransferable, union rank and file will continue to highly discount the future. Moreover, the decline or slow growth in new employment leads to an older and, perhaps, more myopic rank and file. In response, unionized companies have the incentive to underfund pension plans in order to force current workers to weigh more heavily the future economic viability of the firm (Ippolito, 1985). The effectiveness of this response is somewhat lessened by federally mandated pension guarantees.

A frequently suggested and increasingly common contract provision is to link wage bonuses to firms' profit performance. The major impetus behind the use of profit sharing has been to increase labor productivity, but such arrangements have the potential to affect the time horizon over which rank and file evaluate contract agreements. To the extent that profit-sharing agreements tie worker bonuses to current profits, such arrangements are unlikely to make workers more forward-looking. Indeed, profit sharing is simply a direct tax on the returns from past investments, combined with a redistribution of risk between shareholders and workers. By contrast, tying worker bonuses to changes in the stock market price of the firm (which reflects the present value of current and future company earnings) or the extensive promotion of stock ownership among workers should make workers more forward-looking and, thus, moderate wage demands. Because of the large variability in individual stock prices, however, a strategy that ties compensation to a stock price or one that gives employees a relatively large share of wealth in the stock of a

single company would be very risky for workers.[28] Few unions have embraced such proposals in the past, and there is no reason to expect that more would do so in the future.

For union bargaining outcomes to have relatively small effects on firm investment behavior, union premiums must not only be modest, but wages (or the union tax) cannot vary directly with the level of quasi-rents. Of course, in the very long run, it is implausible for union gains not to be a tax on quasi-rents. A long-run bargaining protocol that stipulates fixed compensation increases each contract period or that ties wage increases to opportunity cost wage increases outside the firm, however, would be relatively more neutral with respect to company investment policy than are union demands that vary directly with current company earnings. For example, for many years the UAW had a set wage rule of an annual 3 percent increases plus a COLA (Katz, 1987). Operating under protocols in which wage increases are not tied to future earnings will make firms more likely to invest in income-producing tangible and intangible capital. Of course, firms may still retain the incentive to move resources away from union toward lower-cost nonunion plants (see Verma, 1985).

Established protocols, however, require a good labor relations environment, forward-looking behavior by both bargaining parties, the absence of opportunistic (i.e., short-run maximizing) behavior by either of the parties, a prominent role for reputational effects, and, consequently, an environment where long-run promises are credible despite the dependence on short-run repeated bargaining. Equally important, stable protocols require relatively stable product and labor market conditions. Without such stability, even well-established protocols are unlikely to survive. Indeed, the traditional UAW-GM bargaining protocol collapsed under the strain of slow wage growth elsewhere in the private sector during the 1970s, coupled with increased foreign competition and the sharp downturn in automobile sales after 1979 (Katz, 1987).

The level of union representation in an economy is a function of, *inter alia*, past unionization organizing activity and success, the legal and economic environment, and worker and management preferences. Ultimately, union bargaining outcomes that significantly reduce profitability and appropriate firms' quasi-rents will reduce tangible and intangible capital investment, which in turn will lead to declines

[28] Moreover, because much of this risk is "unsystematic" (i.e., it is uncorrelated with the market return and can be largely eliminated through diversification), it is not compensated in the market by a higher mean return.

in union employment. If management resistance to union organizing is to diminish, a necessary (but not sufficient) requirement is that large disparities in economic performance between union and nonunion companies be reduced. Such an outcome would require a moderation in compensation demands on the part of union workforces, coupled with a fuller development of the collective voice and productivity-enhancing aspects of union representation.

Development in these directions will not be easy. Given a tradition of strong management resistance to unions, a highly competitive economy, an unattractive organizing and bargaining environment, and governmental labor policies that increasingly provide to all workers what once was the domain of collective bargaining (e.g., plant closing notification and worker safety regulations), more moderate union policies may hold little appeal for either organized or unorganized workers. If labor unions are to reverse the decline in membership, however, they must help bring about beneficial workplace outcomes that cannot be realized in nonunion work environments, while simultaneously working to lessen the disparities in economic performance between union and nonunion companies.

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Table 1
Company Union Coverage by Industry Group, 1977
(unweighted)

Industry Group	N	$\overline{UN}$ [a]	Standard Deviation
Total	706	.331	(.280)
Food and kindred products	71	.419	(.271)
Textiles and apparel	39	.233	(.296)
Chemicals, excluding drugs	43	.286	(.195)
Drugs and medical instruments	38	.138	(.181)
Petroleum refining	29	.281	(.188)
Rubber and misc. plastics	25	.381	(.248)
Stone, clay, and glass	24	.444	(.256)
Primary metals	41	.613	(.222)
Fabricated metal products	39	.316	(.280)
Engines, farm and const. equip.	25	.384	(.226)
Office, computers, and acct. equip.	22	.043	(.073)
Other machinery, not electric	48	.369	(.284)
Electrical equipment and supplies	47	.081	(.164)
Communications equipment	27	.456	(.243)
Motor vehicle and transp. equip.	43	.523	(.260)
Aircraft and aerospace	11	.305	(.235)
Professional and scientific equip.	31	.116	(.195)
Lumber, wood, and paper	55	.387	(.300)
Misc. manufacturing & conglomerates	48	.343	(.255)

[a] UN is the proportion of a firm's North American workforce covered by a collective bargaining agreement in 1977.

Table 2
Mean Outcomes by Union Category, 1972-80

	Nonunion[a]		Low Union		Medium Union		High Union		All Firms	
Variable[b]	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
UN	1,320	0.000	1,473	0.138	1,632	0.452	1,416	0.709	5,841	0.333
δ_k	1,320	0.101	1,473	0.084	1,632	0.073	1,416	0.068	5,841	0.081
INV/S	1,320	0.065	1,473	0.063	1,632	0.055	1,416	0.060	5,841	0.060
K/S	1,320	0.859	1,473	0.971	1,632	1.034	1,416	1.182	5,841	1.014
INV/K	1,320	0.079	1,473	0.064	1,632	0.054	1,416	0.054	5,841	0.062
L/S	1,320	0.033	1,473	0.031	1,632	0.029	1,416	0.029	5,841	0.030
CAPAGE	1,320	5.744	1,473	6.778	1,632	8.066	1,416	8.600	5,841	7.346
$R\&D_1/S$	975	0.045	1,075	0.021	1,261	0.015	865	0.011	4,176	0.023
$R\&D_2/S$	1,320	0.033	1,473	0.015	1,632	0.012	1,416	0.007	5,841	0.016
PAT/S	1,117	0.189	1,406	0.133	1,548	0.118	1,356	0.061	5,427	0.122
ADV_1/S	749	0.029	738	0.032	740	0.025	636	0.019	2,863	0.027
ADV_2/S	1,320	0.017	1,473	0.016	1,632	0.011	1,416	0.009	5,841	0.013
AGE	1,320	42.560	1,473	58.387	1,632	60.494	1,416	62.509	5,841	56.398

[a]Nonunion (UN=0); Low Union (0<UN .30); Medium Union (.30 UN<.60); High Union (UN .60).
[b]Variables are defined as follows: UN: Proportion of firm's workforce covered by collective bargaining agreement; δ_k: gross rate of return to capital and gross cash flows divided by the value of the gross inflation-adjusted capital stock; INV/S: annual capital investment expenditures, divided by sales; K/S: gross inflation-adjusted capital stock (current dollars) divided by sales; INV/K: annual capital investment, divided by the gross capital stock; L/S: employees per $1,000 (constant 1972) of sales; CAPAGE: average age (years) of capital stock; gross book value of plant minus net book value of plant, divided by current year depreciation; $R\&D_1/S$: R&D expenditures divided by sales (R&D-active firms only); $R\&D_2/S$: R&D expenditures divided by sales (all firms); PAT/S: stock of patents granted (with assumed 15% depreciation rate), divided by millions of 1972 dollar sales; ADV_1/S: advertising expenditures divided by sales (advertising-active firms only); ADV_2/S: advertising expenditures divided by sales (all firms); and AGE: company age; years since incorporation.

Table 3
Capital Investment Regression Results[a]
(absolute value of t-statistics in parentheses)

Variable	(1)	(2)	(3)	(4)
UN-LOW	-0.050	-0.104	-0.092	-0.158
	(2.07)	(4.22)	(3.56)	(6.07)
UN-MED	-0.157	-0.174	-0.236	-0.260
	(6.27)	(6.80)	(8.86)	(9.65)
UN-HIGH	-0.102	-0.101	-0.195	-0.189
	(3.80)	(3.69)	(6.82)	(6.54)
pk	5.139	4.724	–	–
	(29.72)	(27.31)		
ln(K)(-1)	0.989	0.863	0.965	0.809
	(74.02)	(51.60)	(67.42)	(45.85)
ln(L)	0.063	0.198	0.084	0.252
	(4.19)	(10.80)	(5.23)	(13.06)
AGE/100	-0.239	-0.235	-0.287	-0.292
	(8.65)	(8.43)	(9.69)	(9.88)
GROWTH	0.377	0.381	0.895	0.849
	(7.73)	(7.97)	(18.32)	(17.93)
I-GROWTH	1.162	0.917	1.287	1.018
	(7.32)	(5.60)	(7.55)	(5.85)
I-EARN	0.230	0.319	0.282	0.339
	(4.99)	(4.13)	(5.70)	(4.14)
I-CR	0.094	-0.025	0.178	0.039
	(1.78)	(0.37)	(3.16)	(0.55)
I-IMPORT	-0.539	-0.354	-0.727	-0.419
	(4.35)	(2.58)	(5.48)	(2.87)
I-UN	-0.030	0.206	-0.048	0.285
	(0.47)	(2.19)	(0.70)	(2.86)
IND	no	yes	no	yes
YEAR	yes	yes	yes	yes
$\overline{R}^2$	0.909	0.914	0.896	0.903
N	5,841	5,841	5,841	5,841

[a]Low Union (0<UN .30); Medium Union (.30 UN<.60); High Union (UN .60). Nonunion (UN=0) is the omitted reference group.

Table 4
R&D Investment Regression Results[a]
(absolute value of t-statistics in parentheses)

Variable	(1)	(2)	(3)	(4)
UN-LOW	-0.291	-0.281	-0.303	-0.292
	(9.34)	(9.10)	(9.67)	(9.42)
UN-MED	-0.301	-0.315	-0.329	-0.34
	(9.43)	(9.78)	(10.25)	(10.56)
UN-HIGH	-0.446	-0.438	-0.477	-0.462
	(12.58)	(12.25)	(13.38)	(12.91)
pk	2.062	1.692	–	–
	(8.79)	(7.37)		
ln(R&D Stock)(-1)	0.629	0.545	0.635	0.55
	(61.45)	(49.56)	(61.67)	(49.78)
ln(K)	0.008	0.171	-0.003	0.153
	(0.47)	(7.13)	(0.18)	(6.40)
ln(L)	0.427	0.361	0.435	0.377
	(19.92)	(14.52)	(20.14)	(15.11)
AGE/100	-0.115	-0.163	-0.139	-0.189
	(3.16)	(4.47)	(3.79)	(5.19)
GROWTH	0.475	0.442	0.703	0.626
	(7.06)	(6.85)	(11.23)	(10.43)
I-GROWTH	0.833	0.277	0.828	0.26
	(4.05)	(1.33)	(3.99)	(1.25)
I-EARN	1.154	0.706	1.17	0.733
	(17.29)	(6.73)	(17.39)	(6.95)
I-CR	-0.334	-0.472	-0.32	-0.479
	(4.77)	(5.40)	(4.53)	(5.44)
I-IMPORT	0.542	0.391	0.451	0.353
	(3.52)	(2.35)	(2.91)	(2.11)
I-UN	-0.595	-0.222	-0.598	-0.186
	(7.28)	(1.70)	(7.25)	(1.42)
IND	no	yes	no	yes
YEAR	yes	yes	yes	yes
$\overline{R}^2$	0.889	0.899	0.886	0.898
N	4,176	4,176	4,176	4,176

[a]Low Union (0<UN .30); Medium Union (.30 UN<.60); High Union (UN .60). Nonunion (UN=0) is the omitted reference group.

Table 5
Union R&D and Capital Investment Effects by Industry Group, 1972-80[a]

	Ln(INV) Equations					Ln(R&D) Equations				
		(1)		(2)			(3)		(4)	
Industry Group	N	UN-DUM	|t|	UN-DUM	|t|	N	UN-DUM	|t|	UN-DUM	|t|
All Manufacturing	5,841	-0.149	(7.08)	-0.221	(9.97)	4,176	-0.297	(11.04)	-0.316	(11.70)
Food & kindred products	562	-0.144	(1.73)	-0.343	(3.92)	329	0.212	(1.68)	0.216	(1.71)
Textiles & apparel	322	0.011	(0.14)	-0.031	(0.35)	166	-0.009	(0.06)	-0.012	(0.08)
Chemicals, excluding drugs	366	0.093	(0.92)	-0.024	(0.23)	314	-0.338	(2.69)	-0.387	(3.04)
Drugs & medical instruments	316	0.048	(0.81)	0.024	(0.38)	305	-0.511	(8.72)	-0.511	(8.74)
Petroleum refining	246	-0.166	(1.56)	-0.239	(2.27)	151	0.221	(1.49)	0.203	(1.37)
Rubber & miscellaneous plastics	211	-0.245	(2.48)	-0.205	(1.89)	187	0.009	(0.10)	0.010	(0.10)
Stone, clay, & glass	212	-0.332	(2.13)	-0.771	(4.59)	134	[b]		[b]	
Primary metals	354	-0.334	(2.24)	-0.692	(4.57)	132	0.935	(2.70)	0.849	(2.32)
Fabricated metal products	335	0.030	(0.36)	0.001	(0.02)	204	-0.141	(0.95)	-0.085	(0.57)
Engines, farm, & const. equip.	205	-0.138	(0.95)	-0.305	(2.16)	198	-0.105	(0.82)	-0.374	(2.94)
Office, computer, & acct. equip.	174	-0.292	(2.02)	-0.419	(2.79)	168	-0.159	(1.36)	-0.185	(1.62)
Other machinery, not electric	389	-0.26	(3.60)	-0.352	(5.20)	336	-0.345	(4.98)	-0.422	(6.19)
Electrical equipment & supplies	389	-0.161	(1.92)	-0.174	(2.02)	336	-0.508	(5.93)	-0.513	(5.95)
Communication equipment	226	-0.211	(2.13)	-0.139	(1.33)	199	-0.865	(8.08)	-0.865	(8.09)
Motor vehicle & trans. equip.	338	0.058	(0.57)	0.080	(0.74)	266	-0.149	(1.25)	-0.148	(1.24)
Aircraft & aerospace	97	-0.331	(2.04)	-0.309	(1.93)	83	-0.183	(1.19)	-0.204	(1.32)
Professional & scientific equip.	255	-0.143	(1.87)	-0.206	(2.61)	252	-0.399	(3.71)	-0.422	(3.86)
Lumber, wood, & paper	452	-0.184	(2.28)	-0.394	(4.74)	198	0.154	(0.94)	0.166	(1.05)
Misc. manuf. & conglomerates	392	0.177	(1.63)	0.175	(1.61)	218	0.979	(2.45)	0.925	(2.20)

[a]Columns (1) and (3) include δ_k; columns (2) and (4) exclude δ_k. All regressions include the control variables ln(L), AGE, GROWTH, I-GROWTH, I-EARN, I-CR, I-IMPORT, and year dummies. The ln(INV) equations include ln(K)(-1) and the ln(R&D) equations include ln(R&D Stock)(-1) and ln(K). The all-manufacturing regressions include these controls plus I-UN and industry dummies.
[b]UN-DUM=1 for all "R&D-active" firms in the stone, clay, and glass category.

Table 6
Union R&D and Capital Investment Effects by Year, 1972-80[a]

	Ln(INV) Equations					Ln(R&D) Equations				
		(1)		(2)			(3)		(4)	
Year	N	UN-DUM	$\|t\|$	UN-DUM	$\|t\|$	N	UN-DUM	$\|t\|$	UN-DUM	$\|t\|$
1972-80	5,841	-0.149	(7.08)	-0.221	(9.97)	4,176	-0.297	(11.04)	-0.316	(11.70)
1972	628	-0.154	(2.14)	-0.198	(2.76)	447	-0.197	(2.06)	-0.23	(2.39)
1973	648	-0.255	(4.22)	-0.350	(5.36)	473	-0.244	(2.99)	-0.252	(3.07)
1974	675	-0.045	(0.76)	-0.102	(1.59)	497	-0.340	(4.12)	-0.341	(4.13)
1975	690	-0.124	(2.05)	-0.201	(3.17)	500	-0.263	(3.36)	-0.289	(3.69)
1976	706	-0.260	(4.31)	-0.303	(4.82)	510	-0.361	(4.53)	-0.371	(4.63)
1977	684	-0.185	(3.11)	-0.244	(3.93)	485	-0.289	(3.86)	-0.311	(4.14)
1978	654	-0.076	(1.29)	-0.131	(2.07)	458	-0.297	(3.84)	-0.293	(3.81)
1979	590	-0.130	(1.98)	-0.243	(3.45)	414	-0.344	(4.25)	-0.384	(4.73)
1980	566	-0.016	(0.25)	-0.178	(2.50)	392	-0.235	(2.91)	-0.295	(3.63)

[a]Columns (1) and (3) include δ_k. Columns (2) and (4) exclude δ_k. All regressions include the control variables ln(L), AGE, GROWTH, I-GROWTH, I-EARN, I-CR, I-IMPORT, I-UN, and industry dummies. The ln(INV) equations include ln(K)(-1) and the ln(R&D) equations include ln(R&D Stock)(-1) and ln(K). The pooled 1972-80 regression includes these controls and year dummies.

Data Appendix: Regression Variable Definitions

UN	Proportion of firm's North American workforce covered by a collective bargaining agreement in 1977.
ln(INV)	Log of current investment expenditures, in millions of 1972 dollars, deflated by GNP investment implicit price deflator.
ln(R&D)	Log of R&D expenditures, in millions of 1972 dollars. Deflator shown in Cummins et al. (1985).
$\eth_k$	Gross rate of return on capital; gross cash flows (income plus depreciation plus interest income minus inventory and imputed income adjustments), divided by the gross capital stock (plant and inventories) adjusted for inflation (Cummins et al., 1985).
ln(K)	Log of gross inflation-adjusted capital stock, in millions of 1972 dollars, deflated by GNP investment implicit price deflator.
ln(K)(-1)	Log of capital stock net of current investment, in millions of 1972 dollars.
ln(R&D-Stock)(-1)	Log of R&D stock, net of current expenditures, in millions of 1972 dollars, calculated based on annual R&D expenditures and assumed 15 percent depreciation rate (Body and Jaffe, no date). Deflator shown in Cummins et al. (1985).
ln(L)	Log of employment, in thousands.
AGE	Company age, measured by years since incorporation.
GROWTH	Annualized logarithmic growth rate in firm sales between years t and t-2; sales deflated by industry-specific price indices (Cummins et al. 1985).
I-GROWTH	Annualized logarithmic growth rate in industry shipments between years t and t-4 in firm's primary reported industry; shipments deflated by industry-specific price indices (Cummins et al. 1985).
I-EARN	Log of average industry earnings, measured by total industry payroll divided by employment, in 1972 dollars, deflated by GNP deflator.
I-CR	Four-firm concentration ratio in firm's primary reported industry, adjusted for regional markets and imports, available for 1972 and 1977. Post-1977 data assigned 1977 values; 1973-1976 data assigned values based on linear interpolation.
I-IMPORT	Share of imports in domestic sales in firm's primary reported industry, defined as 100[IMPORTS/(SHIPMENTS+IMPORTS-EXPORTS)], available for 1972 and 1977. Post-1977 data assigned 1977 values; 1973-1976 data interpolated.
I-UN	Proportion of eligible workers who are union members in firm's primary two- or three-digit industry during 1976-78.