

BARGAINING AND THE ROLE OF EXPERT AGENTS: AN EMPIRICAL STUDY OF FINAL-OFFER ARBITRATION

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Abstract—Expert agents, such as lawyers, play a prominent role in conflict resolution, yet little is known about how they affect outcomes. We construct a model that permits us to estimate the influence of agents and test whether the parties in a dispute face prisoner's dilemma incentives. Using eighteen years of final-offer arbitration data from New Jersey, we find the parties do significantly better when they retain agents and that the parties learn about this benefit over time. However, we also find that the gain to using an agent is fully offset when the opposing party also hires an agent. Since agents are costly, this noncooperative equilibrium is Pareto inferior.

I. Introduction

RATIONAL arrangements to resolve unproductive disputes are a key determinant of how well a modern economy operates. Yet few empirical studies of field data, designed to test the functioning of these systems, currently exist.¹ In this paper, we study a final-offer arbitration system used in New Jersey with data we have systematically collected over the eighteen-year life of the program. Final-offer arbitration requires the parties to make binding offers from which an arbitrator, selected in part by the parties, must make a choice without compromise. Covering the wages of police officers and firefighters, this system was designed by an economist and provides a unique setting for the study of strategic interaction.² It also provides an opportunity to characterize with publicly available data an arbitration system for resolving disputes and the role of expert agents in the process. We use these data to provide a stylized description of the basic operating characteristics of the system. We also develop a simple structural model, which can be estimated and tested with our data, for bargainers' behavior and the role of expert agents (who are typically lawyers) in that behavior.

Our empirical analysis provides convincing evidence that, left alone, the parties do not construct and present their offers as successfully as when they retain expert agents to

assist them. Apparently even in this relatively simple bargaining environment, the parties derive considerable benefits from expert assistance. However, when both parties hire an agent, the benefits cancel each other out, so that the parties encounter the equivalent of prisoner's dilemma incentives: despite their cost and the zero-sum nature of the game, each party has an incentive to hire an agent regardless of what the other party does.³ While prisoner's dilemma incentives are discussed in every elementary economics text, this is the first example we are aware of that carefully documents such an incentive structure in any field or naturally occurring economic data.

Our data reveal a number of empirical regularities, as well as some time series patterns to be explained. First, the data indicate that employer victory rates, which in early periods were well below the 50% that was initially anticipated, have converged toward that rate over time. Likewise, the difference between the parties' offers has decreased over time. Concurrently, the use of third-party agents to assist the parties has increased, particularly for employers. Coupled with the substantially higher observed victory rates for parties that retain third-party agents, these facts suggest an important role for agents in the bargaining process and learning in the early years of the system, particularly for employers.

To capture these facts, we set out a structural model in which arbitrators behave as statistically exchangeable random variables. As in earlier work, our data provide strong support for this representation of arbitrator behavior, but they also support the finding that arbitrator behavior is altered to favor the party represented by an agent. This leads us to specify a two-stage process in which each of the parties first decides whether to hire an agent and then decides a final offer. We begin by modeling experts as advocates who move the arbitrator to favor their client's position independent of the facts. Characterizing the parties' offers as a forward-looking Nash equilibrium in expected utilities and using standard utility functions and approximations, leads to the conclusion that the employer win rate should be close to 50%. More generally, the model implies that the win rate, and the difference between the parties' offers, should be approximately independent of whether the parties retain a third-party agent. We provide two extensions that can generate employer win rates and differences in final offers that are a function of agent use: learning about the benefits of agents and agents as information providers.

Our models also have predictions regarding the use of third-party agents, which depends on the expected benefits

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¹ See Abowd and Lemieux (1993), Adler, Hensler, and Nelson (1991), Bhagat, Brickley, and Coles (1994), Currie and McConnell (1991), Cutler and Summers (1988), Mas (2006), McCall (1990), Pencavel (1991), and Tracy (2003).

² See Lester (1984). The use of arbitration systems has grown steadily for the resolution of disputes involving divorce and child custody, securities regulation, international business disputes, and labor contracts (including the setting of major league baseball salaries).

³ See Ashenfelter, Bloom, and Dahl (2004), Bazerman et al. (1992), and Gilson and Mnookin (1994).

and costs of their use. When expected benefits are high relative to costs, as we show them to be for many of the parties, retaining an agent is a dominant strategy (that is, optimal despite the other party's behavior), and the parties may face incentives to hire agents even if, in equilibrium, they do not improve results. The models predict that the demand for the services of an agent by one party is independent of the demand by the other party in our setting. This hypothesis is easily subject to empirical tests with our data.

The empirical results provide convincing evidence for many of these elementary predictions. First, the estimated payoff matrix for the parties provides strong evidence that many of the bargaining pairs face prisoner's dilemma incentives each time they bargain. Second, the data indicate that each party's observed demand function for agents is independent of the other party's behavior, which is confirmation that the parties play dominant strategies. Third, the parties have slowly evolved to the equilibrium predicted by the noncooperative behavior that prisoner's dilemma incentives create, and the use of third-party agents has become nearly universal. A simple model of learning, particularly as it applies to employers, can empirically match the observed patterns of agent use over time and explain the fact that early in the system's history, win rates and the gap in final offers are both functions of agent use.

The paper is structured as follows. We begin with a description of our data and their collection. We then set out our model and its testable implications. Our empirical results are described in a sequence that begins with tests for dominant strategy play in the hiring of agents and continues with evidence on the role agents play in arbitrator behavior. We then discuss extensions to the model that allow for learning and agents as information providers, and discuss the role risk aversion plays in our framework.

II. Data

A. *New Jersey's Arbitration System*

The history behind the development of public sector arbitration in New Jersey began in 1968, when public sector employees were granted the right to engage in collective bargaining but strikes were forbidden. While this restriction guaranteed community police and fire protection, it also led to drawn-out negotiations and impasse. To ensure that contracts were kept current, the New Jersey Fire and Police Arbitration Act was approved in May 1977.

The act specifies that police and fire department workers, and their municipal employers, must start the collective bargaining process at least 120 days before a contract expires. If an agreement is not reached by 60 days before this date, the two parties must begin formal arbitration proceedings. Although conventional arbitration can be invoked if both sides agree, the terminal procedure by law is final-offer arbitration. In contrast to conventional arbitration, where the arbitrator often specifies a salary increase somewhere

between the proposals of the two sides, with final-offer arbitration, the arbitrator is limited to choosing either the final salary proposal of the municipality or the union.

Formal arbitration proceedings involve the choice of an arbitrator, several intermediate hearings where documentation is passed back and forth, and a final hearing where the arbitrator provides the ruling. At each of the points where the parties interact, they can observe whether the other party has retained an expert agent and can respond by hiring an agent for future interactions if it is in their best interest. Since there are often large gaps between such interactions, there is time value to hiring an agent. The proceedings usually span several months and can often take a year or longer. Therefore, it is natural to think the payoff to hiring an agent will increase by every month and for every additional hearing the agent is on the case. We do not observe the timing of when agents are hired, so we will not formally model this time value. However, it plays an important background role in terms of generating a prisoner's dilemma. If there were no time value, then there would be no advantage to hiring an agent first (since the other party would respond by hiring an agent instantaneously), and therefore a prisoner's dilemma could not exist.

The act also established the New Jersey Public Employment Relations Commission (PERC), whose function is to impartially administer the act. PERC assigns arbitrators to cases by giving each side the same list of seven arbitrators. Each side is allowed to eliminate three names and must rank the remaining four. The arbitrator with the highest combined rank is given the job of deciding the case. The parties involved in the dispute split the cost of the arbitrator, whose fee schedule is set by PERC. This setup implies that arbitrators should be "statistically exchangeable" (since pro-union or pro-employer arbitrators will not be chosen), a hypothesis we test and find support for later in the paper. Further details on the 1977 act can be found in Bloom (1980).

In 1996, the act was amended so that conventional arbitration became the default mechanism if the sides could not agree on a procedure. In addition, arbitrator selection changed, so that a computer program randomly picks a name from PERC's approved list of arbitrators. While it would be interesting to study what effect these changes have had on the use of arbitration and its outcomes, we focus on the earlier period before the system was altered.

We collected data for the period 1978 to 1995, when final-offer arbitration was the default procedure and the parties had considerable input in choosing the arbitrator. PERC keeps a copy of the legally binding docket describing the arbitration proceedings for each case. These dockets typically record the final offers of the two parties, the arbitrator's award, who attended the hearings, relevant dates, and summaries of the arguments. We obtained photocopies of the dockets for all arbitrated disputes handled by PERC in New Jersey for our time period. To ensure the quality of the data, each case was read and the data collected using a standard form independently by two readers. Any discrepancies

were then rechecked by a third individual to resolve any errors. For this time period, we collected and entered data on 896 final-offer arbitration cases from arbitrators' written dockets.

B. Data Description

Table 1 provides summary statistics on the 845 (of 896) cases with available information on agent use that were resolved by final-offer arbitration in New Jersey from 1978 to 1995. Our empirical results are based on this selected sample of cases that could not be resolved on mutual terms. The table also reports summary statistics for the subsample of cases with available information on the arbitrator's decision and the final wage offers, as this sample will be used in some of our later analyses. Most cases involve a dispute over pay raises, and a majority of the cases involve police officers.⁴ The data show that arbitrators have typically been more likely to select the union's offer than the employer's offer, with employers winning about 40% of the cases submitted to arbitration. This result is inconsistent with the notion that the equilibrium outcome in this dispute resolution system is a 50% victory rate, a finding we return to later in the paper. Union bargainers are far more likely to enlist the assistance of a professional agent to help select the arbitrator, prepare the case, attend various hearings, and present the case to the arbitrator. Unions employ third-party agents in 83% of the arbitration cases compared to only 62% for employers. Expert agents are most often lawyers, but they can also be labor relations specialists, professors, accountants, or other professionals.⁵

Many variables are common to both the employer and union and are likely to affect the costs of obtaining representation. One of the most important characteristics affecting the cost of retaining an agent is the size of the bargaining unit. For example, for a large bargaining unit, the monetary cost of retaining an agent on a per person basis will be smaller than for a small bargaining unit. We were able to collect information on the size of the bargaining unit for two-thirds of the sample. From these data we were able to confirm that the population of the municipality, which we collected for almost every bargaining unit from the 1980 U.S. Decennial Census, is a good proxy for the number of employees.⁶ To provide a sense of the mapping between these two size measures, in the table we also report

⁴ There are relatively few fire units involved in arbitration since smaller localities typically have volunteer fire departments. The "other" category refers to a small number of bargaining units, such as nurses or educators, that were not required to use the arbitration system but were permitted to use the system set up by PERC.

⁵ The criteria we use to label someone as an agent is a representative who handled at least two arbitrated disputes for at least two different employers or unions in the period spanned by the data. This definition is meant to exclude municipal staff members or full-time union representatives (working for a single municipality or union) who are not third-party specialists in labor disputes.

⁶ A regression of the number of unformed employees on the "population of municipality" categories appearing in table 1 has an R^2 of .62.

TABLE 1.—SUMMARY STATISTICS FOR FINAL-OFFER ARBITRATION CASES IN NEW JERSEY, 1978–1995

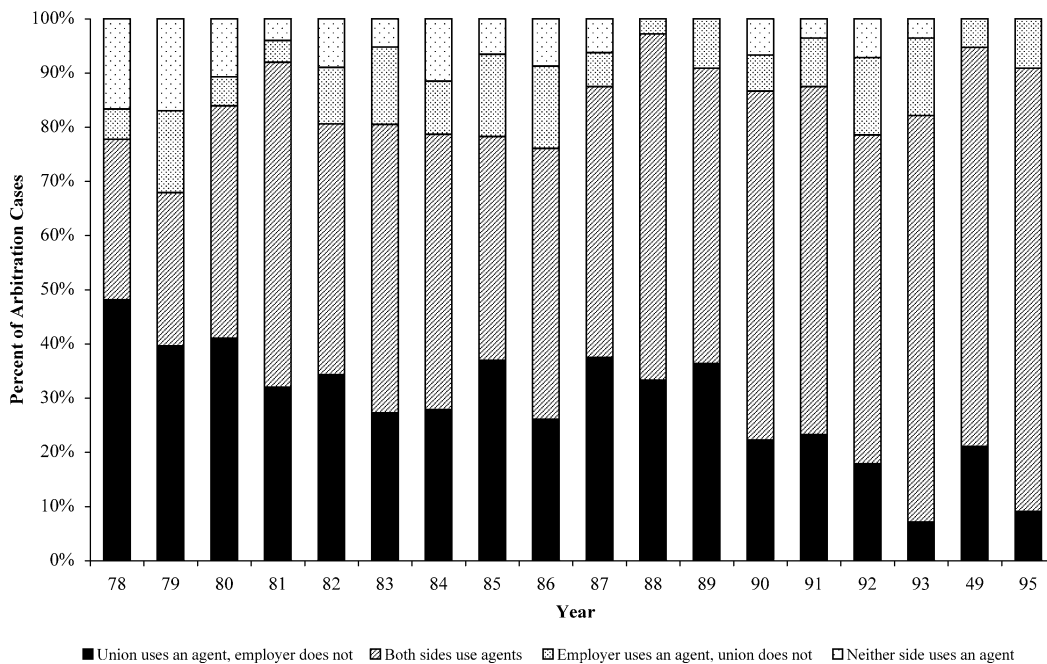
| | (1) | (2) |
|--|------|------|
| Agent use (%) | | |
| Union uses an agent | 83.1 | 84.4 |
| Employer uses an agent | 61.7 | 61.1 |
| Neither side uses an agent | 7.3 | 6.8 |
| Union uses an agent, employer does not | 31.0 | 32.1 |
| Employer uses an agent, union does not | 9.5 | 8.9 |
| Both sides use agents | 52.2 | 52.3 |
| Employer victories (%) | | |
| Overall | 39.1 | 38.1 |
| Neither side uses an agent | 41.0 | 40.5 |
| Union uses an agent, employer does not | 19.0 | 19.6 |
| Employer uses an agent, union does not | 70.9 | 69.1 |
| Both sides use agents | 44.9 | 43.8 |
| Difference in final offers (median percentage point difference) | | |
| Neither side uses an agent | — | 2.11 |
| Union uses an agent, employer does not | — | 1.95 |
| Employer uses an agent, union does not | — | 1.59 |
| Both sides use agents | — | 1.52 |
| Disputed items (%) | | |
| Wages only | 12.8 | 14.0 |
| Benefits only | 5.1 | 0.0 |
| Wages and benefits | 82.1 | 86.0 |
| Type of unit (%) | | |
| Police | 84.7 | 90.6 |
| Fire | 13.2 | 9.4 |
| Other | 2.0 | 0.0 |
| Population of municipality (%) | | |
| Population ≤ 5,000 (median 9 employees) | 9.5 | 11.5 |
| 5,000 < population ≤ 10,000 (median 16 employees) | 15.1 | 16.8 |
| 10,000 < population ≤ 15,000 (median 26 employees) | 12.3 | 12.7 |
| 15,000 < population ≤ 25,000 (median 39 employees) | 14.7 | 15.5 |
| 25,000 < population ≤ 50,000 (median 71 employees) | 15.7 | 13.5 |
| 50,000 < population ≤ 100,000 (median 142 employees) | 8.6 | 7.4 |
| Population > 100,000 (median 209 employees) | 6.2 | 6.5 |
| County case (median 38 employees) | 14.2 | 12.7 |
| State case (median 3,525 employees) | 1.3 | 1.3 |
| Unavailable (median 26 employees) | 2.3 | 2.1 |
| Number of years covered by award (%) | | |
| One | 17.7 | 18.2 |
| Two | 48.1 | 54.7 |
| Three or more | 24.9 | 27.1 |
| Unavailable | 9.3 | 0.0 |
| Number of times a municipality uses arbitration (%) (319 different municipalities) | | |
| One | 41.4 | 38.3 |
| Two | 27.3 | 27.5 |
| Three | 13.2 | 14.6 |
| Four | 6.3 | 6.6 |
| Five or more | 11.9 | 12.9 |

Column 1 uses the 859 (out of 896) final offer arbitration cases with available information on agent use. Column 2 limits the sample to 620 cases where the arbitrator's decision and the final wage offers are available. Employer victories in column 1 use 845 cases for which the arbitrator's decision was available. Median employees calculated for the population categories using 576 cases for which data on the number of employees in the bargaining unit was available using the sample in the first column.

the median number of employees for each of the population groups. The number of years covered by the award likely influences the benefit of hiring an agent compared to the costs in a similar manner. Only one-fifth of arbitrated cases cover a one-year contract, and roughly half of cases being arbitrated cover a two-year period. As we shall see, these variables affect the likelihood that an agent is retained in the expected way.

How do agents affect the arbitration process, and do the parties learn and adapt to the incentives of the system of final-offer arbitration over time? To answer these questions,

FIGURE 1.—PATTERN OF THIRD-PARTY REPRESENTATION IN FINAL OFFER ARBITRATION CASES IN NEW JERSEY, 1978–1995



we begin by looking at whether hiring an agent corresponds to a greater probability of success in arbitration. Table 1 reveals that by employing an agent, the parties to a dispute increase the chance their final offer will be selected by around 22 to 30 percentage points. The win rate of the employer is 41% when neither side uses an agent, a rate that is not statistically significantly different from the 45% win rate when both sides use agents. Each side greatly increases the chance their offer will be selected by hiring an agent; however, when both sides pay for costly agents, the probability of victory is roughly the same as when neither side hires an agent. If the parties to a dispute did not change their final offers when hiring agents, this table could be interpreted as evidence that the parties face a prisoner's dilemma: hiring an agent pays off, but if both parties engage in this behavior, they are not as well off as if neither party did.

However, the parties will generally change their final offers in response to the hiring of agents, since they care not just about "winning" (that is, having the arbitrator choose their final offer) but also the awarded wage increase. The model we develop in the next section captures both of these dimensions: the probability of winning and the award wage increase. Table 1 displays the difference in the final offers of the parties as a function of agent use. The tabulations suggest the gap in final offers is unrelated to agent use by unions, while the final offers are closer together in cases where employers hire agents. The median difference in offers falls from roughly 2 percentage points to 1.5 percentage points when the employer hires an agent. Almost all of this reduction is accounted for by the low use of agents by employers in the early years of the system.

When final-offer arbitration began in New Jersey, employers and unions arguably had little information about

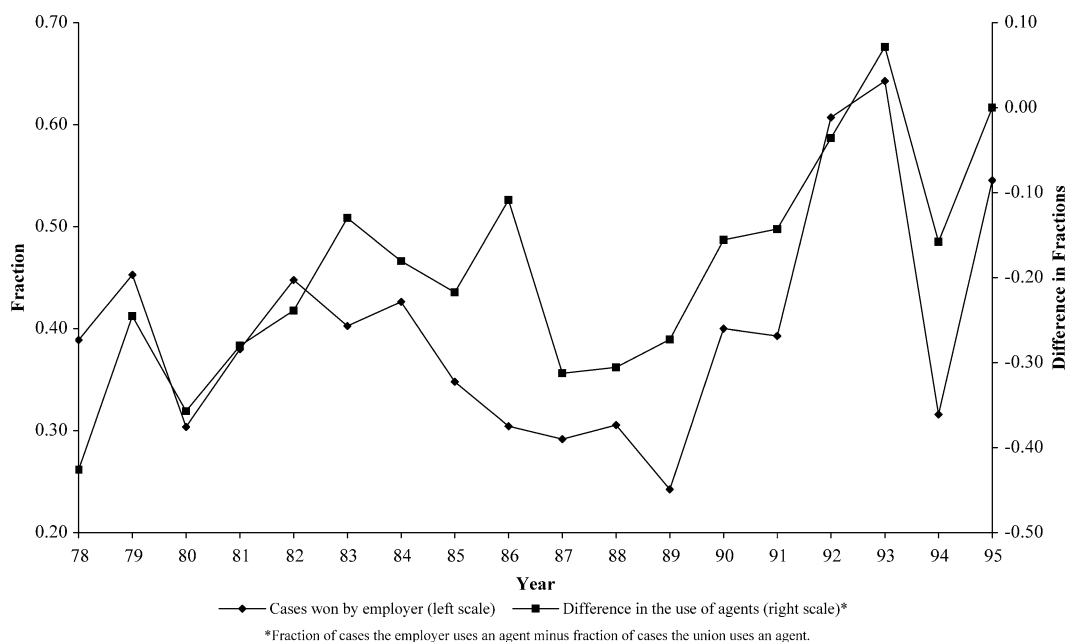
arbitrators' behavior and whether agents could influence outcomes. Figure 1 plots the pattern of agent use by employers and unions over time. In 1978, the first year of arbitration in New Jersey for police and fire employees, both sides used an agent in only 31% of arbitration cases. By the end of our sample, however, employers and unions both hired agents in 82% of all cases. The largest portion of the increase resulted from a decrease in the fraction of arbitration cases in which the union hired an agent but the employer did not. One explanation we explore later in the paper for this pattern is that some parties (particularly employers) learned about the benefits of agents only over time.

Figure 2 displays how employer victory rates over time correlate with the differential use of third-party representation. The solid line plots the fraction of cases won by the employer each year. The bottom time series represents the fraction of cases in which the employer used an agent minus the fraction of cases in which the union used an agent. This difference became much less negative over time, so that by the end of the sample, third-party representation rates for employers and unions were almost equal. The two series tracked each other remarkably well. A regression of the employer victory rate on the difference in agent use yielded a coefficient estimate of .47 (s.e. = .16) with an adjusted R^2 of .32. Taken together, these descriptive data suggest that agents play a crucial role in influencing outcomes in this arbitration system.

III. Baseline Model

In this section, we model the choices of the arbitrator and the adversarial parties in final-offer arbitration. The sequence of final-offer arbitration is as follows. First, the

FIGURE 2.—EMPLOYER VICTORY RATE AND THE DIFFERENTIAL USE OF THIRD-PARTY REPRESENTATION BY THE EMPLOYER AND UNION, 1978–1995



union and employer each chooses whether to hire an agent, then each side submits a final offer to the arbitrator, and finally the arbitrator chooses one of the final offers without compromise. In contrast to previous work, both parties are allowed to be risk averse. We work backward to solve for the optimal choices to see whether the benefits and costs of third-party representation are structured so as to create a prisoner's dilemma for some of the bargaining pairs. In section V, we explore two extensions to this baseline model: learning about the benefits of agents and agents as information providers.

A. The Arbitrator's Decision

At first glance, final-offer arbitration appears to be a complicated three-party game involving the arbitrator, employer, and union. Fortunately, the way arbitrators are chosen allows us to simplify the game into two stages. Because both parties have considerable input into which arbitrator will handle their case, arbitrators will survive only if they are indistinguishable from each other (that is, they cannot be clearly pro-union or pro-employer). As a result, arbitrators behave as though they are statistically exchangeable with each other, and the only difference between arbitrators is a forecast error.⁷ From the point of view of the parties, the arbitrator's decision may be thought

of as a random variable. We test this assumption empirically later in the paper and find support for it.

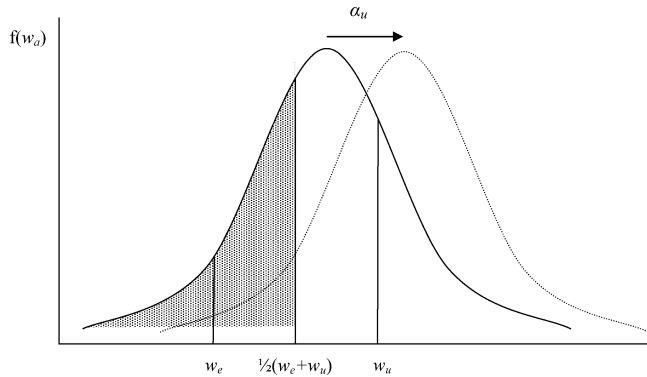
How does the arbitrator select from the employer and union proposed wage increases, denoted by w_e and w_u ? We use a simple model first proposed by Farber (1980) that has been remarkably successful in several applications. The arbitrator first decides what would be a reasonable award, w_a , and then selects whichever final offer is closest to it. Let w represent the wage from the previous contract, so the proposed wages in dollar terms are $(1 + w_e)w$ and $(1 + w_u)w$. The arbitrator selects the employer's offer if $|w_a - w_e| \leq |w_u - w_a|$, which, as long as $w_u > w_e$, can be written as

$$w_a \leq \frac{(w_e + w_u)}{2}. \quad (1)$$

If arbitrators are statistically exchangeable, w_a may be modeled as being drawn from a common probability density function. This distribution can be viewed as the distribution of preferred wage increases for a large sample of arbitrators who are making a decision on the same case. Figure 3 illustrates how the probability of an employer victory depends on the final offers of both parties in this simple baseline model. If w_a has a normal distribution with mean μ and standard deviation σ , it follows that the employer's offer is chosen with probability $\Pr(w_a < (w_e + w_u)/2) = \Phi((w_e + w_u)/2\sigma - \mu/\sigma)$, where Φ is the standard normal cumulative distribution function. This model can readily be modified to account for the effects of legal representation. Suppose agents shift the arbitrator's distribution of preferred awards favorably for their clients. Then if the union employs an agent, it increases the mean of this distribution by the quantity α_u , as depicted in figure 3. Similarly,

⁷ This characterization of arbitrator behavior was first used by Farber and Katz (1979) and Farber (1980) and tested by Ashenfelter and Bloom (1984). Bloom and Cavanagh (1986), Block and Stieber (1987), Farber and Bazerman (1986), and Olson, Dell'Omo, and Jarley (1992) provide evidence on arbitrator behavior and selection. Ashenfelter, Currie, Farber, and Spiegel (1992) use this assumption in their experimental design. A survey of the evidence on arbitrator behavior is provided by Ashenfelter (1987).

FIGURE 3.—PROBABILITY OF AN EMPLOYER VICTORY AS A FUNCTION OF THE FINAL OFFERS AND THE EFFECT OF THE UNION HIRING AN AGENT



The shaded area represents the probability of an employer victory given the employer's final offer, w_e , and the union's final offer, w_u . When the union hires a lawyer, the distribution of the arbitrator's preferred award shifts by the quantity α_u .

representation for the employer shifts the distribution to the left by the quantity α_e . With the addition of agents, the probability that the employer wins is

$$\begin{aligned} \Pr\left(w_a - \alpha_e L_e + \alpha_u L_u \leq \frac{w_e + w_u}{2}\right) \\ = \Phi\left(\frac{w_e + w_u}{2\sigma} + \frac{\alpha_e}{\sigma} L_e - \frac{\alpha_u}{\sigma} L_u - \frac{\mu}{\sigma}\right), \end{aligned} \quad (2)$$

where L_e and L_u are dummy variables equal to 1 if the employer and union hire an agent, respectively. The coefficients on these dummy variables tell us how much the arbitrator's notion of a fair award is influenced by agents. Estimates of these coefficients will form the basis of our test for the presence of prisoner's dilemma incentives.

B. Formulation of Final Offers

If agents increase the probability of winning an arbitration case, the parties should use this information in formulating their final offers. In choosing a final offer, each side trades off the benefit of a larger wage increase (or decrease) with the probability that its offer will be selected. In contrast to previous work, we allow both sides to be risk averse. Expected utility as a function of the final offers and legal representation for the employer and union are, respectively,

$$\begin{aligned} EU(w_e, w_u, L_e, L_u) = & PU[(1 + w_e + c_e L_e)w] \\ & + (1 - P)U[(1 + w_u + c_e L_e)w], \end{aligned} \quad (3)$$

$$\begin{aligned} EV(w_e, w_u, L_e, L_u) = & PV[(1 + w_e - c_u L_u)w] \\ & + (1 - P)V[(1 + w_u - c_u L_u)w], \end{aligned} \quad (4)$$

where P is the probability that the arbitrator will choose the employer's offer (as described in equation (2)), $U(\cdot)$ and $V(\cdot)$ are the employer's and union's utility functions, and c_e and c_u are the costs of hiring an agent for the employer and union. We approximate the utility of the parties by constant absolute risk aversion (CARA) utility functions, with

$U(x) = -e^{-\gamma_e x}$ and $V(x) = -e^{-\gamma_u x}$. The first-order conditions for utility maximization with respect to w_e and w_u are

$$\frac{\partial P}{\partial w_e} (e^{\gamma_e w_e w} - e^{\gamma_e w_u w}) - P(\gamma_e w e^{\gamma_e w_e w}) = 0, \quad (5)$$

$$\frac{\partial P}{\partial w_u} (e^{-\gamma_u w_u w} - e^{-\gamma_u w_e w}) + (1 - P)(\gamma_u w e^{-\gamma_u w_u w}) = 0. \quad (6)$$

In a Nash equilibrium, these equations must be satisfied simultaneously. Noting that the arbitrator treats the wage offers of the parties symmetrically, after some algebra, equations (5) and (6) jointly imply that each side wins approximately 50% of the time in equilibrium. The surprising feature of this prediction is that it holds for a reasonable range of risk-aversion parameters for the employer and union (see section V C).

It is now easy to show the final wage offers of the employer and union are

$$w_e \approx \mu - \alpha_e L_e + \alpha_u L_u - \frac{\sigma}{2\varphi(0)}, \quad (7)$$

$$w_u \approx \mu - \alpha_e L_e + \alpha_u L_u + \frac{\sigma}{2\varphi(0)}, \quad (8)$$

where $\varphi(0)$ is the normal pdf evaluated at 0. These equilibrium final offers are a function only of agent use and the parameters associated with the arbitrator's distribution. In the limiting case of risk neutrality, no approximations are necessary, and equations (7) and (8) hold as equalities. A more detailed derivation of the results in this section and a discussion of the accuracy of the approximations can be found in the appendix.

C. Incentives to Hire an Agent

When deciding whether to hire an agent, each side trades off the benefit of legal representation with the cost. Benefits are captured by α_e and α_u , the mean shifts in the arbitrator's distribution of preferred awards. Costs, previously denoted as c_e and c_u , should be interpreted broadly and could include agent fees as well as the ease with which representation can be obtained. To facilitate comparison to the benefits, costs are measured as the proportion that legal expenses are of the old wage bill (the old wage multiplied by the number of employees).

In equilibrium, the expressions for expected utility based on equations (3) and (4) and CARA utility functions can now be expressed solely as functions of legal representation. After a normalization of the utility functions (using positive affine transformations), it can be shown that

$$EU^*(L_e, L_u) \approx \alpha_e L_e - \alpha_u L_u - c_e L_e, \quad (9)$$

$$EV^*(L_e, L_u) \approx -\alpha_e L_e + \alpha_u L_u - c_u L_u, \quad (10)$$

TABLE 2.—PAYOFF MATRIX FOR EMPLOYER AND UNION STRATEGIES TO USE AN AGENT

| | Union | |
|----------------------|-----------------------------|--|
| | No Agent | Agent |
| Employer No Agent | 0, 0 | $-\alpha_u, \alpha_u - c_u$ |
| Agent | $\alpha_e - c_e, -\alpha_e$ | $\alpha_e - \alpha_u - c_e, \alpha_u - \alpha_e - c_u$ |

The first entry represents the employer's payoff, and the second entry represents the union's payoff. α_e and α_u represent the shift in the mean of the distribution of arbitrator awards resulting from the use of an agent for the employer and union, respectively. c_e and c_u represent the cost (as a percentage of the wage bill) of using an agent for the employer and union, respectively.

where * indicates the utility function has been normalized (see the appendix). In the limiting case of risk neutrality for both parties, these expressions do not involve any approximations but are exact. It is now a simple matter to calculate optimal agent use.

To better understand when prisoner's dilemma incentives arise in the framework just developed, it is useful to construct the payoff matrix as a function of legal representation. Table 2 displays expected utility based on equations (9) and (10). The upper-right-hand corner to the matrix in table 2 contains the payoffs to the employer (first entry) and the union (second entry) as calculated for the case where the union retains an agent and the employer does not. The payoffs are expressed relative to the case where neither party retains an agent, where the payoffs in this latter case have been normalized to 0. The same type of analysis easily fills in the remaining parts of the payoff matrix.

In the model, each party hires an agent if the benefits exceed the costs. The payoff matrix implies the union has a dominant strategy to hire an agent if $\alpha_u - c_u > 0$, since then it pays for the union to retain an agent regardless of what the employer does. For example, if the employer does not retain an agent, the union receives an expected wage increase of $\alpha_u - c_u$, which is greater than 0. (The payoff $\alpha_u - c_u$ is called "the temptation" in the extensive literature on the prisoner's dilemma.) Likewise, if the employer retains an agent, the union is certainly better off doing so also. (The quantity $-\alpha_e$ is called the "sucker's payoff.") It is easy to see that when $\alpha_e - c_e > 0$, precisely the same reasoning applies to the employer's choices.

In general, one might think that whether one party hires an agent depends on what the other side does. However, in the model where the parties have dominant strategies, this is not the case. We discuss two empirical tests for dominant strategies in the next section and find empirical support for the form of the payoff matrix appearing in table 2.

To ensure a prisoner's dilemma, it must also be the case that the payoffs when neither side hires an agent exceed the payoffs when both sides hire an agent. This will be the case when $\alpha_e - \alpha_u - c_e < 0$ and $\alpha_u - \alpha_e - c_u < 0$, since both parties would clearly be better off if they could agree not to hire agents, even though noncooperation is the dominant strategy. If the benefits to hiring an agent are symmetric (i.e., $\alpha_u = \alpha_e$), the payoff matrix simplifies and implies a prisoner's dilemma. In what follows, we find empirical support

for symmetric benefits. Under symmetry, if the union and the employer do what is in their individual best interests, both retain agents and spend c_u and c_e , respectively. However, the arbitration results are precisely the same as what would have occurred if neither union nor employer had retained costly agents. The private demand for legal services generated in this way is socially inefficient.⁸

IV. Empirical Results

A. Tests for Dominant Strategies and Determinants of Agent Use

In the model just developed, each party has a dominant strategy for whether to hire an agent since their optimal strategy does not depend on what the other party does. It is important to remember that agent use is observable to the other side with a lag. After an arbitration hearing where a party observes its opponent has hired an agent, it can respond by hiring an agent for future interactions in the often lengthy arbitration process. It is therefore reasonable to assume that the parties can use strategies that condition on their opponent's actual agent use and that there is a time value to hiring an agent first. In this setting, we propose a simple test for dominant strategies.⁹

Suppose the benefits of hiring an agent are constant but the costs vary. If there are no covariates to explain costs, a simple chi square test of independence can be used to test for dominant strategies. With a p -value of .164, this test fails to reject the null hypothesis that employers and unions play dominant strategies in the hiring of legal representation. Of course, this test does not control for common cost variables that affect both sides' decision to hire an agent in a similar fashion. It also fails to control for trends in agent use, which may be important if it takes time for the parties to learn about the benefits of agents.

With variables to explain costs, each side's decision to hire an agent can be written as

$$\Pr(L_e = 1) = \Pr(\alpha_e - \beta_e X_e > \varepsilon_e) \quad (11)$$

$$\Pr(L_u = 1) = \Pr(\alpha_u - \beta_u X_u > \varepsilon_u), \quad (12)$$

where X_e and X_u are observed variables that affect the employer's and union's costs and ε_e and ε_u are the corresponding error terms. Dominant strategies imply that the error terms ε_e and ε_u are uncorrelated. Assuming the underlying distribution is bivariate normal, the appropriate test

⁸ It is important to remember not all units will find themselves in a prisoner's dilemma in our setup. Only bargaining pairs for which the lower right-hand corner of table 2 is the Nash equilibrium face such incentives. The setup also easily explains why we might observe some bargaining pairs in each of the cells of table 2.

⁹ Note that in a setting with mixed strategies, our test would be uninformative, since each player effectively conditions on the strategy profile of the other player and we as econometricians only observe equilibrium plays.

TABLE 3.—DETERMINANTS OF THIRD-PARTY REPRESENTATION, WITH A TEST FOR DOMINANT STRATEGIES

| | Bivariate Probit | | | | | | | |
|---|------------------------|----------------|------------------------|-------------------|------------------------|--------------------|------------------------|-------------------|
| | (1) Agent Hired by: | | (2) Agent Hired by: | | (3) Agent Hired by: | | (4) Agent Hired by: | |
| | Employer | Union | Employer | Union | Employer | Union | Employer | Union |
| Population (25,000<pop≤50,000 omitted) | | | | | | | | |
| pop≤5,000 | | | -.193 (.184) | -.311 (.218) | -.166 (.191) | -.410* (.229) | -.233 (.222) | -.677** (.282) |
| 5,000<pop≤10,000 | | | -.312* (.162) | .001 (.204) | -.332** (.169) | -.100 (.216) | -.349* (.201) | -.323 (.272) |
| 10,000<pop≤15,000 | | | -.236 (.170) | .079 (.215) | -.252 (.176) | -.004 (.225) | -.377* (.216) | -.306 (.285) |
| 15,000<pop≤25,000 | | | -.018 (.164) | -.130 (.199) | -.047 (.169) | -.238 (.209) | -.019 (.206) | -.423 (.267) |
| 50,000<pop≤100,000 | | | .398** (.202) | -.385* (.223) | .335 (.206) | -.429* (.236) | .499* (.279) | -.696** (.308) |
| Pop>100,000 | | | -.030 (.214) | -.481** (.236) | -.120 (.221) | -.565** (.250) | -.184 (.267) | -.585* (.318) |
| County case | | | .035 (.168) | -.150 (.199) | .025 (.177) | -.146 (.215) | -.029 (.222) | -.499* (.281) |
| State case | | | -1.711** (.543) | -.695 (.436) | -1.690** (.526) | -.618 (.474) | -7.263 (9498) | -.651 (.634) |
| Unavailable | | | -.228 (.319) | -.572* (.334) | -.155 (.335) | -.602* (.351) | -.153 (.432) | -1.04** (.430) |
| <i>p</i> -value | | | | .002 | | .008 | | .102 |
| Contract length (one year omitted) | | | | | | | | |
| Two years | | | | | .716** (.141) | .201 (.158) | .690** (.167) | .233 (.188) |
| Three years or longer | | | | | .850** (.177) | .326 (.206) | .770** (.214) | .449** (.254) |
| Unknown | | | | | .598** (.235) | .056 (.271) | | |
| <i>p</i> -value | | | | | | .000 | | .000 |
| Disputed items (wages and benefits omitted) | | | | | | | | |
| Wages only | | | | | .074 (.279) | .681* (.393) | -.254 (.160) | -.050 (.187) |
| Benefits only | | | | | -.233 (.140) | -.112 (.159) | | |
| <i>p</i> -value | | | | | | .155 | | .273 |
| Type of unit (police omitted) | | | | | | | | |
| Fire | | | | | .168 (.153) | -.049 (.177) | -.001 (.217) | -.050 (.187) |
| Other | | | | | -.646** (.329) | -2.109** (.396) | | |
| <i>p</i> -value | | | | | | .000 | | .760 |
| Year dummies included? | No | Yes | | | Yes | Yes | Yes | Yes |
| <i>p</i> -value | | | | | .085 | .134 | | |
| Correlation coefficient (ρ) | .089 (.064) | .060 (.069) | | | -.009 (.073) | | -.018 (.087) | |
| Likelihood ratio test of $\rho = 0$ | 1.933 | .748 | | | .016 | | .042 | |
| <i>p</i> -value | .164 | .387 | | | .901 | | .837 | |
| Log likelihood | -960.7 | -896.9 | | | -855.0 | | -602.8 | |
| Observations | 859 | 859 | | | 859 | | 620 | |

Standard errors in parentheses. Column 4 only includes cases where the arbitrator's decision and the final wage offers are available (the main sample used in table 4). **Significant at the 5% level, *10% level.

for dominant strategies is whether the correlation coefficient from a bivariate probit differs significantly from 0. If so, we can reject the null hypothesis of dominant strategies.

Table 3 estimates the bivariate probit described by equations (11) and (12). The table records the value and significance of the correlation coefficient, which should be 0 under the dominant strategy hypothesis. The first specification, which does not include any covariates, yields a correlation coefficient ρ of .09, with a relatively large standard error. The likelihood ratio test for $\rho = 0$ has an almost identical *p*-value compared to the chi square test reported (.164

versus .162). The second specification adds in year and population dummies. Both sets of dummies significantly affect the probability that each side hires an agent. Including these dummies cuts the correlation coefficient by one-third, from .09 to .06. The third column in table 3 adds in other covariates that are likely to affect agent use, and the correlation coefficient reduces to essentially 0. The likelihood ratio test that $\rho = 0$ has a *p*-value of .90, indicating that dominant strategies in agent use cannot be rejected. In the final specification, we restrict the sample to wage disputes with available information on final offers (the main

TABLE 4.—PROBABILITY THE EMPLOYER'S FINAL OFFER IS CHOSEN BY THE ARBITRATOR

| | Probit | | | | | | | |
|--|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Employer hires an agent | .756** (.098) [.274] | .708** (.112) [.255] | .733** (.123) [.262] | .760** (.282) [.271] | .699** (.128) [.249] | .613** (.293) [.220] | .697** (.129) [.248] | .697** (.129) [.248] |
| Union hires an agent | -.667** (.122) [-.260] | -.637** (.144) [-.249] | -.562** (.152) [-.219] | -.543** (.233) [-.212] | -.597** (.157) [-.232] | -.659** (.245) [-.256] | -.600** (.157) [-.233] | -.600** (.157) [-.233] |
| Both sides hire agents | | | | -.032 (.308) [-.012] | | .104 (.319) [.039] | | |
| Average of final offers | | | | | .311** (.054) [.116] | .313** (.054) [.117] | | .319** (.055) [.119] |
| Employer final offer | | | | | | | .203** (.055) [.076] | |
| Union final offer | | | | | | | .116** (.048) [.043] | |
| Difference in final offers | | | | | | | | -.044 (.044) [-.016] |
| Population dummies included? <i>p</i> -value | No | No | Yes .014 | Yes .014 | Yes .006 | Yes .006 | Yes .005 | Yes .005 |
| Year dummies included? <i>p</i> -value | No | No | Yes .491 | Yes .493 | Yes .006 | Yes .006 | Yes .006 | Yes .006 |
| Agent effect symmetric? <i>p</i> -value | .543 | .684 | .367 | .645 | .606 | .926 | .621 | .621 |
| Offers treated symmetrically? <i>p</i> -value | | | | | | | .321 | |
| Log likelihood | -501.5 | -382.9 | -363.8 | -363.8 | -342.5 | -342.5 | -342.0 | -342.0 |
| Observations | 814 | 620 | 620 | 620 | 620 | 620 | 620 | 620 |

Standard errors reported in parentheses. Marginal effects calculated at the means reported in brackets. Population dummies are defined in table 1. Specification 1 uses data from all final offer arbitration cases where the arbitrator's decision is available, while Specification 2-7 further restrict the sample to cases where the final wage offers are available. "Agent Effect Symmetric" tests the null hypothesis that the coefficients on "Employer Hires an Agent" and "Union Hires an Agent" are equal in magnitude and opposite in sign. "Offers Treated Symmetrically" tests the null hypothesis that the coefficients on "Employer Final Offer" and "Union Final Offer" are equal. **Significant at the 5% level, *10% level.

sample used in table 4). Again, we find a very small correlation coefficient, with an associated *p*-value of .86. Although not shown due to space constraints, ρ is small and not significantly different from 0 for either early or later subsamples of the data.¹⁰

Why do some parties retain arbitrators while others do not? The coefficients on the control variables in table 3 provide some insight into this question. Although not shown, the coefficients on the year dummies generally rise over time for employers but have no obvious trend for unions. This corresponds to the pattern shown in figure 1. We explore these time trends in more detail when we discuss learning in section V. Both sides are more likely to hire agents if the dispute involves a multiple-year contract. Whether the case involves only a wage or benefit dispute does not have a jointly significant effect. It also appears that units not involving firefighters or police are much less likely to hire legal representation. These few cases involve nurses, communication and transportation workers, public school teachers, and university staff (in contrast to fire and police

units, these workers were allowed to strike in New Jersey). For these workers, the sides were not required to submit their cases to binding arbitration but were allowed to take advantage of the mechanism in place in New Jersey.

The population of the unit (a proxy for the number of employees; see table 1) also plays an important role for both employers and unions. Employers in municipalities with fewer than 25,000 residents are less likely to hire an outside expert, while employers in mid-sized cities (50,000–100,000 residents) are more likely to hire an agent. The propensity to hire an agent is not monotonic, however. Large cities (over 100,000 residents) and state cases are less likely to hire an outside expert compared to the mid-sized cities. One interpretation for these findings is that the cost per employee was perceived to be relatively high for small boroughs and townships. Midsize cities found it more cost-effective to hire agents. For very large employers, the scale may have warranted an internal expert on staff, with no need to hire an outside agent. A somewhat different pattern emerges for unions. Unions in mid-sized and large cities are substantially less likely to hire agents, with the demand for agents being largest in the relatively small municipalities (with the exception of the smallest municipalities). This is consistent with larger unions having specialists on staff and

¹⁰ For example, in the first four years of our data, when agent use by employers was particularly low, the correlation coefficient was .012 and not significantly different from 0.

with small unions perceiving a larger gain to agents compared to small employers.¹¹

Another test for the presence of dominant strategies in the payoff matrix can be performed when estimating the probability of an employer victory as described in equation (2). An interaction term for legal representation, $L_e L_u$, could be included in this probit equation. The coefficient on this interaction term should be 0 if the benefit of agent use does not depend on the other party's use. This test reveals whether the actual benefit of an agent is independent of the other party's choice, while the previous test reveals whether the parties' perceptions of the incentive structure imply dominant strategies. We report the results of this second test in the next section.

B. Estimates of the Benefits of Agents

The previous section presented evidence that the use of agents by employers and unions is independent of what the other party does. However, this does not guarantee prisoner's dilemma incentives. For the use of agents to be inefficient, it must also be the case that the payoffs when both sides use an agent are less than the payoffs when neither side uses an agent. This is guaranteed to occur when the benefits to using an agent by the employer and union result in similar mean shifts (in opposite directions) in the distribution of arbitral awards. In this section, we estimate the benefits to legal representation in our model and test for symmetric benefits.

Table 4 contains the results of fitting probit functions similar to equation (2) to the actual decisions of arbitrators.¹² The dependent variable is an indicator for whether the employer "wins" the case, that is, a dummy variable that equals 1 if the arbitrator chooses the employer's final offer and 0 otherwise. The first column uses all final offer cases, whereas the second (and remaining) columns use only final-offer cases for which information is available on the wage offers of the union, and employer. Specification (3) adds in year and population dummies. The results from the first three columns tell a similar story: the marginal effect of hiring an agent on the probability of winning is around 25% for both the employer and the union, and we cannot reject a symmetric agent effect. The fourth column adds in an interaction term for whether both parties hire an agent. If the payoff structure supports dominant strategies, the coefficient on this variable should be 0, the actual estimated marginal effect is

very small (-1.2%) and not significantly different from 0. Including the interaction term has very little effect on the other coefficient estimates, although the standard errors on the coefficients for agent use increase substantially.

The next two specifications in table 4 add in the average of the parties' final offers. The results indicate that when the employer hires an agent, the distribution of awards shifts upward by around two-thirds of a standard deviation of the distribution of arbitral awards. Likewise, when the union retains an agent, the distribution of awards shifts downward by around two-thirds of a standard deviation. In the bottom panel, we test whether these mean shifts are equal in magnitude for the employer and union. In both specifications, the null hypothesis of a symmetric agent effect cannot be rejected.¹³

The final two columns consider alternative specifications for how final offers enter the regression. First, arbitrators could treat employer and union final offers differently. Column (7) includes the employer and union final offers separately in lieu of the average of the two. While the coefficient on the employer's final offer is larger, the null hypothesis that the offers are treated symmetrically cannot be rejected. The last column adds, in addition to the average of the final offers, the difference between the final offers, which can be viewed as a proxy for the size of the disagreement or a proxy of uncertainty. The coefficient on the difference is negative but insignificant, while the coefficient on the average of the offers is largely unchanged. Perhaps more important, the estimated effects of using an agent are the same as before. Finally, it could be the case that employers and unions hire agents to reduce the variance in outcomes for a given set of final offers. Although not shown, when agents use is interacted with the average of the final offers, the coefficients on these interaction terms indicate that hiring an agent has little effect on the variance of the award distribution, although the estimates are imprecise.

Since our panel of arbitration cases spans eighteen years, our data set contains many disputes decided by the same arbitrator, as well as many cases represented by the same agent. Table 5 uses these unique aspects of the data to estimate probit models that control for individual agent effects and individual arbitrator effects. The first column adds in dummy variables for the experienced agents, where "experienced" is defined as an agent who handled at least 35 arbitration cases. These agent dummies enter the probit equation significantly, with the effect of using a (nonexperienced) agent being somewhat smaller compared to the estimates in table 4. One agent, Mr. Loccke, was especially experienced. He represented the union in 25% of all arbitra-

¹¹ When similar bivariate probits are run on the subsample of cases where information is available on the number of employees in the unit, controlling for the number of employees instead of population yields very similar results. Using population dummies yields an estimate for ρ of $-.019$ (p -value = .844), while using number of employee dummies yields $-.023$ (p -value = .844). The specification based on the number of employees fits the data slightly better, with a log likelihood for the regression of -500.8 versus -503.6 .

¹² We acknowledge that if there is selection in which parties choose to hire an agent (for example, based on the ex ante subjective belief about the strength of the case), then the coefficients on the agent dummies in these probit regressions will be biased.

¹³ One empirical issue arises when interpreting the probit results of equation (2) since the final wage offers of the two parties are likely to be measured with error. Since the average of the final offers is close to orthogonal to agent use in this data set, this bias should not markedly affect the coefficient estimates for agents in the probit equation (compare the estimates in columns (3) and (5) in table 4). It will, however, affect the scaling used to obtain the implied mean shifts from using an agent.

TABLE 5.—PROBABILITY THE EMPLOYER'S FINAL OFFER IS CHOSEN, CONTROLLING FOR AGENT AND ARBITRATOR EFFECTS AND CONDITIONING ON POPULATION SIZE

| | Probit | | | | | |
|---|------------------------------|----------------------------|------------------------------|----------------------------|------------------------------|-----------------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Employer hires an agent | .494** (.141) [.180] | .936** (.315) [.209] | .851** (.148) [.297] | .660* (.396) [.256] | .691** (.139) [.238] | .680* (.357) [.262] |
| Union hires an agent | -.418** (.178) [-.162] | | -.671** (.188) [-.261] | -.746 (.538) [-.285] | -.608** (.182) [-.233] | -.619* (.349) [-.242] |
| Average of final offers | .349** (.059) [.131] | .249* (.131) [.065] | .371** (.064) [.139] | .256** (.126) [.102] | .297** (.057) [.108] | .196 (.136) [.078] |
| Experienced agent dummies? | Yes | No | No | No | No | No |
| <i>p</i> -value for employer agents | .000 | | | | | |
| <i>p</i> -value for union agents | .052 | | | | | |
| Only cases where Mr. Loccke hired by union? | No | Yes | No | No | No | No |
| Arbitrator dummies? | No | No | Yes | No | No | No |
| <i>p</i> -value | | | .381 | | | |
| Only cases with Mr. Mitrani as arbitrator? | No | No | No | Yes | No | No |
| Units with small populations? | No | No | No | No | Yes | No |
| Units with large populations? | No | No | No | No | No | Yes |
| Agent effect symmetric? | | | | | | |
| <i>p</i> -value | .736 | | .431 | .863 | .701 | .911 |
| Log likelihood | -322.2 | -83.5 | -291.2 | -40.5 | -281.5 | -54.1 |
| Observations | 620 | 171 | 569 | 77 | 513 | 94 |

Standard errors reported in parentheses. Marginal effects calculated at the means reported in brackets. All specifications include population and year dummies, except specifications 4 and 6 which include population dummies and a cubic in year. See notes to table 4. Specification 1 includes dummies for agents hired by the employer (or union) who handled at least 35 arbitration cases; there are six such agents for the employer and five such agents for the union. Specification 2 includes cases where Mr. Loccke represented the union; when hiring an agent, the union hires Mr. Loccke over 25% of the time. Specification 3 includes cases handled by the 42 arbitrators who handled at least two cases and did not always decide in favor of the union or the employer. Specification 4 includes only cases decided by Mr. Mitrani; Mr. Mitrani was the arbitrator in approximately 10% of all cases decided in arbitration. Specification 5 excludes units with population over 50,000, state cases, and cases with unavailable population (but includes county cases). Specification 6 excludes units with population under 50,000, country cases, and cases with unavailable population. **Significant at the 5% level, *10% level.

tion cases. The second specification includes only the 171 final offer cases where the union hired Mr. Loccke. Holding constant the legal representation of the union in this manner, the employer's use of an agent has a similar effect compared to previous estimates. These results suggest that while experienced agents have strong effects, even relatively inexperienced agents shift the arbitrator's distribution significantly.

If arbitrators are not statistically exchangeable, it is possible that different arbitrators could be systematically pro-union or pro-employer. We test the arbitrator exchangeability hypothesis in the third column of table 5. To construct this test, we include dummies for the 42 arbitrators who handled at least two cases and did not always decide in favor of the union or employer. Not only are the arbitrator fixed effects jointly insignificant, none of the individual arbitrator dummies are significant at the 5% level. This provides strong confirmation that arbitrators are statistically indistinguishable from one another. Moreover, the inclusion of arbitrator fixed effects does not markedly change the estimates of the benefits of agent use. Mr. Mitrani was the arbitrator in approximately 10% of all cases going to arbitration. Specification (4) uses only data from cases he handled. Once again, the estimated benefits of agent use do not change appreciably. The results from these two specifications also suggest that the benefits of legal representation are not primarily due to an agent's assistance in the selection of the arbitrator.

As noted previously, it may well be the case that larger units have in-house specialists, and hence need not hire an

outside expert. Although we cannot identify in-house experts, we can split the sample into units that are more and less likely to have an expert on staff. In the penultimate column of table 5, we limit the sample to bargaining units with populations fewer than 50,000 residents (or county units, since table 1 reveals they also have fewer employees). The estimates for the small unit sample are very similar to those reported in table 4. The last column shows results for bargaining units with populations greater than 50,000 residents (including state units). Interestingly, the estimated effects of using an agent for these large units are also similar to those reported in table 4. These results are suggestive that outside experts do better than in-house specialists.

In summary, the results in tables 4 and 5 provide strong evidence that each party increases the chance that their offer will be accepted when they retain third-party agents. The benefits of agent use appear to be the same for both the employer and union in terms of mean shifts in the award distribution. There also is no significant interaction effect when both parties hire agents on the arbitrator's decision. Given the evidence that each party has a dominant strategy and that the benefits of using an agent are symmetric, we conclude that prisoner's dilemma incentives exist for legal representation in New Jersey final-offer arbitration.

Is there any way to translate the shifts in the award distribution from retaining an agent into dollar terms? Richard Lester helped in the design of New Jersey's final-offer mechanism and followed its use over time. For the mid-1980s, he found that legal fees were generally around \$5,000 per case for the union, and up to \$15,000 per case for

TABLE 6.—PROBABILITY OF RETAINING AN AGENT IN THE CURRENT CASE BASED ON EXPERIENCE

| | Linear Probability | | Probit | | Probit | |
|--|-----------------------------|-----------------|-------------------------------------|---------------------------|-------------------------------------|----------------------------|
| | Experience with Arbitration | | Experience with Agents and Outcomes | | Aggregate Learning from Other Units | |
| | (1) Employer | (2) Union | (3) Employer | (4) Union | (5) Employer | (6) Union |
| Number of previous cases (zero omitted) | | | | | | |
| One | .071 (.059) | .036 (.051) | | | | |
| Two or three | .124* (.067) | -.037 (.058) | | | | |
| Four or more | .200** (.085) | .031 (.073) | | | | |
| Employer lost the previous case (and the union used an agent but the employer did not) | | | .792** (.388) [.255] | .728* (.414) [.069] | | |
| Estimated belief about the benefit of using an agent | | | | | .895** (.328) [.340] | -.397 (.467) [-.097] |
| Municipality fixed effects included? | Yes | Yes | No | No | No | No |
| <i>p</i> -value | .000 | .000 | | | | |
| Log likelihood | | | -65.8 | -37.9 | -489.7 | -349.2 |
| Observations | 477 | 477 | 120 | 122 | 814 | 814 |

Standard errors reported in parentheses. Marginal effects calculated at the means reported in brackets. Specifications include disputed items, type of unit, number of years covered by award, and population of municipality dummies (unless subsumed by municipality fixed effects). Specifications 1 and 2 restrict the sample to cases where agent use by the bargaining pair varies over time and include 111 municipality fixed effects. Specifications 3 and 4 restrict the sample to cases where the union used an agent in the previous municipality case, but the employer did not, and also include a cubic in year. Specifications 5 and 6 use the sample of cases corresponding to table 4, specification 1.

the employer (Lester, 1989). A permanent increase in the compensation of a police officer by 1% would have a discounted present value of perhaps \$2,000 to \$3,000 for this same time period. It would take a bargaining unit of only five to ten employees to make it well worth the cost for each party individually to retain an agent. In short, the incentive structure in New Jersey's arbitration system seems to create a prisoner's dilemma for most of the parties.

V. Extensions

One of the more interesting time series patterns in our data is the rising use of agents over time, something not modeled in section III. The model in section III also assumed that the hiring of an expert openly shifts the distribution of the arbitrator's preferred award. The resulting Nash equilibrium had both parties shift their bids in the same direction and the same amount as the mean shift due to agent use, so that both sides were predicted to win 50% of the time regardless of agent use. The data reveal a different pattern, with the party hiring an expert being more likely to win. In this section, we provide extensions to the baseline model that can explain the increasing use of agents and the higher win rate associated with agents. We begin with a learning model and then develop a model in which agents are information providers. We end the section with a discussion for why the equilibrium win rate might differ from 50% even when there is no differential use of agents.

A. Learning about the Benefits of Agents

A simple learning model can explain both the rising use of agents and the increased win rate associated with them.

In particular, in this section we find evidence that employers initially believed the benefit of hiring an agent was low, but over time they figured out an agent's value. A learning model also helps explain the convergence in final offers that occurs after the first few years of this new arbitration system. We first test for learning at the local level, where the parties learn from their own experiences. We then estimate a model of Bayesian learning at a more aggregate level, where the parties learn from other bargaining units.

Table 6 examines learning at the local level, where employers and unions learn from past interactions with the system and each other. The first two columns regress current employer and union use of agents on the number of times the municipal bargaining pair has been to arbitration.¹⁴ The first column shows that even after controlling for municipality fixed effects, the number of previous arbitration cases has a significant effect on employers' use of agents. Employers who have been to arbitration at least four times in the past are 20% more likely to hire an agent compared to employers with no past experience. In contrast, the number of previous cases for the union has no sizable or significant effect on current agent use.

The number of previously arbitrated cases is a rough measure of experience and does not account for past agent

¹⁴ We use linear probability models to avoid any bias arising from the incidental parameters problem with fixed effects in probit estimation. In this table, we assume learning takes place at the municipality level, so that a fire and a police department interacting with the same municipal employer are counted as the same bargaining pair. To focus on learning, we restrict the sample to cases where agent use by the bargaining pair varies over time, although results are similar if these cases are included. These regressions do not include year controls, as year and number of previous arbitration cases are too highly correlated to yield a precise estimate when they are included.

use or outcomes. To more precisely test for learning at the local level, we examine whether past arbitration outcomes as a function of past agent use affect current agent use. Recall that the largest increase in agent use occurs for employers, so this is the phenomenon we seek to explain. Therefore, consider observations where a union previously hired an agent but the employer did not and the same parties find themselves in arbitration again. We have 122 such cases in our data set. The idea is that if the employer lost the previous case (where the union used an agent but the employer did not), it should be more likely to infer that agents are valuable and hire an agent for the current arbitration case. We estimate a probit model for whether the employer uses an agent as a function of whether the employer lost the previous case on this restricted sample.¹⁵ The results indicate that an employer that lost the previous case is 26% (p -value = .04) more likely to hire an agent this time compared to an employer that won the previous case. Similarly, but with a smaller magnitude, unions are 7% (p -value = .06) more likely to hire an agent if the employer lost the previous case in this situation. This finding provides evidence that employers and unions learn from their experiences.¹⁶

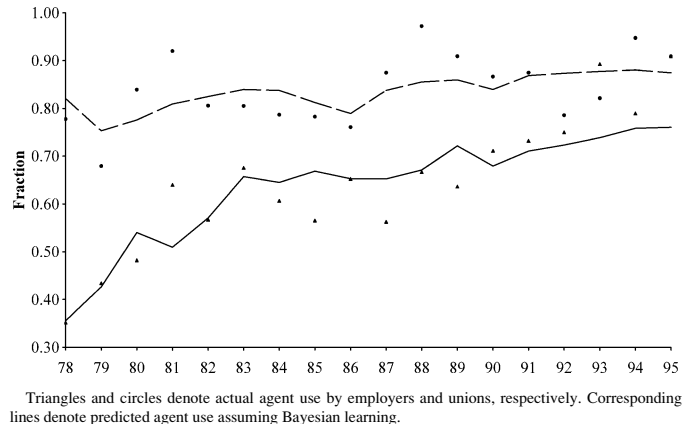
To examine learning at a more aggregate level, we present a simple Bayesian learning model where employers and unions learn from the experience of the system as a whole. The model captures the idea that New Jersey's final offer arbitration system was new in 1978, when little was known about how expert agents would affect outcomes. As time progressed, the value of agents could be inferred from actual arbitrated cases, with prior beliefs mattering less as new information arrived. This type of learning assumes that employers and unions in one municipality learn from the experiences in other municipalities. To formalize this idea, let employers' prior beliefs about the benefit of using an agent have a normal distribution, with mean $\alpha_{e,0}^*$ and variance $\lambda_{e,0}^*$. Assuming new data arrive each period and also have a normal distribution, employers update their beliefs about the true benefit (previously denoted as α_e) by taking a weighted average of their prior and all data up to that point. At time $t + 1$, beliefs for the employer are given by

$$\alpha_{e,t+1}^* = (\lambda_{e,0}^* + \lambda_{e,t}) \left(\frac{\alpha_{e,0}^*}{\lambda_{e,0}^*} + \frac{\alpha_{e,t}}{\lambda_{e,t}} \right), \quad (13)$$

¹⁵ We limit the set of cases to those decided at least twelve months apart, to get rid of simultaneous cases (for example, where a municipality is concurrently bargaining with both a police union and a fire union).

¹⁶ We can also condition on cases where, in the previous arbitration case between the parties, the employer hired an agent but the union did not. Unfortunately, this is a small sample (only 32 observations), so there is little identifying variation and we cannot feasibly control for covariates. The results indicate that employers that won previously are 25% (p -value = .08) more likely to hire an agent than if they lost. A similar probit for unions indicates no effect, with a large standard error (-1%, p -value = .96).

FIGURE 4.—ACTUAL VERSUS PREDICTED AGENT USE ASSUMING BAYESIAN LEARNING, 1978–1995



Triangles and circles denote actual agent use by employers and unions, respectively. Corresponding lines denote predicted agent use assuming Bayesian learning.

where $\alpha_{e,t}$ and $\lambda_{e,t}$ denote the mean and variance of the data available at time t . A similar equation can be written for unions.

Does this simple learning model help explain the pattern of agent use over time? To answer this question, we first estimate a series of probit regressions of equation (2) using data up to time period $t - 1$ and using the same specification as table 4, column (1). The estimates of α_e and its associated standard deviation based on data up to $t - 1$ will be used for $\alpha_{e,t}$ and $\lambda_{e,t}$ in equation (13). We then estimate the prior beliefs $\alpha_{e,0}^*$ and $\lambda_{e,0}^*$. Consistent with the low use of agents by employers at the beginning of the period, the prior belief $\alpha_{e,0}^*$ was estimated to be close to 0 for employers, while the corresponding estimate for unions was large and negative (suggesting employers started with inaccurate beliefs and unions started with accurate beliefs).¹⁷ Finally, using these priors and the data and updating equation (13), we calculate Bayesian time-period-specific estimated beliefs about the benefits of an agent separately for unions and employers. To test whether beliefs matter, we estimate probits for agent use that include these beliefs about the benefit of an agent as an additional regressor. Importantly, we do not include year dummies in this probit, since the exercise is to see how well this simple model of learning can explain the time pattern in agent use. The results for this test appear in the final two columns of table 6. The coefficients on beliefs about the benefits of an agent are sizable and statistically significant for employers but not for unions.

Figure 4 plots the actual proportion of cases where an agent is retained by the employer (the triangle symbols) and

¹⁷ We estimated the priors using maximum likelihood of a probit regression of agent use by the employer (or union) on beliefs, where beliefs are updated using equation (13) as described in the text. The estimates of the priors on mean beliefs are .08 (s.e. = .21) for employers and -.87 (s.e. = .23) for unions. The estimated prior on the variance of beliefs is equal to .41 for employers, which equates to less precision than one year of observed data. The union likelihood function was unstable, so we set the prior on the variance equal to that for employers.

the union (circles) year by year. The solid lines indicate predicted agent use based on the learning model. The model for aggregate learning does a reasonable job of predicting the time series patterns of agent use. It can explain why employers infrequently hired experts in the beginning and why it took some three or four years for them to figure out the benefit of experts. It can also match some of the rise in agent use near the end of the sample, which could be due to the fact that agents are getting slightly better over time for employers.¹⁸ The model also matches the pattern for unions, although there is less variation to explain. For all but 3 of 36 observations, predicted agent use based on the learning model is within 2 standard deviations of actual agent use.

To summarize, there is evidence for learning at both the individual bargaining level as well as learning from the experiences of others. The Bayesian learning model does a good job of explaining the rising use of agents over time, which is one of the most striking patterns in our data. Additionally, learning provides an explanation for why the probability of winning depends on agent use, whereas the simplest model suggests a win rate of 50% regardless of agent use. Parties that underestimate the value of an expert agent will not hire an agent and, moreover, will formulate a final offer that is too extreme when the other side hires an agent. This is because the misinformed parties who have not yet learned about the benefits to agent use do not recognize the mean shift in the arbitrator's distribution which occurs when the opposing side hires an agent, and fail to adjust their final offer accordingly. The number of parties that have not figured out the mean shift resulting from agent use declines over time as learning takes place, with agent use being nearly universal by the end of our sample.

Learning by employers is also consistent with the time series pattern in final offers. Table 1 documented that the average difference in final offers varies based on whether the employer used an agent. Interestingly, this gap depends on agent use in a significant way for only the first few years of our data, which is precisely when the majority of learning occurs (see figure 4). A regression using data from 1978 to 1981 reveals that the difference in final offers is over 40% larger when employers do not use an agent but does not significantly depend on whether unions use an agent. In contrast, regressions using data from 1982 and later show almost no effect for employer or union agents on the gap in

final offers.¹⁹ This pattern is consistent with learning by a large fraction of employers in the first few years of the sample: employers did not recognize the mean shift in the arbitrator's distribution when the unions hired agents. As a result, their final offers were too low and resulted in both a lower probability of employer victory and a larger gap in final offers. After the first few years of this new arbitration system, it appears that a majority of the parties understood the benefits of agent use.

B. Agents as Information Providers

In section III, we modeled agents as advocates, where they could change the arbitrator's notion of what would be a fair wage settlement. It could also be the case that agents provide private information about what final offer to present to the arbitrator.²⁰ A model where agents are information providers offers a second rationale (the first being learning) for why the win rate will be a function of agent use.

As before, suppose the arbitrator selects the wage offer that is closest to his preferred award, w_a , and that the parties maximize expected utility based on CARA utility functions. However, instead of agents shifting an arbitrator's distribution of preferred awards favorably for their clients, let agents instead provide information on what an arbitrator's preferred award will be in a specific case. More formally, suppose w_a is the sum of three normally distributed random variables b_e , b_u , and v , where $b_e \sim N(0, \sigma_e^2)$, $b_u \sim N(0, \sigma_u^2)$, and $v \sim N(\mu, \sigma_v^2)$. For simplicity, let b_e , b_u , and v be independent, as this assumption does not change the main insights. If the employer hires an agent, the agent provides private information by revealing b_e , which the employer can use in formulating its final offer. Similarly, a union agent reveals b_u to its client.

In this setup, agents reveal private information about the location and reduce the variance of the arbitrator's preferred award, w_a , for their clients. If no agent is hired, the relevant distribution for the client is $w_a \sim N(\mu, \sigma_e^2 + \sigma_u^2 + \sigma_v^2)$. The relevant conditional distribution for the union if it hires an agent is $w_a|b_u \sim N(\mu + b_u, \sigma_e^2 + \sigma_v^2)$, and similarly for the employer: $w_a|b_e \sim N(\mu + b_e, \sigma_u^2 + \sigma_v^2)$. The client conditions on this private information about the arbitrator's distribution when formulating the final offer.

As before, we assume employers and unions maximize expected utility, but substitute in the relevant unconditional

¹⁸ In theory, the rise in the use of expert agents over time could be due to agents getting more valuable over time. It is also possible that the sample of cases that proceed to arbitration changes over time, since we do not observe disputes that are being settled on mutual terms. However, the estimated benefits change only modestly over time, which implies that agents are not getting more valuable and suggests the sample is not changing dramatically. For employers, the marginal effects of agent use increase slightly, rising from .24 to .28 to .33 across 1978 to 1983, 1984 to 1989, and 1990 to 1995, although the estimates are not significantly different from each other. For unions, there is no clear or statistically significant pattern, with marginal effects of $-.024$, $-.17$, and $-.20$, respectively.

¹⁹ When the same specification as table 4, column 5, is used, the coefficients for employer and union agent use, respectively, are $-.94$ (s.e. = .36) and $-.09$ (.45) for 1978–1981 and $-.04$ (.13) and $-.01$ (.17) for 1982–1995.

²⁰ We thank an anonymous referee for suggesting this idea. As the referee pointed out, it is formally similar to a model of electoral competition in which parties are trying to determine the stochastic location of the median voter and parties care both about winning the election and implementing their preferred policies. When both political parties pay for more accurate data, the payoffs remain the same in equilibrium. Bernhardt, Duggan, and Squintani (2007) provide a theoretical model in which candidates maximize their probability of being elected after receiving private polling signals.

or conditional distribution for the employer and union into equations (3) and (4). For example, consider the case where the employer does not hire an agent, but the union does and observes b_u . In this case, the Nash equilibrium condition is

$$\frac{\partial P_{w_a}/\partial w_e}{P_{w_a}} \approx \frac{\partial P_{w_a|b_u}/\partial w_u}{1 - P_{w_a|b_u}}. \quad (14)$$

Equation (14) pins down a unique equilibrium, since for normal distributions, the ratio of the density function to the distribution function is monotonically decreasing (and monotonically increasing for the hazard function).²¹ It can also be shown that the union will be more likely to win as a result of hiring an agent. The reason is that the information provided by the union's agent reduces uncertainty about the arbitrator's distribution. Intuitively, the trade-off between asking for a more extreme offer versus having that more extreme offer accepted is now steeper for the union than the employer in equilibrium.

More generally, there are analogous Nash equilibrium conditions similar to equation (14) for all combinations of agent use. As we did in section III, we can calculate the equilibrium wage offers and the predicted benefit of hiring an agent for forward-looking parties. The resulting expressions are complicated in part because the private signals provided to the parties by their agents are not revealed to the econometrician. Unfortunately it is not feasible to estimate the structural parameters of this learning model without making very strong and arbitrary assumptions.²² Although we cannot directly estimate the informational benefit of hiring an agent, there are several important implications for win rates from the learning model that can be tested with our data.

First, if neither side hires an expert, the probability of an employer victory should be approximately 50% in equilibrium. Second, if only one side hires an expert, then the party hiring the expert should win more than half the time. Third, if union and employer agents provide equally valuable information on average ($\sigma_e^2 = \sigma_u^2$), then the informational advantage to hiring an agent will cancel out when both parties employ agents. In this case, both the average of the final offers and the employer victory rate will be the same as when neither side hires an agent.

Similar to the previous model, a prisoner's dilemma will exist if the players have dominant strategies and the informational benefits to hiring an agent are equal for both parties. The previous test for dominant strategies applies

²¹ This monotonicity is true for a broader class of distributions but not for all distributions. For example, if the distribution of w_a was exponential, the ratio of the density function to the distribution function would be flat, and there would be no equilibrium.

²² The expected payoff as a function of agent use involves the integration over the random variables b_e and b_u of implicit functions defined by the relevant normal densities and normal distributions. In addition to the distributional assumptions on the random variables b_e and b_u and v (whose realizations we do not directly observe), one would need to make arbitrary assumptions to separate out changes in wage offers to due to realizations of the random variables b_e and b_u versus heterogeneity across individual cases in the location of v .

equally well in this informational setting. Although we cannot feasibly estimate the informational benefits (σ_e^2 and σ_u^2), we can test whether the change in probability resulting from agent use is the same for employers and unions. If the two parties have CARA utility functions, this is a test for approximately equal informational benefits.

Our previous empirical results confirm an important prediction of the information story: when only one side hires an agent, it is more likely to win. There is also good empirical evidence that this informational advantage cancels out when both sides hire agents. Overall, the raw employer win rate when neither side hires an agent is not statistically different from the win rate when both sides hire agents (see table 1). The probit estimates in table 4 confirm this pattern by revealing large but offsetting changes in the probability of an employer victory as a result of agent use. This is true regardless of the set of covariates included, including whether the average of the final offers is a control variable. We take this as reduced-form evidence of prisoner's dilemma incentives. Finally, the model is broadly consistent with the basic pattern that the final offers are closer together in the later years when agents are more widely used.

C. Risk Aversion and NonWage Considerations

The advocacy and informational models in sections III and VB assumed CARA utility functions. In both models, the results on equilibrium win rates and expected payoffs as a function of agent use were approximate and relied on the fact that $e^x \approx 1 + x$ for small values of x . If both parties are risk neutral, no approximations are necessary, and the results are exact. An important question is how accurate such approximations are for reasonable values of the risk-aversion parameters.

Without the approximation, it can be seen from the Nash equilibrium condition that the more risk-averse party will win more than 50% of the time, consistent with Farber and Katz (1979) and Farber (1980). However, the approximation of a 50% win rate is reasonably accurate in the current application. To see this, note that the expressions $\gamma_e w$ and $\gamma_u w$ are the coefficients of absolute risk aversion for the employer and union multiplied by the old wage, or, in other words, the coefficients of relative risk aversion. A value of 1 or 2 is often used as a value for relative risk aversion in a variety of settings. The difference in the final offers ranges from .004 at the 10th percentile to .032 at the 90th percentile in our data set, with a median difference of .012. Hence, $\gamma_e w(w_u - w_e)$ and $\gamma_u w(w_u - w_e)$ will be small numbers and the approximation $e^x \approx 1 + x$ will be fairly accurate. For example, suppose employers are close to risk neutral with $\gamma_e w = .001$, unions are risk averse with $\gamma_u w = 2$, and $w_u - w_e = .032$. In this example, the approximation $P \approx .5$ is very close to the true value of $P = .492$. The intuition for why risk aversion is a second-order issue is that the parties are arguing over wage increases that are small relative to the base wage.

Of course, it is possible that the parties do not have CARA utility functions or that the union's risk-aversion parameter is very large relative to the employer's. In such cases, the equilibrium win rate could diverge further from 50%. It is also possible that wages are not the only outcome the parties care about. For example, Mas (2006) finds that in the months after New Jersey police officers lose in arbitration, arrest rates, sentence lengths, and crime reports rise relative to when they win. The declines are larger the further the awarded wage is from the union's final offer. These findings suggest that employers should factor in this extra outcome when formulating their final wage offer. It would also help to explain why the win rate differs from the fifty-fifty split predicted by the model. One other reason the win rate could differ from 50% initially is that unions start with more accurate signals about the distribution of w_a . This system of private information fits naturally in a model with agents as information providers but could also be included in a model with agents as advocates.

V. Conclusion

Our study of a carefully structured arbitration system suggests that agents play an important role and that the parties do respond, albeit over several years, to strategic incentives to alter their behavior. First, a simple structural model of bargaining that separates the arbitrator's behavior from the strategic interaction of the parties is consistent with the data. Second, the empirical evidence is strong that the parties face incentives to employ costly third-party agents to improve their outcomes. In a simple model we show that if the parties have dominant strategies, the demand for an agent by one party is independent of the other party's behavior. This implication of the model for the behavior of the parties is easily tested, and our data are consistent with it.

We also show that for many of the bargaining pairs, the structure of the payoff matrix they face in each bargaining round is much like that in the classical prisoner's dilemma: the benefits to the parties dissipate if both retain agents. As is well known (see Kreps, 1991, for example), when there is repeated play, the parties may arrive at cooperative arrangements despite the existence of a prisoner's dilemma payoff matrix in each round of bargaining. When the system began, the parties did not always retain agents, even when it would have been in their unilateral interest to do so. The data also suggest that when agents were retained in the early period, it was primarily by unions, which in turn enjoyed higher-than-predicted win rates as a result. These patterns are consistent with a model of learning, where employers in particular learned about the benefits of agent use early in the system's history. By the end of our sample, the parties had approached the point where agents were being employed nearly universally, despite the evidence that when both parties employ agents, they do not influence outcomes.

A key question for future research is the extent to which the findings in this application are likely to be informative

in other situations of bargaining and conflict. The role of agents in conflict resolution has been the source of a great deal of recent research, and the variety of settings in which the issue arises is large.²³ One important issue is the extent to which there is heterogeneity in the long-run outcomes of different systems. Far more study of the evolution of these systems over time is needed if we are to understand how to design systems that will encourage productive bargaining and cooperative behavior in a wide variety of settings.

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²³ A particularly interesting example is Mnookin and Susskind (1999), which reports studies ranging from sports agents to diplomats.

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APPENDIX

This appendix fills in the details for section III. We first show that equations (5) and (6), together with symmetric treatment of the wage offers by the arbitrator, jointly imply that each side wins approximately 50% of the

time in equilibrium. Setting equation (5) equal to equation (6) yields $\gamma_u(e^{\gamma_e w(w_u - w_e)} - 1) / \gamma_e(e^{\gamma_u w(w_u - w_e)} - 1) = P / 1 - P$. Since $e^x \approx 1 + x$ for small values of x , this equation implies each side wins approximately 50% of the time in equilibrium. As described in section VC, this approximation is fairly accurate in the current setting.

We now show how to derive the expressions for the final wage offers in equations (7) and (8). Noting that P is a standard normal distribution and substituting $P \approx .5$ into equations (5) and (6) yields $(\varphi(0) / \sigma + \gamma_e w) e^{\gamma_e w_e w} \approx (\varphi(0) / \sigma) e^{\gamma_e w_e w}$ and $(\varphi(0) / \sigma + \gamma_u w) e^{-\gamma_u w_u w} \approx (\varphi(0) / \sigma) e^{-\gamma_u w_u w}$, where $\varphi(0)$ is the normal pdf evaluated at 0. Taking logs of both sides of these two expressions and noting that $\ln(1 + x) \approx x$ for small values of x , both equations yield $w_u - w_e \approx \sigma / \varphi(0)$, and therefore $w_e \approx .5(w_e + w_u) - \sigma / 2\varphi(0)$ and $w_u \approx .5(w_e + w_u) + \sigma / 2\varphi(0)$. The approximation is fairly accurate, since σ is small (.0083 in the empirical work). Since $P \approx .5$, it follows that $\Phi^{-1}(P) \approx 0$, which implies the average of the wage offers, $.5(w_e + w_u)$, equals $\mu - \alpha_e L_e + \alpha_u L_u$ in equilibrium. Substitution yields equations (7) and (8).

Finally, we show how to arrive at equations (9) and (10). Since utility functions are invariant with respect to positive affine transformations, it is convenient to first normalize the utility functions so that $U^*(L_e, L_u) = 1 / (\gamma_e w) + (1 / (\gamma_e w e^{\gamma_e w(1+\mu)})) U(L_e, L_u)$ and $V^*(L_e, L_u) = 1 / (\gamma_u w) + (1 / (\gamma_u w e^{-\gamma_u w(1+\mu)})) V(L_e, L_u)$.

Substituting these normalized utility functions into expressions for expected utility and using the approximation $e^x \approx 1 + x$ for small values of x yields equations (9) and (10) after some algebra. The final approximation is fairly accurate, since the net effect of agent use by the parties after subtracting the relevant cost is a small fraction of the wage bill and σ is small.